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The Proceedings of the

23rd Annual International Conference on Digital Government Research (DGO2022)

Intelligent Technologies, Governments and Citizens

June 15-17, 2022

Virtual Conference Platforms: Zoom and Discord

Loni Hagen, Mihkel Solvak, Sungsoo Hwang, Editors



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VALERIE GREGG INTERNATIONAL STUDENT FUND



The Board of the Digital Government Society inaugurated the Valerie Gregg International Student Fund (the Fund) to honor Valerie Gregg's commitment to building a sustainable digital government research community. As an NSF program manager for digital government, Valerie worked tirelessly to build bridges across disciplines, professions, and cultures. The Fund, seeded with a bequest from her estate, is dedicated to Valerie's special interest in supporting doctoral students as they embark on their research careers.

To continue her legacy and honor her dedication, the DGS is seeking personal and institutional contributions to the Fund on an ongoing basis for the purpose of funding the participation of doctoral students in the Doctoral Colloquium at the International Conference on Digital Government Research.

To contribute to the Fund, please contact Mila Gasco <mgasco@albany.edu>, Treasurer of the Digital Government Society. Further information about the Valerie Gregg International Student Fund can be found at https://dgsociety.org/awards/#ValGregg.

DIGITAL GOVERNMENT SOCIETY PRESIDENT WELCOME LETTER

Dear Digital Government Members, Practitioners, Scholars and Partners,

Welcome to the 23rd International Digital Government Research Conference dg.o 2022, held again as a virtual conference! A virtual conference enables easy participation from all around the globe, although efforts might be required as this is nighttime for some.

The conference theme this year, “Intelligent Technologies, Governments and Citizens” reflects the core of the Digital Government Society (DGS). New technologies are emerging, influencing governments and their constituents. This is also reflected in the conference organizations in which intelligence technologies are used to ensure engagement between conference participants and digital government society members. Specifically, the poster session which could be viewed in virtual reality using a headset.

Although the pandemic is ebbing away, we decided to have another online conference. We have learned from last year’s experiences and have designed this year a program that includes synchronous and asynchronous communication and interactions and using a mix of media. The conference program focused on mutual learning and engagement among the participants coming from all over the world.

The conference chairs, program chairs, program chairs, poster chairs, doctoral colloquium chairs and program committee has, once again, prepared an attractive program including workshops, keynotes, paper presentations, panels and posters. The variety of views and topics will likely result in discussion and new insights to advance our research. Thanks to the conference organizing teams, the track chairs, PC members for all the hard work and care that you have all placed into planning and getting ready the digital architecture to host the conference. I want to express my gratitude to the Program Chairs Loni Hagen, University of South Florida, Mihkel Solvak, Tartu University, Estonia and Sungsoo Hwang, Yeungnam University, South Korea, for creating such an interactive and inspiring program.

I would like to thank our conference organization team for the extensive time and dedicated effort invested in this event to make it a reality for all of us. I want to acknowledge them all without mentioning all the dozens of names here. Sincerely thank all the chairs of the different committees of the conference for their tireless efforts and countless hours. Having meetings with worldwide participation results in having persons for whom it is very early in the morning, late in the evening or even midnight. This is the charm of a worldwide organization but also requires substantial efforts and dedication from the organizational team. Also, thanks to the student volunteer for managing all the sessions in such a smooth way. Finally, I would like to thank all our sponsors for their continued support of the different awards and activities of the conference.

On behalf of my colleagues both officers and members of the board of the Digital Government Society, I hope you will enjoy our online dg.o 2022!!

Sincerely,

Marijn Janssen, President of the Digital Government Society (2022-2023)

CONFERENCE CHAIRS WELCOME LETTER

Dear Conference Participants and DGS members,

Welcome to dg.o 2022, the 23rd Annual International Conference on Digital Government Research. The theme is “Intelligent Technologies, Governments and Citizens”. Data and computational algorithms make systems smarter, but should result in smarter government and citizens. Intelligence and smartness affect all kinds of public values - such as fairness, inclusion, equity, transparency, privacy, security, trust, etc., and is not well-understood. These technologies provide immense opportunities and should be used in the light of public values. Society and technology co-evolve and we are looking for new ways to balance between them. Specifically, the conference aims to advance research and practice in this field

The keynotes, presentations, posters and workshops show that the conference theme is very well-chosen and more actual than ever. The challenges posed by new technology have underscored the need to grasp the potential. Digital government brings into focus the realization of public values to improve our society at all levels of government. The conference again shows the importance of the digital government society, which brings together scholars in this field. Dg.o 2022 is fully online and enables to connect to scholars and practitioners around the globe and facilitate global conversations and exchanges via the use of digital technologies. This conference is primarily a live conference for full engagement, keynotes, presentations of research papers, workshops, panels and posters and provides engaging exchange throughout the entire duration of the conference.

We thank you for your valuable contribution to the excellent offering of the conference including keynotes, panels, paper sessions, posters, workshop, and tutorials. We are also grateful for paper and poster authors for their production of video presentations to share their work. Your contributions constitute the essence of the conference theme -- a digital government community working collaboratively to create public values via the study of digital innovations.

We are thankful for the program chairs and track chairs for their dedication to the success of the conference. Professors Loni Hagen, Mihkel Solvak and Sungsoo Hwang have developed a great conference program with an ACM proceeding. We would like to thank Catherine L. Dumas, Simmons University, USA and David Valle-Cruz, Universidad Autónoma del Estado de México for making the poster session a success. Moreover, we thank track/panel/workshop/tutorial/poster chairs for their excellent work in developing the state-of-the-art content for our community.

We thank the conference organization team for their dedication and effort to make a fully online conference a success. In particular, Dr. Loni Hagen from the University of South Florida, who was instrumental in making this conference a success. The virtual conference organization team is supported by student volunteers who are essential for success. The support of the Digital Government Society board also has our gratitude.

Welcome and please enjoy the conference to celebrate our incredible digital government community. We look forward to your participation in plenary, keynote, panel, workshop, tutorial, paper, poster sessions, and networking events. Moreover, your participation in the online platform will further enrich knowledge sharing and collaboration among our digital government colleagues.

The Conference Co-Chairs

Marijn Janssen, Delft University of Technology, the Netherlands

Robert Krimmer, Tartu University, Estonia

PROGRAM CHAIRS WELCOME LETTER

Dear Colleagues,

Welcome to the 23rd Annual International Conference on Digital Government Research!

The conference theme is “Intelligent Technologies, Governments and Citizens” and features a variety of rigorous research presentations. Out of 93 submissions, 51 papers, 2 interactive panel sessions, 3 workshops, and 16 posters were accepted to be presented at the conference. The program also includes keynote speeches in plenary panels by prestigious practitioners in the field of digital government.

The conference program was made possible by the support and commitment of the program committee members. A total of 113 program committee members and voluntary reviewers provided 192 high-quality and comprehensive peer reviews for the submissions. Papers were vetted and selected through a rigorous academic review process. Track chairs and members of the program committee all worked hard to ensure a successful conference. We thank all who have been part of this effort. Special thanks go to the organizing committee, program committee members, and Ph.D. volunteers who generously devoted their time to prepare this conference. Also, special thanks go to Matias Casas and Lilith Holland from University of South Florida and Dylan Parker, the webmaster, for your support throughout the process.

We hope you find the dg.o 2022 conference stimulating and rewarding, and each of you can find useful information to bring back to your professional settings. We believe that together we will ensure the success of the dg.o 2022 conference and future ones.

Best Regards,

Program Co-Chairs

Loni Hagen, University of South Florida, USA

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KEYNOTE SPEAKER 1

Blockchain, its Applications: the Past, the Present and the Future Possibilities and Challenges for Governments

(June 15, 2021)

Olivier Rikken – Ledger Leopold

Abstract

Blockchain, although often predominately associated with cryptocurrencies, can be seen as a core technology that entails many more application possibilities. Smart Contract Applications, Evidence and Provenance Uses and Decentralized Autonomous Organizations can offer many opportunities for both Industry as well as Governments, but (large scale) implementations also run into various challenges. During this keynote, Olivier Rikken will go over the core technology, its possible applications and various examples of implementations and challenges faced during implementation and challenges for future growth and applications in the Government Sector.

Biography

Olivier Rikken MSc MBA is an often asked keynote speaker on blockchain, Smart Contracts and Decentralized Autonomous Organizations (DAOs). Throughout his career he worked in various industries, always in roles responsible for both business strategy and reorganization/process improvement on the one hand and IT development on the other. He advises various companies and blockchain start-ups and is very actively involved in the Dutch Blockchain Coalition, the ISO world standardization group on blockchain, is affiliated to Delft University of Technology where he researches the Governance of DAOs and teaches at various universities worldwide as (guest) lecturer. With Ledger Leopard, he builds and implements various blockchain solutions in industries and governments. Besides that, he is Board Member of the 2token foundation, researching the regulatory side and possibilities and challenges of tokenization. Finally he chairs the EuroStableCoin workgroup in the Netherlands.

KEYNOTE SPEAKER 2

Data protection is innocent! Why can't we really have data for our AI?

(June 17, 2021)

Dan Bogdanov, PhD – Chief Scientific Officer at Cybernetica

Abstract

Data protection regulation often gets blamed for stifling innovation. This is a bit unfair, as even when we manage to solve the protection of actual data with, e.g., privacy enhancing technologies, other things can still prevent our cool AI application from happening. Is the data really there? Who should cover the cost of bringing it into use? Or, most importantly, should we even be building this application? I'll illustrate these topics with three stories of intriguing government data analysis projects where the privacy problems were solved, but other problems turned out to be the blockers.

Biography

Dr. Dan Bogdanov met his first significant privacy challenges while working with the data collection systems of the Estonian Genome Foundation. This pain inspired him to start researching cryptographic solutions for privacy problems. He is the inventor of Sharemind, a secure multi-party computation system for collecting, sharing and processing private data. Sharemind is a new kind of computer that analyses digital data without seeing the individual values. This achieves beyond-the-state-of-the-art data protection, as has been demonstrated in various applications processing tax, education, genomic and financial data. He has a deep and practical experience in understanding the power of data along with the importance of individual and corporate privacy, governmental data security and integrity. He is now working on digital identities as the Chief Scientific Officer at Cybernetica.

DG.O 2023: Building Safe and Secure Cross-border Digital Public Services

The Digital Government Society (DGS) will hold the 24th Annual International Conference on Digital Government Research – dg.o 2023 – in Tartu, Estonia, with a special focus on building safe and secure cross-border services. The conference main organizer is the ERA Chair of e-governance and digital public services, Center for IT Impact Studies (CITIS) in the Johan Skytte Institute of Political Studies at the University of Tartu.

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Communication between Citizens and Public Organizations as a means of Public Value Co-creation.

Foteini, Vagena
Department of Computer and Systems Sciences,
Stockholm University
fotvagen@gmail.com

Eriks, Sneiders
Department of Computer and Systems Sciences,
Stockholm University
eriks@dsv.su.se

ABSTRACT

ICT mediated online or offline communication can lead to public value co-creation if citizens' input is taken into account by the government to improve its services. Since existing studies have looked into the co-creation process holistically, there are calls for an in-depth understanding of the role of communication whilst offering conceptual clarity to the co-creation process. This study aims to fill these gaps by employing the grounded theory literature research, to analyse and define co-creation in terms of its properties and relationships to communication and public value concepts. The subsequent conceptual framework integrates all the identified concepts to represent co-creation as the functional relationship between the adjustable communication concepts and the public value responses, which are conceptualized as independent and dependent variables respectively. The enablers and constraints emerged through the analysis are aligned with the co-creation properties and correspond to the initial impeding or facilitating conditions of the co-creation process. The results provide a concise and clear, structured representation of the co-creation process in terms of its interacting concepts and relate the co-created public values to crisp communication properties facilitating the validation and refinement of the derived framework by further empirical research. Amidst contemporary socioeconomic challenges, this study could be used to optimize the co-creative potential of public services in terms of existing enabling - disabling conditions and public value requirements.

CCS CONCEPTS

• **Human Centered computing**; • **Social and professional topics**;

KEYWORDS

Co-creation, Communication, Public value, Collaborative intelligence

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1 INTRODUCTION

The co-creation process in the public sector, is regarded as a solution to today's multi-faceted socioeconomic challenges as it makes use of collective dynamics through open collaboration and the exchange of information, in order to align public policy with citizens needs and expectations. In this context, according to [27], co-creation is related to public value as it entails citizens collective contributions in the provision of public services. Moreover, all the co-creation theories acknowledge the role of communication mediated by ICT as an enabler of stakeholder interactions. Specifically, Public service dominant logic (PSDL) considers co-creation as the joint contribution of involved stakeholders [42], while the Service Science (SS) perspective regards the interacting entities as social service ecosystems [23]. Public Service Logic (PSL) focuses on the interacting resources between provider and citizens service logic entities [15, 29] and the Social Constructionist (SC) approach elaborates on the characteristics of social interactions to fine-tune output public value with citizens' expectations [34].

Recent studies have highlighted the role of communication in the co-creation of public value process. Specifically, [39, 40] have looked into citizens' direct feedback concerning public organisations in Rwanda and Stri-Lanka and have suggested that citizens multi-angled contribution to the evaluation of public services is valuable. To achieve co-creation and improve public services, public organizations have gradually employed ways to monitor, crowdsource and analyse citizens' input. For example, the city of Chicago has analysed citizen sourced data to develop and test a working predictive critical food safety violations model, in order to deliver proactive services to the citizens by preventing food born illness outbreaks [25]. Social media monitoring has been suggested to provide real time situational information in crisis events [28], however it is often associated with the lack of effective communication strategies [13, 16, 24]. To this front [16], have conducted a field study to test sensors as means to facilitate citizen sourcing towards data-driven decision making.

There are observed conceptual inconsistencies concerning co-creation as it is often conceptualized in continuum or interchangeably with the similar term co-production [12, 16]. Yet scholars stress the need to demarcate the two conceptually related terms [29, 45], while addressing the role of communication within the co-creation process [10, 17]. In addition, existing research has focused on the holistic overview of the co-creation process, developing a theoretical framework on the basis of actors, processes and content [40, 41]. However, the lack of specificity can hamper understanding of the communication as a factor which influences the co-creation

process and the interrelations between the co-creation elements. Therefore, there is limited research on the patterns, regularities and relationships between communication and co-creation. This study aims to address this research gap by revisiting literature in order to develop a conceptual framework that relates co-creation to communication and public value concepts, define them in terms of their properties and describes their relationships and functions.

2 THEORETICAL BACKGROUND – CO-CREATION OF PUBLIC VALUE THEORY

Essentially, co-creation implies the involvement of different actors working together as active operant resources to determine and create value [15, 43]. Although the co-creation concept was developed within the marketing field, its service dominant logic principles can also relate to the public administration. Hence, according to PSDL, the public services constitute the prime unit of exchange and the tangible operand resources are considered transmitters of the knowledge, skills or services used by citizens in the process of value creation [42, 43]. Hence, public value is co-created by the joint contribution of the public service providers and citizens. Based on this notion, the SS approach considers the formation of different dynamic service ecosystems consisting of people, technology and organizations whose interactions co-create value by integrating their resources [23]. The PSL is based on the principles of PSDL but perceives citizens and government as different service logic entities combining each other's value propositions and claims with their own resources. Co-creation is achieved through the mutual interactions between these service logic entities so as to equate the value-in-use- to the value propositions [15]. The SC considers the co-creation of value in social context which emerges naturally through the interactions of the different stakeholders in order to build relational social systems [34].

2.1 Co-creation – Co-production

The notion of public value as coined by [27], also relates to the concept of co-production which is often used interchangeably with co-creation in the relevant literature. Although the terms present basic similarity in the citizen involvement required to achieve the output public value, scholars have pointed out several differences. Co-production is reportedly a linear logic process owing to the dominant role of the government [29], as opposed to the dynamic and unpredictable co-creation process [9, 35]. Consequently, co-production is associated with the GDL and the implementation stage of public services. Moreover, the citizens' involvement in co-production has been perceived by scholars as unavoidable and a conscious add-on of the service delivery process whereas ambiguity exists over the conceptual position of service evaluation.

On the other hand, co-creation falls under the service dominant logic conceptual framework which stands for the improvement and development of public services on the basis of citizens' needs and expectations, thus enhancing democracy and outcome public values. In this vein, co-creation assumes reconfiguration of the traditional top-down hierarchy as it entails citizens' value propositions and resource integration considering citizens as active partners rather than passive service receivers. In fact, literature reports that co-creation involves the conception of public services at a strategic level implying that the citizens are the initiators and co-designers of the public services whereas the government's role is to provide administrative and expert support on the process [4, 44].

2.2 Communication and the use of ICT

Following the SDL paradigm, stakeholder interactions are regarded as operant resources in the co-creation process which according to [43] produce effects enabling the amplification of value by creating additional operant resources. ICT and innovative smart technologies are considered operand resources which facilitate the exchange of operant resources and the co-creation of public value.

Government communication functions range from information dissemination to citizen consultation, to finally reach citizen active participation and engagement in public discourse. This variation of communication functions corresponds to the gradual increase of the level of citizens interactions and the e-government evolution.

In this context, one-way communication involves the creation of open government portals and websites to increase citizens' awareness, while two-way communication implies bilateral communication and web2.0 services focused on persuading the citizens to accept the government policies and assuming the gradual horizontal and vertical integration of government institutions. Multilateral communication flow builds on the organisational integration to promote democratic processes towards citizens' active participation in decision making.

Digital platforms can encourage highest levels of government or citizen led communication opting for multilateral discussions or stakeholder competition according to their type and degree of openness. In this context, public organisations can use popular commercial platforms (Facebook, Twitter) to combine social and business affordances while encouraging participation diversity which is seen as an important factor for comprehensive problem solving. Conversely, government-initiated platforms can be employed to promote focused public discourse and co-created service provision.

Stakeholders' interactions can be encouraged and analysed by means of various support tools and platform extensions developed with natural language processing and artificial intelligence technology. For example, community trends as captured by sentiment analysis tools can be taken into account in policy planning and decision making, thus promoting transparency.

3 RESEARCH METHODOLOGY

The grounded theory was the selected research strategy as it enables the inductive generation of theory providing insights on areas in need of further scholarly attention. Three fundamental principles guide this research as suggested by [14]: Emergence of theory from contextual data alienated from any predetermined ideas of the researcher, constant comparison of the emerged knowledge to reveal concepts (including core-concepts) their properties and relationships, and theoretical sampling of emerged data directing the exploration and analysis of new data until the point of saturation where no additional concepts can emerge. Grounded theory was informed by literature review for data collection by means of five systematic and iterative stages as suggested by [46] in order ensure rigour in concept-centric data analysis and knowledge building. The method was performed as follows: **Definition stage** where

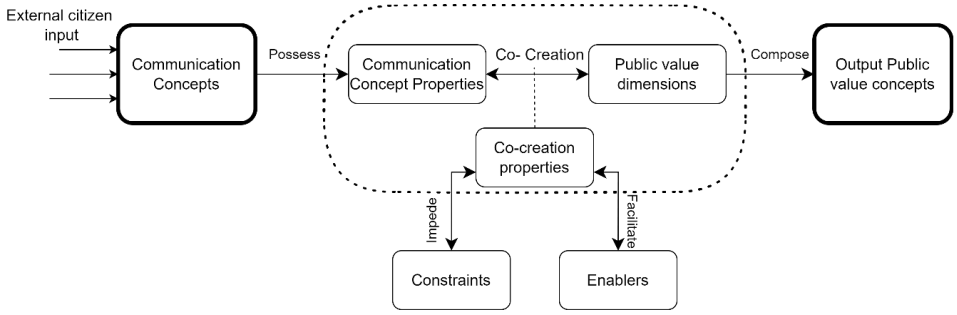


Figure 1: Ontology of the co-creation process

criteria were set according to the scope of the study. The sampling criteria included all types of English language peer reviewed articles (conference, journal, book chapters). Preference criterion was set for the most recent and relevant publications ranging from 2015. The starting year was chosen to capture the application of the formative stages of e-government evolution. The literature sample was sourced from the fields of Information Systems, E-government, Public administration, Public management as these fields relate to the scope of the study. Data sources criteria included two electronic data bases namely, Scopus and Google Scholar as their wide accessibility allows replicable search results. The following search queries were used to align the breadth and relevancy of the search to the scope of the study.

- ("Public value" OR "e-government") AND "co-creation" AND ("communication" OR "interaction")
- ("Public value co-creation") AND "e-government" AND ("social media")
- ("Public value" AND "communication channels") AND ("co-creation") AND ("e-government" OR "social media")

Search The articles were considered in terms of containing the search terms in their title or abstract. The first two queries returned a limited amount of hits, so the third query was put forward to widen the search while adjusting its relevancy. In total, the three search queries yielded 317 unrefined hits. **Selection stage** Literature search results were cleaned from duplicates and inaccessible papers. Selection of the final 31 papers was based on the relevancy of the article contents to the aim and research questions of the study. Different types of research were included in the literature sample to enable evidenced understanding and multi-angled conceptual interrelations. **Analyse** Open coding involved the generation of all the concepts used in the study. Axial coding involved the identification of concept relationships and further concept categorization by identifying their properties. Selective coding involved concept refinement into two core-concepts "communication" and "public values", their overlapping conceptual property (co-creation) and the identification of enablers and constraints further categorized in terms of their nature (technical- social). A qualitative software (Atlas.ti) was used for the coding analysis, assisting in the elimination of conceptual inconsistencies by means of tabular and visual coding maps. Finally, the theoretical framework emerged during this stage by assembling all concepts into a diagram that explains co-creation process. P**resentation,** which involves the display of the key findings and recommendations based on the theoretical sorting of the results.

4 RESULTS

Analysis of the 31 literature papers resulted in an informal ontological model which indicates the main co-creation features as depicted in figure 1. The rounded rectangles represent the elicited concepts, and the highlighted ones represent identified the core-concepts. The arrow lines represent the relationships which emerged through the relational statements found in the literature.

The communication concepts and the public value concepts were identified as the co-creation core-concepts due to their indispensable input and output roles in the co-creation process. They are described in sections 4.1 and 4.2 respectively. The communication concepts possess intrinsic properties described in table 2, while the public value concepts are composite concepts consisting of combinations of public value dimensions summarized in table 4. The manifestations of mutual co-creation properties between specific communication concepts and public value dimensions indicate interactions which determine the co-creation process mechanism. These co-creation links are summarized in section 4.5 in respect to the input communication concepts and output public values. The dashed line marks the interactions within the internal co-creation process context. The enablers and constraints represent the existing state and capabilities of the co-creation process in terms of their interactions with its properties and are described in section 4.6. This ontology model was converted into a UML conceptual framework which is explained in detail in section 4.4.

4.1 Communication concepts

Communication concepts (core-concept): are the higher order entities identified through selective sorting which represent the means of getting involved in co-creation as instantiated by their different properties.

Further details of the communication concept properties are given in table 1

The communication concepts shown in table 1 are explained as follows. **Complaints:** Their purpose is assumed as informative as they are ways used by the citizens to reprort issues concerning their experience with public services, hoping for future changes and service improvements [18, 40]. Moreover, [25] attest cases of

Table 1: Summary of communication concepts and their properties

Communication concepts					
	Complaints	Q&A	Deliberation (forums)	Polls/ voting/ petitions	Consultation/ feedback
Initiation	C2G	C2G	C2G, G2C	G2C, C2G	G2C
Direction	One way	2way/One way C2C & C2G	multilateral	One way	2 way
Timeliness	Asynchronous	Asynchronous/ real time	Asynchronous/real time	Asynchronous	Asynchronous/real time
Directness	Direct	Direct/indirect	Direct	Direct	Direct/ indirect
Style	Formal/informal	Formal/ informal	Formal/ informal	Formal	Formal/informal
Mode	Online/offline	Online/ offline	Online/ offline	Online/offline	Online/offline
Content	Predictive informative	Informative prescriptive	Informative Supportive	Prescriptive Informative	Informative
Citations	[2, 18, 25, 40]	[2, 21, 40]	[2, 12, 18, 20, 22, 28, 30, 35]	[18, 22, 36, 40]	[2, 12, 18, 33, 40]

using complaints to optimize public service provision. Complaints are initiated online or offline by the citizens [2, 40].

Q&A: These are reciprocal interactions to citizen initiated questions about any related government matter within their interest such as policies or services [2]. Citizens' questions can be answered instantly or in due course in case the response of appropriate department(s) [40]. In either case, the process can involve human-to-human online or offline interaction, chatbot or precomposed FAQ. Q&A can constitute an informal or formal process of informing citizens and in the latter case literature attests that its purpose can be prescriptive [2, 21]. **Forums:** Forums provide the common shared space for multilateral stakeholders' interactions. They can have service (participatory budgeting) or social oriented content and can provide informational and emotional support to involved citizens [2, 18]. In addition to online platforms, living labs and workshops can be considered offline meeting places which, in this case, require synchronous communication. **Polls/ voting/ petitions:** These are opinion expressing interactions initiated either by the governmnet (polls) or by the citizens (petitions), which aim to influence governmnet policies and political decision making. As such, they constitute unidirectional interactions whose effect is based on participation quantity and the collective dynamics generated. They can take place offline however, literaure attests that olnine communication capabilities can facilitate participation due to the ease of use and the reduced costs [18], however, in both cases security measures have to ensure the confidentiality and appropriacy of citizens' input [36]. In addition to providing the government with citizens' information their role is also prescriptive in the case of elections or any other official ballot referendum [40]. **Consultation/ feedback:** Two-way government-initiated interactions entailing the citizens consultation in order to improve service provision. Feedback can be crowdsourced through social media communication [2, 12], however, IoT technology can be employed to obtain real-time citizen feedback [16]. Moreover, offline feedback can be obtained with the use of real-life surveys. In any case the purpose is to obtain citizens evaluation information which could add value to public services [33, 40]. Table 2 below, gives a description of the communication concept properties grounded in selected literature:

4.2 Public value concepts and their dimensions

In order to describe the multifaceted nature of public value concepts, they were reflected as collections of public value dimensions documented within the literature as "the different claims for public value creation" [17]. These public value dimensions are summarized in table 3

Consequently, the elicited public value concepts representing the citizens expectations concerning the provision of public service according to [27], were described in terms of their contributing public value dimensions. Table 4, summarizes and relates the identified public value concepts to their contributing public value dimensions as reported within the literature.

4.3 Co-creation properties

The co-creation properties, which emerged through theoretical sorting, describe the main perceived characteristics of co-creation which affect its actualization for the different communication concepts. The properties can explain how the communication and public value concepts interact and change through the co-creation process.

4.3.1 Process dynamics. Co-creation is described as a dynamic process [29, 30]; therefore, its properties can offer more in depth understanding about the co-creation dynamic effects.

Table 2: Descriptions of the communication concept properties.

Citations	Description of the communication concept properties
[2, 5, 21, 28, 30]	Initiation: C2G indicates bottom up unsolicited citizen communication which can increase the government listening skills [2, 5, 28]. G2C initiated communication which is reached by people in need of specific information [30].
[35]	Direction: This property denotes the direction of communication flow and can be one way, bilateral or multilateral involving interactions among all involved stakeholders [35]
[7, 33]	Timeliness: Denoting synchronous or asynchronous communication responses and is related to the quality of the output services [7]
[3]	Directness: Direct communication is defined as the absence of automatic communication practices (human-to-human interactions) [3]
[28]	Style: This property is distinguished in formal oral or written communication (based on legal or technical institutional provisions or informal content interactions involving socially oriented conversations and variety of communication methods (videos, storytelling) [28]
[2, 33]	Mode: Online virtual or offline physical interactions pertaining short term loosely coupled or long term citizen-to government relationships respectively [2, 33]
[2, 24]	Content: Informative content involving the exchange of information, knowledge and experiences [2, 12]. Prescriptive: Interactions suggesting legally binding or mandatory action [28] Supportive/emotional: Generated to offer emotional support, it can assist the establishment of relationship between the citizens and the public organizations [24]

Table 3: Descriptions of public value dimensions

Citations	Description of Public value dimensions
[2, 17]	Social (Community) public value: Denotes the social cohesion achieved by social interactions towards common goals [17] As reported in literature, the sense of belonging can enhance the citizen engagement in community public value creation [2].
[12, 31, 32]	Democratic public value: This dimension refers to citizens right to participate in public discourse and collective decision making. [12]. It relies on inclusive interaction strategies and broad citizen participation [31, 32]
[7, 38]	Citizens' satisfaction – service effectiveness: This dimension refers to the compatibility of the public service delivery to citizens' needs and expectations, resulting in citizens' satisfaction [7]. It is related to the quality of public services as perceived by the citizens
[3, 7, 22]	Legitimacy public value: Refers to the feeling of acceptance and respect of government processes which is related to the alleviation of information asymmetries and the government accountability and transparency.
[1, 7, 32, 35]	Service delivery quality: This dimension is defined as the comparison of perceived service performance in respect to perceived citizens' expectations. It is related to the perceived ease of use and usage behaviour of services [7] as well as to communication characteristics such as timeliness [1, 32, 35]
[30, 35]	Service efficiency: It denotes the ability to deliver the expected public services with minimal resource waste [30]. The lean government principles are reportedly related to service efficiency [35]
[2, 12, 26]	Financial performance: This dimension signifies the resources used to generate public value and it has been compared to sharehorder value by Moore (1995). Although the primary concern for financial assets was criticized in respect to the co-creation process, the fact that communication can contribute to financial performance by reducing coordination and transaction costs was generally acknowledged [2, 12, 26]
[3, 33]	Citizen empowerment: It is defined as the encouragement of citizens to participate in decision making co-creation activities and assumes the delegation of power to the citizens
[11, 12]	Organizational outcomes: This dimension implies the transformation of public organizational structure in order to improve service provision, strengthen democratic processes and increase citizens' appreciation

Amplification: Co-creation process is characterized by the amplification of outcome public value owing to the network effect and the growing number of network users. To this front, Intelligent Information technology can enhance the network effect by facilitating stakeholder interactions and improving the public service accessibility and delivery quality [2, 36].

Unpredictability: The unpredictability of the co-creation process is the dynamic yet balancing effect of the desired diversity of citizens input which may involve conflicting citizen input [11, 17, 35]. As pointed out by [3], the output value-in use is uniquely formulated according to the communication context.

Table 4: Summary of public value concepts in terms of their contributing public value dimensions.

Citations	Public value concepts	Contributing dimensions
[7, 12, 22, 33, 37]	Accountability – Transparency: Citizen's expectations which co-creation initiatives can help satisfy by means of communication	Legitimacy: Achieve public acceptance and attenuate corruption through openness Citizens' satisfaction – service effectiveness: Tailoring services to citizens' needs Citizen empowerment: Empowering citizens can increase accountability and trust in government actions Organizational outcome: Organisational transformation leads to openness and transparency
[3, 18, 19, 30, 32, 38]	Sustainability: The resilience of co-creation processes over time assisted with the use of communication.	Community (social value): Socially just and ethical values can strengthen social coherency and establish long-term G2C relationships. Efficiency: Optimum resource allocation and collective intelligence through co-creation can support sustainable governance in tackling complex socioeconomical challenges Financial performance: The economic value can contribute to sustainability as it denotes economic health and long-term economic capacity of a public organization.
[6, 11, 26, 30, 36]	Innovation: The development of solutions and services based on new original ideas in order to benefit citizens engage them in co-creation initiatives and improve service quality.	Organizational outcomes: Contributes to innovation by restructuring the public services both in terms of technology and culture Citizens' satisfaction – service effectiveness: Innovation can facilitate the understanding of citizens' needs Service delivery quality: Innovation can result from new forms of public service delivery which can create yet more innovation.
[3, 30, 32, 35, 41]	Collaboration: Signifies the flawless communication across internal and external organizational boundaries and among all involved stakeholders.	Citizens' empowerment: The provision of tools and mechanisms to enable communication and collaboration Organizational outcomes: Assumes the organizational changes and stakeholder roles to achieve collaboration Community (social) value: Collaboration is related to community value in solving common problems and achieving community goals.
[11, 17, 24, 31, 41]	Equity – Inclusion: The promotion of social justice and fairness by addressing the variety and diversity of citizen's needs	Citizen satisfaction – service effectiveness: Including the widest possible range of citizens denotes more accurate representation of citizens' needs hence the co-created public value leads to more effective services Democratic values: These relate to the democratic quality of the co-creation process by providing appropriate participation opportunities to citizens according to their situation and needs.

4.3.2 Citizen centricity. This perspective bases the decision-making process on citizens collective intelligence such as crowd-sourcing, regarding citizens as partners rather that clients [3, 26].

Permanence: Literature attests that the permanent availability of communication concept instantiations (like forums) denotes the political predisposition towards a citizen-centric governance model and the willingness of the government to align decision making with citizens' opinions [33, 35]. The consequent continuity of stakeholdders' active involvement in co-creation could account for the success of the co-creation process as noted by [3].

Heterogeneity: Heterogeneity indicates the diversity of the stakeholders involved in the co-creation process which relates to the effectiveness of the co-creation process as the citizens' input reflects the variety and complexity of real life societal systems [11, 16]. Social oriented platforms favour heterogeneity according to [24].

4.3.3 Active participation and engagement. Literature suggests that the co-creation process is based on the citizens' active participation for shaping public policies and services [30, 33]. Therefore, it is considered as an important factor for the success of the co-creation process.

Participation frequency: This co-creation property refers to the citizens iterative interactions with the government indicating effective communication of citizens' needs and improved citizen satisfaction [24, 30].

Participation Volume: The quantity of citizens input indicates the significant issues to direct the co-creation activities [40]. Typically, platforms can facilitate the concentration of large citizen numbers of interacting citizens adding value to the output service provided [26].

4.4 The co-creation conceptual model

The results of the theoretical sorting were consolidated in a conceptual co-creation model shown in figure 2. UML was the preferred

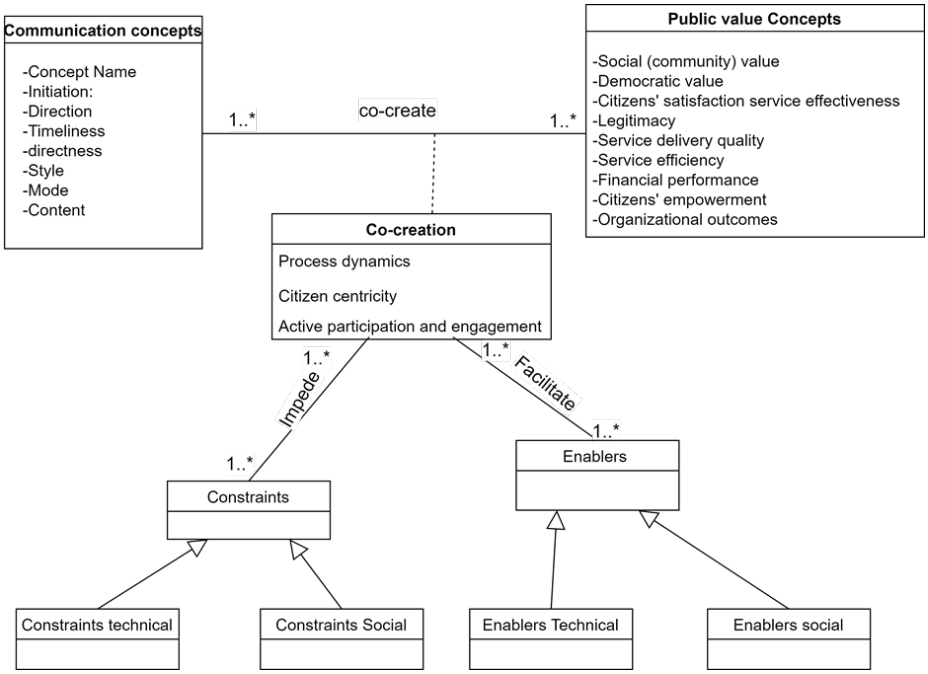


Figure 2: Co-creation conceptual model

modelling language as the emerged concepts, their variations and associations can be represented concisely and accurately.

The communication and public value concepts were represented as classes and instantiated by their different property combinations. Co-creation was identified as a conceptual overlap of the communication and public value concepts and owing to its dynamic nature, it was modelled as an association of the two core concepts, defined by its association class attributes. The enablers and constraints were integrated in the framework as classes directly connected to the co-creation association class each containing social and technical category sub-classes.

4.5 Co-creation links

Based on the derived conceptual framework in figure 1, the communication concepts are associated with the coded "Public value concepts" such that one communication concept can contribute to one or more public value dimensions. This association of the two classes which represents the shared interactions among their attributes is conceptualized as the co-creation of public value. The following table 5, summarizes the analysis results, thus demonstrating the indirect communication to public value concept property co-creation interactions. As it can be seen, there is a different variation of the interacting communication concept properties for each public value concept. It can therefore be assumed that as these property variations indicate interactions with the corresponding public value concepts, the communication concepts whose properties match these variations can offer important contributions to the co-creation of the respective public values.

Transparency and accountability are based on openness which in turn depends on citizens' empowerment to actively engage in communication with the government. Hence [11, 32, 35] multilateral and bidirectional communication help overcome accountability challenges and establish transparency. Also, increased citizen's satisfaction is related to short service delivery processes due to its immediate interaction effects [30], and to online communication as it facilitates accessibility [7]. Indirect communication can reduce response times while supporting data-driven decision making contributing to legitimacy and transparency [16]. Moreover, informative and supportive communication content can alleviate information asymmetries and establish a shared set of values with the citizens, leading to trust and legitimacy [3, 22], whereas formal personalized recommendations can improve service effectiveness [12, 18].

Sustainability relates to community value in aligning to dynamic interaction of digital ecosystems through multilateral communication [22]. Multilateral C2C communication can increase service efficiency in providing an alternative way to alleviate some government's workload [2]. Also, timely responses can improve the process performance and service efficiency by providing services at the right time [31]. Online communication relates to resource conservation while indirect communication contributes to sustainable economic growth [7, 26]. Collective intelligence is considered a sustainable practice for the mitigation of future and present challenges [36]

Innovation is related to improved citizens' satisfaction through collective citizens' information input [2, 26]. Online citizens' communication can promote service delivery quality by reducing service times and enabling multidirectional communication internally

Table 5: Public value concept relationships to communication concepts through their interacting properties

Public value concept	Public value dimensions	Interacting Communication concept property values	Communication concepts
Accountability- Transparency	Citizens' Satisfaction- Service effectiveness Legitimacy Citizens' Empowerment Organisational outcomes	Online, Real-time, Informative, Prescriptive, supportive, Formal, indirect, Multilateral, Bidirectional	Forums, Consultation/Feedback, Polls/Voting/Petitions, Complaints, Q&A
Sustainability	Social (community) value Service efficiency Financial performance	Multilateral, Bidirectional, Online, Real-time, Informative, Indirect	Forums, Consultation/Feedback, Q&A
Innovation	Citizens' Satisfaction – Service effectiveness Service delivery quality Organizational Outcomes	Multilateral, One-way, informative, Online, Real-time, Indirect, Citizen-initiated	Forums, complaints, Consultation/Feedback
Collaboration	Social community value Citizens' Empowerment Organizational value	Direct, Informative, Online, Multilateral, Two-way	Forums
Equity- Inclusion	Democratic value Citizens' satisfaction-Service effectiveness	Citizen-initiated, Multilateral, Online, Informative, Indirect	Forums, Complaints, Polls/Voting/Petitions, Consultation/Feedback

across fractured silos and externally throughout the involved stakeholders [2, 21]. Moreover, self-service communication can transform the traditional communication flow, service times and delivery process into an innovative citizens' experience based on improved organisational public value.

Collaboration can be nurtured by citizen's solidarity and the co-creation of community value for a common goal [20]. This way, knowledge can be co-created through multilateral, direct deliberation achieving potential negotiations among the diverse input in view of the common benefit [3]. Online communication can empower citizens to join in collaborative initiatives and increase organisational value by loosening institutional boundaries due to the facilitation of information transfer and its distanceless collaboration capabilities [3]. In this context, government's role can be shifted to a collaborative model involving citizens in decision making.

The relationship between the government and the citizens implies the citizen involvement in the decision making on equal terms granting them the right to initiate and get involved in multilateral public deliberation [35, 41]. To this front online communication can increase the level of citizens inclusion and equity by connecting dispersed populations or people with physical disabilities with the government [31]. Moreover, indirect automatic citizen interactions can adapt service provision to citizens needs increasing service effectiveness and co-creating equity [21, 40].

4.6 Enablers and constraints

Several existing preconditions can facilitate or impede the co-creation process [38]. These are identified as enablers and constraints, and are represented as abstract super classes, instantiated by the corresponding "technical" or "social" child subclasses as shown in figure 2. These identified entities which emerged through selective grounded theory coding are summarized in the following tables in terms of their effect on co-creation properties.

Blockchain technology can reportedly amplify co-creation capabilities by instilling citizens' confidence in their interactions with the government raising participation feasibility [36]. Data analytics can boost value-in-use improving government services leading to unpredictable problem-solving according to citizens' needs. Institutionalization of data analytics is a requirement for data-driven policy based on co-created public value [1]. Gamification can motivate citizens' participation [1, 18]. OGD and the digital service delivery give the opportunity to either the citizen or the government to create new resources, thus amplifying their initial value. Permanence is important for attracting citizens participation and OGD-intensive decision making [25]. Digital platforms can encourage citizens' participation and knowledge accretion by means of their design, governance model and structure [2, 16]. Moreover, they can encourage stakeholders' heterogeneity according to their architecture, implying the unpredictability of the final co-creation outcome [9, 26]. Automatic communication practices can enhance the network effect while achieving heterogeneous, community wide participation [7]. Cloud technologies can boost service efficiency by shifting legacy systems to better technological solutions reducing maintenance costs [36]. Crowdsourcing and opensourcing can create operant resources through cooperation or competition (hackathons) using the collaborative or competitional dynamics to amplify the output co-created value [3]. Multi-channel service delivery, encompassing both traditional and smart communication methods can encourage citizens' participation and heterogeneity while its amalgamation with data-driven processes can enhance interoperability within the public sector [1]. A summary of the technical enablers can be seen in table 6.

Table 6: Summary of technical enablers in terms of their interacting co-creation properties

Enablers technical	Interacting co-creation properties	Citations
Blockchain technology	Amplification, Permanence, Participation	[36]
Data analytics and validation process	Unpredictability Amplification, Permanence	[1, 13]
Gamification	Permanence, Participation (volume, frequency),	[1, 18, 30]
OGD – digital service delivery	Amplification Permanence, Participation	[3, 11, 12, 25]
Open architecture	Unpredictability, Amplification Heterogeneity, Participation (volume)	[2, 3, 9, 26, 36]
Crowdsourcing and Open sourcing	Unpredictability, Amplification Heterogeneity, Participation (volume)	[3, 9, 16, 30]
Automatic communication practices (AI, IOT)	Amplification, Permanence Unpredictability, Heterogeneity Participation	[1, 7, 16, 20, 36]
Ubiquitous services	Amplification, Permanence	[1, 36]
Hackathons	Amplification, Heterogeneity	[3, 26]
Digital platforms	Amplification, Unpredictability, Permanence, Heterogeneity Participation	[2, 11, 16, 24, 28, 36]
Multi-channel service delivery	Heterogeneity, Participation, Permanence	[1, 16]

Table 7: Summary of social enablers in terms of their interacting co-creation properties

Enablers Social	Interacting Co-creation properties	Citations
Political support	Permanence Participation	[3, 16, 17, 35]
Openness	Amplification, Unpredictability Permanence Heterogeneity Participation	[2, 3, 5, 12, 16, 25, 32, 33, 36]
Increase absorptive capacity	Amplification, Permanence	[3, 19, 32]
Public sector transformation	Amplification Permanence	[19]
Sense of belonging	Amplification Permanence, Participation	[3, 6, 18, 22, 26]
Perceived usability and usefulness	Heterogeneity, Participation	[7, 16, 30, 31]

Social enablers are summarized in table 7. Political support is required to establish permanent communication structures which would encourage citizens' participation [20, 35]. Government openness is related to inclusion and citizens' increased participation, while reconsideration of the government's role is required to take advantage of the accumulated citizen's knowledge in order to improve the public services [36]. The absorptive capacity of an organization can maximize its effectiveness depending on its permanent capability to subsume citizens' input. In this context, public sector transformation implies the integration of processes, reconsideration of roles and establishment of appropriate resources (ICT infrastructure and OGD) to achieve flawless internal and external communication leading to service efficiency and effectiveness amplification [19]. The sense of ownership can amplify community public value by working towards a common goal while stimulating participation [22]. Finally, the perceived usability and usefulness influences the citizens' attitude towards broad or heterogeneity or domain specific participation according to the aims of the co-creation project [7, 30].

As seen in table 8, literature attests that the collection and management of big citizens' data can raise privacy and security issues resulting in negative public value. These issues are related to distrust in government actions which can affect citizens' participation in co-creation initiatives [21]. The GDPR which was put forward to establish a transparent legal framework for the protection of collected citizens' data, has also received criticism on the basis of obstructing the co-creation process due to restrictions on private data usage [1, 36]. Financial, infrastructure and operational problems are related to respective inadequacies in the technological and human capital which in turns affect citizens' participation and heterogeneity potentials [9]. Also, insufficient support of co-creation initiatives due to resource deficiencies can accumulate frictions with existing regulations and social groups [36]. Inadequate data accessibility is related to insufficient network density or institutional and legal system inefficiency to reasonably adjust the provision of information to citizen's needs [31]. As a result, accessibility issues may limit the scope and participation rate of the co-creation initiatives.

A summary of the identified social constraints is presented in table 9. Misinformation can distort the co-creation process outcome

Table 8: Summary of technical constraints in terms of their interacting co-creation properties

Constraints technical	Interacting Co-creation properties	Citations
Privacy and Security issues	Amplification Permanence, Participation	[1, 7, 13, 21, 31, 36]
Financial, infrastructure and operational problems	No amplification Insufficient Heterogeneity (interoperability issues) Permanence issues Reduced participation	[1, 9, 13, 36]
Accessibility	Lack of accessible data provision, Lack of heterogeneity, Reduced Participation	[13, 20, 26, 31]

Table 9: Summary of social constraints in terms of their interacting co-creation properties

Constraints social	Interacting Co-creation properties.	Citations
Misinformation	Amplification Permanence	[2, 13, 28]
Administrative tradition – view citizens as clients	No Amplification, Outmoded policies and standards, Discouraging Participation	[1, 3, 13, 24, 28, 36, 37]
Lack of trained personnel	Dysfunctional process dynamics, Dysfunctional communication strategy, Problem clarity and choice of design, Reduced participation	[13, 16, 24, 40]
Fractured organizational silos	No networks no sharing, No permanent integration and interoperability	[13, 36, 37]
Conflicting perceptions of public value	Co-destruction of public value, Step out of the co-creation process	[17, 41]
Digital divide	No heterogeneity, Participation	[13, 16, 31]

by amplifying false information through online informal networks [2]. Viewing citizens as clients can diminish citizens' participation as they are deprived from their responsibility to respond to government's actions [3]. Moreover, adherence to outmoded government-centric policies can lead to overlooking the benefits of citizens' accumulated experience and knowledge [1]. Lack of trained personnel can result in dysfunctional co-creation process dynamics, and incoherent or misaligned communication strategies leading to reduced citizens 'participation [13]. The digital divide phenomenon has been related to accessibility and infrastructure inadequacies affecting citizens' participation and broad inclusion (heterogeneity) [31]. Fractured organizational silos can cause interoperability problems affecting permanent integration and the establishment of common standards [37]. Conflicting perceptions of value can lead to potential co-destruction of public value demotivating citizens' participation in co-creation projects [17, 41].

5 PRACTICAL APPLICATION

The practical relevance of the derived framework lies in the proposed guidelines for the implementation of co-creation strategies aligned with citizens' needs. The process can start by considering citizens' expectations, raised through analysis of the communication between the citizens and public organisations, as indicators of desired public value concepts. These are regarded as the generic co-creation objectives driven by citizens' needs. The decomposition of public values into their component dimensions (table 4) can provide a more accurate reading of citizens' expectations and their impact on the co-creation process. Next, appropriate communication concepts can be implemented by reference to table 5. Further, the organizational capacity in terms of existing enabling and constraining factors can be assessed. Depending on the co-creation scope, the effect of individual enablers and constraints on the process can vary based on the suitability of their interacting co-creation properties. For example, openness which is identified as an enabler, can be a constraint for domain-specific co-creation projects emphasizing expert opinion sharing. Conversely, the absence of an enabler can turn it into a constraint. Therefore, risk assessment methods could be employed to consider the combined enabler - constraint effect on the co-creation process, to compromise their observed interdependencies. The final step involves improving the expected co-creation performance by leveraging appropriate enabling factors while mitigating unwanted barriers.

6 DISCUSSION AND IMPLICATIONS

The analysis and derived framework, present an in-depth perspective of the way communication between citizens and public organisations contributes to the co-creation of public value. To define clear semantics for the co-creation framework, the identified theoretical sorting results were mapped into ontological concepts. Specifically, two core-concepts were identified namely; the communication concepts instantiated by their shared characteristics, and the public value concepts which were defined according to the combination of their constituent public value dimensions.

In line with the grounded theory method [8], the relationships between the core concepts were described by the interactions between their respective properties, evidenced by relevant relational statements found within the selected literature. Likewise, the facilitating or impeding influence of the enablers and constraints

was rooted in their evidenced interactions with the co-creation attributes.

Thereby, a theory incorporating the derived concepts and relationships was developed by building a conceptual framework to explain the co-creation process. For this purpose, the object-oriented UML was employed so as to represent the concept-centric grounded theory analysis codes and relationships accurately. The framework models the co-creation process as a complex sociotechnical system, depicting communication and public value concepts as the independent and dependent variables of the system respectively. Since co-creation was described in the literature as a dynamic process occurring when the communication and public value concepts are in active existence, it was modelled as an association representing the functional relationship of these core concepts. The co-creation properties were conceptualized as a set of principles which can explain the variable interactions and changes induced. The enablers and constraints were also modelled as initial conditions inflicting positive or negative impact on the co-creation process.

Based on the emerged connections of public value concepts to communication attribute variations as summarized in table, it is understood that adjusting the independent communication variables can achieve optimal public value responses according to set requirements, and possibly counteract any identified initial constraints. Further, the identified enablers and constraints and the ways they interact with the co-creation properties can offer a policy implementation reference of the co-creation potential of public organizations.

The structure of the derived framework allows continuous extension and modifications with additional concepts and properties as they may emerge from future research so as to align with latest communication practices. The connection of public values to concrete communication attributes can facilitate further research on empirical validation and refinement of the emerging theory. To this front, research hypotheses can be drawn upon the derived framework, so as to investigate the influence of the communication concept attributes on public value co-creation. Finally, further research opportunities may arise in transforming the conceptual framework into a mathematical model in order to simulate the dynamic behaviour of the co-creation process. In this case, operationalization of the latent public value variables is required.

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Re-Shaping the EU Digital Identity Framework

Silvia Lips
silvia.lips@taltech.ee
Information Systems Group, Tallinn University of Technology
Tallinn, Estonia

Natalia Vinogradova
natalia.vinogradova@taltech.ee
Information Systems Group, Tallinn University of Technology
Tallinn, Estonia

Robert Krimmer
robert.krimmer@ut.ee
Johan Skytte Institute of Political Studies, University of Tartu
Tartu, Estonia

Dirk Draheim
dirk.draheim@taltech.ee
Information Systems Group, Tallinn University of Technology
Tallinn, Estonia

ABSTRACT

Electronic authentication and digital signature are the base components of the European Union (EU) Digital Single Market. The area is regulated by the eIDAS (electronic identification and trust services for electronic transactions in the internal market) regulation that is compulsory for all Member States since 2018. Despite the Member States' efforts, the regulation implementation has not been as successful as expected. Therefore, the European Commission initiated the eIDAS revision process in the second half of 2020. Based on the collected feedback, the Commission proposed in July 2021 the first draft of the renewed eIDAS regulation establishing the European Digital Identity framework. The aim of this research is to analyze the feedback provided by different countries and sectors in the eIDAS review process (156 pages of material) and evaluate their correspondence to the Commission proposal. The research follows the exploratory case study methodology and we use thematic analysis for the evaluation. The outcome of this study shows whether all relevant expectations of the interested parties are covered by the Digital Identity Framework proposal and the research results are a valuable input for the Commission as the debate over the eIDAS regulation draft is ongoing.

CCS CONCEPTS

• **Social and professional topics → Government technology policy**.

KEYWORDS

eIDAS, electronic authentication, electronic identity, implementation challenges, identity management, digital signature

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1 INTRODUCTION

The European Digital Single Market is one of the backbones of the EU and part of the EU single market strategy [1]. The Digital Single Market largely depends on the electronic identities of Member States and provides trust services regulated by the eIDAS, electronic identification and trust services for electronic transactions in the internal market, regulation. EU citizens need to be able to use their national eIDs for the services in other EU Member States. Meanwhile, there should be a guarantee that different electronic authentication schemes operate across borders without limitations inside the EU and given digital signatures are legally binding in all Member States [21]. According to the European Commission eIDAS impact assessment report, the ongoing COVID pandemic situation has sped up the need for digitization by seven years [2]. This means that the need for digitization and the importance of a well functioning EU Digital Single Market has become even more relevant.

To enable an interoperable and secure e-service provision, cross-border authentication, and acceptance of electronic signatures, the EC adopted, on the 23rd of July 2014, the regulation on electronic identification and trust services for electronic transactions in the internal market and repealing Directive 1999/93/EC (eIDAS) [3]. Until 2016, the adoption of this regulation was voluntary for the Member States. Since September 2018 it has become mandatory [12].

Unfortunately, despite the Member States' efforts, the implementation of the eIDAS regulation has not been simple, and the EU digital market is not operating as expected [12]. Every Member State has its individual digital market operating within the national legal framework. This variety of different digital identification solutions in the EU has gradually become an obstacle in terms of cross-border interoperability in the European internal market [17, 22]. In four years since mandatory implementation, only 59% of the EU population has a chance to benefit from the EU Digital

[1] Single Market and Standard. https://ec.europa.eu/growth/single-market_en
[2] European Commission. eIDAS Impact Assessment Report. https://ec.europa.eu/newsroom/dae/redirection/document/76618
[3] eIDAS regulation. Available: http://data.europa.eu/eli/reg/2014/910/oj

Single Market [4]. Therefore, the EC initiated, in the second half of 2020, the eIDAS public consultation process to collect the interested parties' feedback about the existing regulation and related challenges. The aim was to revise the regulation. After analysing the feedback, the EC proposed, in July 2021, an amended version of the eIDAS regulation, which included the European digital identity framework.

This research focuses on the analysis of the EC's proposal and its correspondence to the feedback received during the public consultation procedure. The aim is to find out, weather the proposal covers public and private sector authorities' main concerns towards the eIDAS regulation, and to provide input to the ongoing eIDAS revision process.

Based on the aim of this research, the main research questions are:

- What are the public and private sector authorities' main amendment expectations towards the eIDAS regulation?
- How do the eIDAS regulation amendments proposed by the European Commission meet the public and private sector authorities' expectations?

Sect. 2 provides an overview of electronic identity and eIDAS related literature. Sect. 3 gives an overview of the eIDAS regulation and its state of play, including the EC eIDAS revision proposal. Sect. 4 describes the research methodology and data collection procedure and analysis method. Sect. 5 presents the research findings from the private and public sector perspective. In Sect. 6, we analyze the the correlation of interested parties' feedback to the eIDAS regulation proposal. Sect. 7 provides an insight to the research limitations and to the future research perspective and we conclude the paper in Sect. 8.

2 LITERATURE REVIEW

The electronic identity is a central concept for the development and operation of digital government [8, 23] and e-commerce [15]. For instance, the eID became a part of the Estonian critical infrastructure [22], and the state itself is the eID primary end-user and highly dependent on its eID [25]. This section provides an overview of the eID and eIDAS related literature that is relevant from this research perspective with the focus on the obstacles and triggers of the EU digital identity implementation from the public and private sector authorities' perspective.

Despite the importance of the concept, there is no universal definition for electronic identity. The literature indicates broad and narrow concepts of identity in the digital space. For instance, Hoikkanen defines the term eIdentity as a "data set related to a personal or collective identity stored and transferred in the electronic systems" [7]. It is worth mentioning that Hoikkanen uses the terms electronic identity, digital identity and eID interchangeably [7]. At the same time, Khatchatourov uses the term eID only in the context of the eIDAS Regulation [8]. Contrary, van Dijck and Jacobs specify eIDs as "digital solutions to prove one's identity", where the main functionalities of the solutions comprise authentication, login and digital signing [26]. Overall, identity in the digital space can relate to all online transactions [8]. Current work focuses on the national electronic identification (eID) and authentication schemes and trust services as part of the EU Digital Single Market.

The topic of eIDAS implementation processes in EU countries is relatively new and only partially researched. Researchers focus mainly on some specific areas or technical issues of the eIDAS [12]. For instance, among technical solutions that are examined in the framework of eID systems and eIDAS: the authentication of additional data and different cryptography solutions [14], pseudonyms and pseudonymous signature [8, 11], and integration of block-chain technology with Qualified Electronic Signatures [24]. Further, there are proposals to widen the scope of the technological solution. For example, including an electronic signature of the ICO smart contracts [27].

Furthermore, the literature analyses the national eID systems, their integration with eIDAS-Node, their further extensions, proposes alternative technical solutions. For instance, the German eID schema is broadly examined [11, 13, 14]. Further, an overview of the Italian architecture for the eIDAS-Node and connection of the eID scheme is provided [21], and the Dutch IRMA eID system is outlined [26]. Some research papers offer various applications of the eIDAS-Node in an educational context [3, 5, 6, 9]. For example, proposing an extension of the basic set of attributes by adding academic attributes as part of citizens' profiles and offer technical solutions. They claim that it would be beneficial for citizens in the education context. In particular, this would save the students' time on the application procedure and allow them to use academic services through national eID [3].

Since the provision of online services is closely related to the concerns of "security, privacy, and trust" [2] moreover, a multitude of various digital identities brings inconveniences for users and endangers their security and privacy in cyberspace [15], privacy aspects are widely discussed in the context of electronic identity, identity management and eIDAS [8, 11, 14]. For example, Kim Nguyen considers aspects of trust that are embedded in the eIDAS regulation. Firstly, he argues that the certification procedure guarantees users that the provider's services are trustworthy. The requirements for the trust services provision, the systems itself and its' elements are established in the European standards. Moreover, the certification is provided by independent third parties and supervised by national agencies. As a result of certification, all qualified trust service providers are registered in the trust lists together with the description of their services. Other criteria that would ensure trust by Nguyen are the "evaluation of the cryptography process, the definition of minimal requirements, and decentralized trust models based on transparency principles" [16].

Some researchers investigated if eIDAS is beneficial for the Member States and their national cross-border programs and e-government objectives or somewhat burdensome. Although eIDAS poses additional obligations on the Member States, they suggest that it rather supports national initiatives and projects, such as e-residency in Estonia, than challenges them. Therefore, it is beneficial for the governments to implement eIDAS [1].

Nevertheless, initial research on eIDAS implementation indicates that some countries are more successful in their endeavours, while others are hesitant and struggle with the eIDAS implementation [17]. Early comparison of national eID systems in Europe demonstrates that there are different technical and organisational

[4]European Commission. eIDAS Impact Assessment Report. https://ec.europa.eu/newsroom/dae/redirection/document/76618

elements between the systems [10], also architectural solutions of the identity systems are diverse [8]. The reason for this diversity can be clarified by the fact that each EU Member State developed their eID management system independently [21], based on the earlier systems and during "incremental innovation" and "path continuation" [10]. Each country tried to meet its' internal goals to provide secure authentication, while "interoperability with other state's eID schemes was no priority" [19].

However, identification and authentication systems of different EU countries have many similarities [20]. The diversity of the rules and systems in the electronic identity management between countries caused issues with interoperability and turned out to be an obstacle for cross-border electronic services and operation of the EU Digital Single Market [19, 21].

Generally, information systems operate on identities that connect citizens with the digital information stored in the databases. If identifiers in different databases vary, cross-referencing the information from one database to another is hindered. Therefore, the main challenge for identity management is to adapt the systems, making them interoperable and enabling cross-referencing and matching the information [4]. In other words, Member States need to implement national gateways, called eIDAS-Node, to connect to the eID systems of the other Member States [21].

Besides interoperability issues, some authors suggest that the difficulties with eIDAS implementation might be caused by the complexity of the eID concept, which encompasses more than outlined by the EU frameworks. Meanwhile, the legislation concentrates mainly on technical and legal interoperability. Other issues of a political and social nature may cause conflicts and obstacles for the eIDAS implementation. For instance, in the case of the Swedish national eID schema, it was challenging to design a new eID system having, at the same time, already existing BankID and considering opinions of all the stakeholders involved [26].

Overall, the main challenges for the member states indicated in the literature are “compliance issues”, “interpretation problems”, “different practices in Member States”, “cooperation and collaboration barriers”, and “representation of legal person” challenges [12]. Besides, the lack of knowledge among users influences the citizens' adoption rate of national eID solutions, which negatively affects the consumption of cross border electronic services. Therefore, countries should increase awareness among citizens about national eID solutions and their benefits and provide them with necessary software and qualified certificates [20].

3 eIDAS AND STATE OF PLAY

The eIDAS regulation grounded the legal foundation for electronic transactions in the EU internal market. The aim was to build trust among consumers, businesses and public authorities in the digital environment, thus boosting electronic commerce and increasing the effectiveness of public and private digital services in the European Union [5]. The regulation was adopted in July 2014 and replaced the directive 1999/93/EC on a Community framework for electronic signatures [6]. eIDAS regulation made possible to recognise other national electronic identification schemes developed in the Member States and uniform requirements for trust services were established [18].

eIDAS regulation entered into force step by step. Figure 1 illustrates in detail the eIDAS implementation timeline from the adoption to the latest European Digital Identity framework proposal. Starting from September 2015, the Member States could start voluntarily recognise each-other´s eIDs. In early 2016, the eID interoperability infrastructure was available for the Member States. From July 2016, provisions referring to trust service rules became effective. Finally, from the 29th of September 2018, eIDAS regulation was obligatory for all Member States and mutual recognition of eIDs became mandatory.

The eIDAS implementation comprises several stages that each country should follow. Firstly, a Member State should start eID pre-notification: officially inform the European Commission about its "intention to notify its eID scheme". Then a peer-review stage follows, where representatives of other Member States examine and assess the eID scheme. After the peer review stage, the country notifies the European Commission about its eID scheme. As soon as the information about notification is published in the Official Journal of the European Union (OJEU), but not later than 12 months, other Member States should recognise the notified eID scheme. Since the recognition, EU citizen can use the recognised eID across borders. Germany was the first country, who notified its eID scheme in 2017, followed next year by Estonia, Spain, Croatia, Belgium, Luxembourg and Italy. Currently, 17 Member States out of 27 passed the eID notification process and three countries (Czech Republic, Norway, Austria) peer-review process is ongoing. [7].

According to the eIDAS regulation, it was planned to revise the regulation and its implementation process by 01.07.2020 [8]. The EC conducted an inception impact assessment of the eIDAS revision and published a proposal to revise the eIDAS regulation on the 23rd of July 2020. According to the Inception Impact Assessment document, the EC proposed three options: [9]

- revise and slightly update the current regulation;
- extend the effect of eIDAS to the private sector;
- launch a European Digital Identity (EUid) or combine these three solutions.

During the public consultation, the EC wanted to collect feedback about the eIDAS implementation challenges from different interested parties and wanted to clarify the direction, where to develop the eIDAS regulation. The feedback was collected 23.07.2020-03.09.2020. Based on the feedback and analysis, the EC proposed in July 2021 a revised version of eIDAS - a framework for European Digital Identity [10]

[5] eIDAS regulation Available: http://data.europa.eu/eli/reg/2014/910/oj
[6] Directive 1999/93/EC. Available: http://data.europa.eu/eli/dir/1999/93/oj
[7] eID User Community.
Available: https://ec.europa.eu/cefdigital/wiki/display/EIDCOMMUNITY/Overview+of+pre-notified+and+notified+eID+schemes+under+eIDAS
[8] eIDAS regulation. Available: http://data.europa.eu/eli/reg/2014/910/oj
[9] Inception Impact Assesment. Available: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=cellar:35274ac3-cd1b-11ea-adf7-01aa75ed71a1
[10] Establishing a Framework for European Digital Identity. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0281

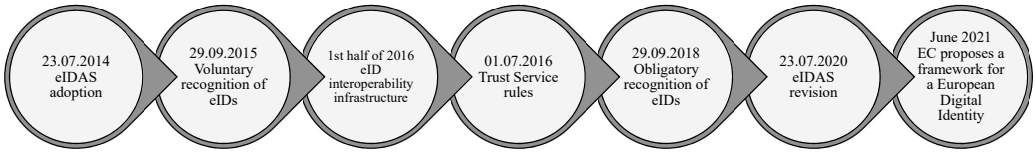


Figure 1: eIDAS timeline

3.1 European Digital Identity Framework Proposal

With the revised version of eIDAS, the EC has broadened the scope of the regulation. Previously, the regulation applied to the electronic signatures, seals, time stamps, documents and registered delivery services. In addition to that, according to the regulation draft, the eIDAS applies to the electronic archiving, attestation of attributes, remote electronic signatures and seal creation devices and electronic ledgers [11].

As a major change, eIDAS proposes the legal framework for EU member states to provide EU digital identity wallets that enable users to decide, depending on the use case and needed security level, when and with whom they share various attributes (e.g. educational data, healthcare information, electronic driving license information etc.). The EU digital identity wallet should also enable electronic authentication in the online environments and giving qualified electronic signatures. The Member States must ensure the wallet solution but its usage by citizens is voluntary. The EC together with Member States will establish the technical architecture, standards and guidelines for EU digital identity wallets (also named as common toolbox) to ensure uniform approach to the wallet solution. [12] Currently, detailed discussion over the EU digital identity wallet concept between the member states is ongoing but the schedule is intense. For example, according to the regulation draft, the Member States should implement it already in June 2024.

The eIDAS proposal specifies requirements for the remote signatures to ensure secure remote signing process. The Member States should follow the European Committee for Standardization (CEN) standards that regulate the operation and authentication to remote Qualified Signature Creation Devices. Moreover, the eIDAS draft proposal aims to harmonize with the other EU legislative initiatives like the EU directive concerning measures for a high common level of security of network and information systems across the European Union (also known as EU NIS directive) [13], Cybersecurity Act [14]and Single Digital Gateway regulation [15].

To summarize the key elements of the eIDAS draft proposal:

- the name eIDAS was replaced by European Digital Identity Framework with a focus on cross-border use;
- European Digital Identity Wallet concept obligatory for Member States was introduced (including Trust Mark);
- proposal enables end users sharing of different electronic attributes within the EU;
- three new qualified trust services were added to the existing list of trust services (electronic archiving, electronic ledgers and the management of remote electronic signature and seal creation devices);
- harmonisation with other EU regulations and standards.

4 RESEARCH APPROACH

The research follows exploratory case study methodology [28]. To answer the research questions, we analysed the European Digital Identity Framework Proposal and feedback provided in the public consultation process initiated by the EC and compared them. The main changes in the eIDAS regulation proposal are presented in Sect. 3.

The feedback on the Inception Impact Assessment and eIDAS regulation was collected by EC from July 2020 to October 2020 and was made available for the public on the EC website. In total, 53 responses in different formats were received from various stakeholders. Some responses contained additional downloadable documents. This research uses only the data that was publicly available.

We extracted the collected feedback from the EC website with the help of the web scraping tool Scraper and downloaded enclosed files from the web pages. In total amount 156 pages of text. Some of the feedback needed to be translated from German, Spanish, and French into the English language for further analysis. During the feedback analysis, we focused separately on two main groups of stakeholders: the public sector representatives and private sector actors of the EU Member States.

After the data extraction, we conducted a thematic analysis of the collected data sets. We conducted the analysis in four rounds using NVIVO data analysis software. Firstly, we sorted the received feedback based on the theme from which country it was sent. Figure 2 presents the detailed data analysis model.

Secondly, we split the data into three groups (case classifications: Stakeholders): the feedback from private, public organisations and others. Initially, we expected to have the most responses from private and public organisations of EU Member States. However, the third sector organisations, EU citizens, and Non-EU organisations actively participated in the public consultation process. Therefore, we formed three groups of cases: stakeholders: public sector, private sector and others.

In the third-round we tried to find a generalisation and central themes in each stakeholder group. We applied inductive data-driven approach to find patterns and probable explanations of the challenges and triggers of eIDAS implementation and stakeholder´s possible expectations. During the final round, we analysed every

[11]Establishing a Framework for European Digital Identity. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0281
[12]Establishing a Framework for European Digital Identity. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0281
[13]EU NIS directive. Available: http://data.europa.eu/eli/dir/2016/1148/oj
[14]Cybersecurity Act. Available: http://data.europa.eu/eli/reg/2019/881/oj
[15]Single Digital Gateway regulation. Available: http://data.europa.eu/eli/reg/2018/1724/oj

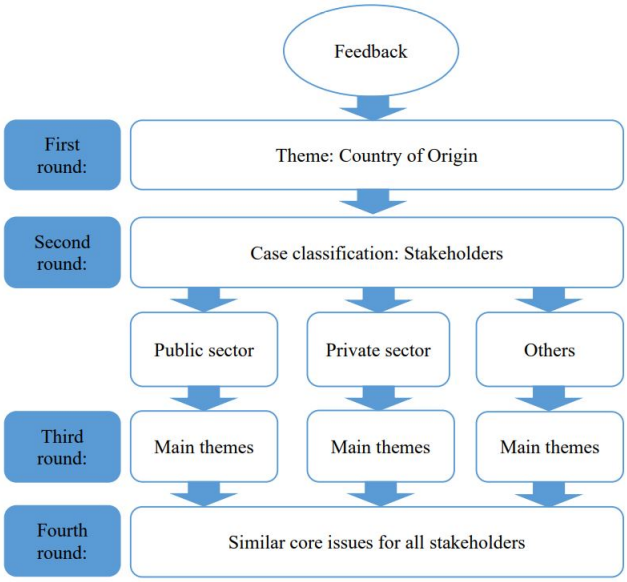


Figure 2: Data analysis model

pillar separately to identify similar problems and core issues for all stakeholders and their possible expectations towards the eIDAS regulation.

5 FINDINGS

During the first round of thematic analysis we identified from which country the feedback was received. Altogether, EC received 53 responses from 16 countries during the public consultation process. Results showed that among the respondents there were representatives of the non-EU countries (Switzerland, UK, USA, Norway), which constituted 19% of all respondents. 7% of the respondents preferred to preserve their anonymity. Therefore, the data about their countries of origin were not available. The largest number of respondents were from France (12), then followed by Germany (7), Belgium (5) and the USA (5). Table 1 represents detailed overview of the respondents by their country of origin.

During the planning phase of the research, we assumed that the largest number of all feedback would be from two types of stakeholders: public and private sector organizations of EU Member States. In contrast, the second round of the data analysis revealed that the third sector organizations, EU citizens and Non-EU organizations actively participated in the consultation process. Therefore, we split the data into three groups by stakeholders: public sector, private sector and others. The following subsections present the research results by each group.

5.1 Private Sector Feedback and Expectations

31 private sector representatives provided their feedback during the public consultation process. 22 of them were EU Member States, 8 responses from non-EU countries and one respondent preferred to stay anonymous.

Business organisations from seven EU countries out of 27 participated directly in the public consultation and sent their feedback. The largest number of responses came from France (7). German and Belgium organisations sent both five responses each. Concurrently, it is worth of mentioning that business association represented the interests of certain domain companies from a range of countries. Large companies (250 employees and more) constituted 33% of all respondents from EU countries. Small (10 to 49 employees) and micro (1 to 9 employees) organisations contributed equally with a 24% participation rate of all EU companies. Medium companies with 50 to 249 employees amounted to 19% of all respondents from EU countries. All participants from the private sector can be split into two groups: separate companies and various business associations representing interests of different sectors (e.g. Internet and IT services, identification and trust services etc.).

The thematic analysis illustrated that respondents from the private sector emphasised six groups of challenges in the eIDAS implementation process:

- the fragmented legal framework and technical requirements;
- obstacles in mutual recognition and the interaction between the eIDAS-Nodes;
- the limited scope of the eIDAS network;
- security and privacy issues;
- excessive specialisation;
- and a different pace of digitization of the Member States

The most mentioned problems were connected to fragmentation in the legal framework (12 times) and technical requirements (22 times). Since these two themes are intertwined and difficult to split we considered them as one group. In the respondents' opinion, the legal framework needs to be more harmonised on the EU level because the national rules of the Member States stay fragmented and undeveloped. Such fragmentation leads to "a high level of uncertainty for businesses and effectively blocks consumers in some Member States". Besides the fragmented legislation, "the technology,

Table 1: Feedback by country of origin

Country	Number of Respondents	Weighted Percentage
France	12	22,64
Germany	7	13,21
Belgium	5	9,43
USA	5	9,43
Italy	4	7,55
Switzerland	3	5,66
Austria	2	3,77
The Netherlands	2	3,77
Czech Republic	1	1,89
Denmark	1	1,89
Estonia	1	1,89
Finland	1	1,89
Norway	1	1,89
Spain	1	1,89
Sweden	1	1,89
UK	1	1,89
N/A	5	9,43
Total	**53**	**100**

eID devices and protocols differ from Member State to Member State". There is also "a lack of common technical standards for digital identity matters". For instance, “the eIDAS does not establish certifiable standards for all digital identity providers”. The topic of remote identity proofing and its' lack of harmonization is the most mentioned in this group (11 times).

Approximately the same number of respondents from the private sector see obstacles in mutual recognition and eID schemes notification procedures (16 mentions), with the interaction between the eIDAS-Nodes (5) and in lack of relevant attributes (3). The category related to mutual recognition and eID schemes notification procedures includes the complexity of the notification process, incompatible requirements between policies, different interpretations of some articles of the regulation by national authorities.

Representatives from the non-EU countries would like the EU to collaborate on the international level and enable mutual recognition of the eID schemes. Moreover, two respondents draw attention to the fact that there is a lack of advisory institution on the EU level that is "advisory/administrative body to support the industry by implementing eIDAS". In addition, national “supervisory bodies have no legal enforcing authority”. Therefore, “a set of baselines of auditing rules and a baselines audit plan for each trust service” needs to be created. Two respondents brought out the need to cover management of emergencies (including back-up of eID schemes for emergency purposes).

There is also a need to amend the interaction between the eIDAS-Nodes (5 mentions). Identity matching is problematic as "some Member states do not have persistent identifiers", “no access requirements to exchange data between two eIDAS services”. Further, the lack of relevant attributes for several services was mentioned three times.

Another group of obstacles is relates to the limited scope of the eIDAS network and lack of demand and use cases, which was mentioned 21 times. Respondents found that "the current eIDAS framework is restricted to specific use-cases and is not a good fit for many solutions providing digital identity verification, particularly in the private sector”. The respondents propose that the framework could be extended to the private sector. Furthermore, more attention should be drawn to user experience and consumer preferences, including authentication processes.

From the security and privacy aspects (16), respondents found that there is a deficit of clarity about the eIDAS levels of assurance and too much interpretation room. Overall, the issue with the level of assurance was mentioned nine times. Some representatives suggested that the eIDAS regulation should be harmonized with the EU Cybersecurity Act and rely on General Data Protection Regulation [16]. 14 respondents from the private sector argued that some eIDAS norms are excessively specialized and, in some countries, local regulations are "restrictive and technology-specific". Consequently, the stakeholders warned that excessive regulation might lead to "rapid regulatory obsolescence" and restriction of innovation.

Respondents propose that eIDAS regulation should remain technologically neutral and used solutions must take into account the dynamic and evolving nature of the digital economy and the infrastructure (e.g. endorsing the OpenID Connect Standard besides SAML).

The different pace of digitization across the EU was mentioned three times (e.g. all Member States do not offer eID).

Regarding the EC's options for further eIDAS framework development (1. revise and slightly update the current regulation, 2. extend the effect of eIDAS to the private sector, 3. launch a European Digital Identity (EUid) or combine these three solutions), the preferences of private sector participants were split mainly between various combinations. 36% (11 respondents) of all private

[16]General Data Protection Regulation. Available: http://data.europa.eu/eli/reg/2016/679/oj

sector respondents, did not choose any option or combination of options. Overall, combinations between options 1, 2 and 3 and their combinations were equally popular.

5.2 Public Sector Feedback and Expectations

Seven representatives from the public sector organizations provided their feedback during the public consultation process (three from the national level, one from local, two from public academic institutions, and one from the postal service provider). Two of them represented French organizations, and others were from Spain, Italy, Estonia, the Netherlands and Finland. It would be better to explore the academic institutions' feedback separately, yet the small number of responses (two) does not allow generalizations. Therefore, public sector stakeholders' expectations also include an opinion of the research institutions.

Overall, the respondents from the public sector found the eIDAS regulation very valuable. However, at the same time, they point out that the legal regulation is not complete and does not cover all important areas, especially from the private sector perspective the whole potential of the regulation is not used.

Public sector representatives see the shift towards the attribute-based approach, but not towards the decentralized architectures, where the storage of attributes is under the direct (physical) control of users. The most frequently mentioned problems were related to the lack of standardization and control (was mentioned in 4 responses). Public sector representatives brought out following aspects regarding standardization:

- it is important to cover transactions between private parties;
- standardize the peer-review procedure;
- specify the minimum criteria relating to remote identification;
- determine the identification of devices and the Internet of Things procedures;
- organize training for citizens.

The revised version of the eIDAS regulation should create a legal grounds for allowing natural and legal persons to use a qualified electronic signature or seal. Some respondents argue that the trust services list should be further expanded or scope broadened (e.g. electronic archiving).

Alternatively, in others' opinion: "The introduction of digital identity trusted services, other than the eIDs already implemented under the eIDAS regulation, should not be pursued. As previously noted, if this were to happen it could undermine the massive efforts, organizational and economic, put in place by the Member States that have already developed notified digital identity systems."

There is also a lack of technological variations of the qualification mechanism or it is too specific. which may lead to the technological neutrality issue that was also brought out by other researchers [27].

When it comes to the three options proposed by the EC (1) revise and slightly update the current regulation, 2) extend the effect of eIDAS to the private sector, 3) launch a European Digital Identity (EUid) or combine these three solutions), respondent opinions were split between the first, second, and combined option. The respondents had different opinions about proposed options on the eIDAS development. Those favouring the first option, were concerned about additional financial costs and organizational changes of the already existing systems, which the second and third solution might cause. The public sector respondents did not show significant support for the third option due to financial considerations and respondents were afraid of setting up and managing parallel eID systems. They also saw a planned EUid as voluntary option. However, respondents found that the third option may be favourable for legal entities.

Public sector representatives supported the principle that notification of national eID schemes would be mandatory. The respondents were concerned about standardization and privacy related issues. People-centric approach was important for the public sector.

5.3 Third Sector, EU Citizens and Other Stakeholders Feedback and Expectations

The third group of respondents included 15 feedback: 10 from the EU Member States, two from non-EU countries (the USA and Switzerland) and three respondents with unavailable data. The most considerable number of responses in this group were from France (4), followed by respondents from Italy (3), Germany (2) and the Czech Republic (1). Five out of fifteen were NGOs from the identification, trust services and research domains, five EU citizens, one from council of notaries and four respondents preferred to remain anonymous.

The thematic analysis reflected four main challenges in the eIDAS implementation process. This includes the first group with fragmented technical requirements and legal framework, the second group with eIDs mutual recognition and lack of relevant attributes, the third group about the limited scope of use cases and finally security and privacy issues. Challenges from the last two groups were mentioned once in each case.

The most mentioned issue was technical requirements fragmentation (8). Respondents found that more strategic directions are needed for leveraging the benefits for the end-users and the system.Respondents expected the European Standard Organizations to complete the current set of eIDAS. They also emphasised that over regulations should be avoided.

The limited scope of the eIDAS framework was mentioned seven times. As a solution they proposed to stimulate the market and create new trust services and extend the regulation over the private sector entities. Some non-EU participants from this group reminded to consider the cases where EU citizens need to use electronic identities outside of the EU and extend interoperability to the international partners.

Security and privacy topics are essential for this group (5 mentions). For instance, some respondents concerned about private trust service providers, who might not guarantee sufficient personal data security if there are no specific rules and standards to follow.

Lack of relevant attributes was mentioned six times, while obstacles in mutual recognition – three times. Some respondents believed that "the notification process at European level shall remain a prerogative". Respondents proposed harmonisation of legal entity datasets and harmonise the identities of professionals using Legal Entity Identifier (LEI) that enables to link persons, companies and devices.

Almost half of the respondents of this group preferred to notify the EC about their concerns on further eIDAS framework development and not to choose between options proposed by EC.

6 DISCUSSION

Based on the research results it is possible to analyse the EC's European Digital Identity framework proposal and different stakeholders' expectations towards it. Stakeholders see various challenges in the eIDAS implementation and many of them are similar. Among mentioned obstacles are fragmented technical requirements and legal framework, the limited scope of eIDAS and use cases, security and privacy issues, the complexity of the notification procedure and excessive specialization. Those perceived shortcomings correspond with the previous research results that indicated "compliance issues", "interpretation problems", "different practices in member states" and "representation of legal person challenges"[12].

If we analyse the EC's proposal, it is possible to say that the EC has covered many of the stakeholders'´ expectations. For example, widening the current eIDAS regulation scope in terms of new trust services, harmonizing the regulation with other EU regulations and standards, focusing on the cross-border service provision inside the EU and clarifying sharing of different electronic attributes.

However, there are some important topics that EC proposal does not address brought out by stakeholders. It has to be noted, that the stakeholders emphasized the need of technology neutrality and they did not prefer the option to launch a European Digital Identity (EUid). The EU digital identity wallet proposal seems to be further development of the initially proposed EUid solution, that enables additional benefits for the users (e.g. attribute sharing, qualified digital signature etc.). Stakeholders also expect solution to the legal entities representation issue that the EU digital identity wallet should solve.

It is questionable if the EC proposal should cover standardized e-service provision across the EU borders with third countries. However, the stakeholders are interested about this topic and would like it to be clarified. The EC proposal does not pay much attention to the notification of the national eID schemes mentioned by the stakeholders. However, the notification process does not have to be regulated on the legal act level and can be specified in other regulatory documents.

Security and privacy issues are not directly reflected in the proposal. However, it is possible to take these aspects into account while designing the technical architecture of the EU digital identity wallet and specifying applicable technical standards. Stakeholders also warn against over regulation and standardization that may also happen during the legislative process.

7 RESEARCH LIMITATIONS AND FUTURE DIRECTIONS

Every research has some limitations. For example if it comes to the stakeholders, then the private sector view was more strongly presented than public sector opinion. Further, it is possible to notice that France was very much engaged in the consultation with the most significant share of all participants. The probable explanation of such interest was that France was preparing to pre-notify its eID scheme under the eIDAS regulation at that time, which resonated through a high participation rate in the consultation process.

On the other hand, the low number of respondents from the public sector and citizens' representatives limit the possibilities to generalize enough the research results of this sector. Moreover, the results reflect only opinions of those, who provided their feedback on the eIDAS public consultation process. We also could only analyse the opinions that were published on the EC website.

Future research perspective should cover analysing the final outcome of the EU Digital Identity Framework regulation. Also, it is possible to evaluate some of the stakeholders´ expectations after the EC and the Member States have agreed the technical details of the EU digital identity wallet solution.

8 CONCLUSION

The eIDAS revision is a part of the EU strategy, because the EU Digital Single Market largely depends on its enablers: eIDs and electronic trust services. To ensure a high usability of eIDs and to correspond to the users needs, it is important to take into account the feedback of different stakeholders in the eIDAS revision process.

This research focused on the public and private sector stakeholders' feedback analysis provided during the eIDAS public consultation procedure initiated by the EC. We compared the stakeholders feedback with the EC eIDAS amendment proposal and establishing a framework for a European Digital Identity. The aim was to identify if the stakeholders´ expectations were covered and to contribute to the ongoing eIDAS revision process. Stakeholders mentioned following challenges regarding the eIDAS regulation: fragmented technical requirements and legal framework, the limited scope of eIDAS and use cases, security and privacy issues, the complexity of the notification procedure and excessive specialisation.

Research results indicate that the majority of the stakeholders' expectations are covered by the EC proposal. However, many aspects and their correspondence to the stakeholders' needs depend on the final technical, architectural and procedural agreements between the EC and the Member States. On the stakeholder level, there are some eID related topics that need EU level solutions, but are left out of the EC's proposal. Discussions concerning the EC's proposal are ongoing and final evaluation can be done once the final regulation draft is accepted.

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Framework for designing interoperable public service architectures with exemplification along small-scale procurement and PEPPOL

Andreas Schmitz
Research Group E-Government,
University of Koblenz-Landau,
Koblenz, Germany
andreasschmitz@uni-koblenz.de

Ansgar Mondorf
Research Group E-Government,
University of Koblenz-Landau,
Koblenz, Germany
mondorf@uni-koblenz.de

Maria A. Wimmer
Research Group E-Government,
University of Koblenz-Landau,
Koblenz, Germany
wimmer@uni-koblenz.de

ABSTRACT

Digitalization of public services, particularly in cross-border contexts, demands for a high level of interoperability. To effectively and systematically cater for interoperability in public service design, architecture development methodologies represent important means of support. The Design Science Research Methodology (DSRM) or the The Open Group Architecture Framework (TOGAF) Architecture Development Method (ADM) provide great tools for rigorously developing digital public services and service architectures. However, these approaches do not per se sufficiently address interoperability. This paper proposes a methodical framework based on DSRM and TOGAF to develop public service architectures, which tackles all layers of interoperability of the European Interoperability Framework (EIF). The proposed framework is tested on the use-case of small-scale public procurement services and on PEPPOL standard specifications. The framework comprises six phases, covering the four layers of interoperability and the TOGAF viewpoints while enabling an iterative design process, which is inspired by DSRM.

KEYWORDS

Interoperability, e-procurement, public services, methodical framework, architecture development

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1 INTRODUCTION

Cross-border interoperability in digital public services is an asset of growing importance for the European Union (EU), as outlined by the New Interoperability Framework (EIF) [1] and literature in the field [2] [3] [4]. The EIF defines a total of twelve principles and four layers of interoperability that should be addressed when designing cross-border digital public services. To ensure coverage of these principles at all levels, interoperability standards in the field of public procurement have been specified in past and present projects and initiatives, such as "Pan-European Public Procurement OnLine" (PEPPOL)[1], "CEN Workshop on Business Interoperability Interfaces for public procurement in Europe" (CEN WS/BII)[2], "Electronic Simple European Networked Services" (e-SENS)[3], UBL[4], the European Norm EN 16931 on e-invoicing[5], eForms[6], The Once-Only Principle (TOOP)[7] project [5], etc. The non-profit organization OpenPEPPOL provides a secure and standardized e-procurement network based on different agreements, components and standards that are currently being used and further developed by many EU member states. National standards such as the German "XRechnung"[8] (Electronic Invoicing) or the Norwegian "Elektronisk handelsformat"[9] (Electronic Commerce Format / EHF) are based on common formats such as the EN 16931 and are also streamlined to be used in the PEPPOL e-delivery network. Therefore, we use PEPPOL as example for the implementation of interoperability standardization in this paper.

Enterprise Architecture (EA) methodologies and frameworks are increasingly used in the design and development of public services [6] [7]. Approaches such as "The Open Group Architecture Framework" (TOGAF) and its "Architecture Development Method" (ADM) offer guidance to comprehensively develop all levels and components of a system [8]. From a scientific perspective, other methodologies such as "Design Science Research" (DSR) [9] [10] [11] or the "Design Science Research Methodology" (DSRM) [12] also support the design process, therewith encompassing a rigor cycle and a relevance cycle.

While these methods are valuable instruments for the general development of public services, none of them directly targets the implementation of interoperability principles and standards as defined in the EIF [1]. This paper aims to fill this research gap and proposes a methodological framework that uses general design and

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[1] https://peppol.eu/
[2] https://standards.cen.eu/dyn/www/f?p=204:32:0::::FSP_ORG_ID,FSP_LANG_ID:2073699,25&cs=15AF0C1A6E029E9FE6E07383C858E58B0
[3] http://www.esens.eu/
[4] https://docs.oasis-open.org/ubl/UBL-2.3.html
[5] https://www.beuth.de/de/norm/din-en-16931-1/327729047
[6] https://ec.europa.eu/growth/single-market/public-procurement/digital-procurement/eforms_de
[7] https://toop.eu/
[8] https://www.xoev.de/xrechnung-16828
[9] https://anskaffelser.dev/

development methods of EA and DSRM, and it extends them with methods applied during the normative development of standards, which are adopted by organizations such as PEPPOL, CEN[10], OASIS[11], ETSI[12] etc. The proposed methodological framework aims to simplify the specification of standards for interoperable public services. It also enables the implementation of interoperability principles at the four levels of interoperability in a structured manner. Based upon the initial establishment of reference architectures, the method shall also simplify the implementation and use of standards such as PEPPOL in solution architectures. In the paper at hand, we finally exemplify the proposed methodological framework by a use case of small-scale public procurement in Germany to illustrate its applicability. In the scope of this use case, a general architecture for interoperable public services is developed that aims to overcome typical problems of interoperability, such as the lack of cross-border participation of small and medium-sized enterprises (SMEs) [13] [14] or the exchange of information between different actors and public entities [1].

Design science research [9] is used to develop the proposed methodological framework. Literature review following Webster and Watson [15] investigates the relevant foundational concepts of interoperability, public services, and standards such as PEPPOL (see section 2). The methodical foundations on DSRM and TOGAF are explained in section 3. Subsequently, the methodological framework to create interoperable public service architectures is developed in section 4, therewith applying the design cycle of DSRM. In section 5, the relevancy of the developed methodological framework is verified through the practical adaption on the use-case of small-scale procurement. Following the rigor, design, and relevancy cycles of DSRM, the resulting methodical framework is critically assessed and discussed in section 6, reflecting strengths and weaknesses identified during the practical usage, and concluding the paper with an outlook on further research needs.

2 FOUNDATIONAL CONCEPTS

To conceptualize the methodical framework for the design of interoperable public services, the first step according to DSRM is to execute the rigor cycle. Following the systematic literature review of Webster and Watson [15], the following subsections investigate foundations on digital transformation of public services, e-procurement, interoperability, and standardization.

2.1 Digital transformation of public services

Digital transformation is a massive trend in delivering both public and private services [16]. Focus lies on improving automation and customizability of service, and on improving efficiency of existing services [17]. Additionally, complete reorganization or entirely new service models may be developed by the use of new information and communication technologies (ICTs) [18]. New technologies commonly used to drive digital transformation include for example cloud-based services, mobile computing, social software, data analytics, and process automation [16]. Also disruptive technologies such as artificial intelligence, internet of things, data-driven policy-making, big data analytics etc. may boost digital transformation [19].

Digital transformation of public service does not only affect the offered services themselves. A multitude of concepts are researched and developed in different scientific fields to support innovations in public service development and to pave the way for successful digital transformation. Rejeb et al argue for the field of e-procurement that several new procedures, data artifacts, and systems must be integrated [20], which are discussed in the next subsection. Interoperability is another key facilitator for digital transformation [2] as discussed in subsection 2.3. To ensure interoperability along digital transformation, standardization is crucial. Relevant initiatives are reviewed in subsection 2.4.

2.2 E-procurement

E-procurement aims to fully digitalize the entire procurement procedure, including the notification, procurement document access, tendering, awarding, ordering, and invoicing phases [21] [22]. A common challenge for e-procurement is to successfully implement new technologies and innovations [20] without creating barriers for the participation of SMEs [13] [23]. Every step that further digitalizes the procurement procedure has the potential to create new barriers for SMEs that have limited technical capabilities. Therefore, all newly implemented technologies and policies should be designed in SME-friendly manner and with as little complexity as possible [24]. This paper is focused on public and small-scale procurement, where SMEs more likely participate.

Among others, important recent developments in e-procurement include the establishment of e-forms based on the European Commission Implementing Regulation 2019/1780[13], the promotion of Dynamic Purchasing Systems (DPS) [25] and e-catalogues [26]. While e-forms establish common standards and terminology to increase the ability of businesses and other organizations to find procurement notices, DPS processes offer an easier way to establish long-term agreements without hindering competition. DPS also enable SMEs to qualify themselves to procurement procedures more easily [25] by using for example the European Single Procurement Document (ESPD) and eCertis[14]. Throughout the process of public procurement, e-catalogues allow to store procurement related information in a more standardized way, thus increasing interoperability and the degree of process automation [26].

2.3 Interoperability

Most European countries have released e-government strategies to reduce interoperability barriers among governmental systems with the objective to create efficient e-government services [27]. Interoperability is defined in the European Interoperability Framework (EIF) as „the ability of organizations[15] to interact towards mutually beneficial goals, involving the sharing of information and knowledge between these organizations, through the business processes

[10] https://www.cencenelec.eu/
[11] https://www.oasis-open.org/
[12] https://www.etsi.org/

[13] https://eur-lex.europa.eu/eli/reg_impl/2019/1780/oj
[14] https://ec.europa.eu/growth/single-market/public-procurement/digital-procurement/european-single-procurement-document-and-ecertis_de
[15] 'Organisations' here means public administration units or any entity acting on their behalf, or EU institutions or bodies.

they support, by means of the exchange of data between their ICT systems" [1].

The EIF [1] defines a total of twelve interoperability principles – including openness, transparency, reusability, and technological neutrality –, which are especially important for standard specifications. Ensuring these interoperability principles, in particular openness, allows for a more efficient and effective sharing of information between different kinds of stakeholders, thus directly supporting all information-related tasks [28]. This further allows realizing open-source solutions and open standard specifications for the public sector, to which all actors can contribute [2], and from which they all can benefit alike. Examples for this are public standards such as PEPPOL, or services such as the ESPD. Openness is also an enabler for transparency and reusability [1]. Technological neutrality implies that all systems and services used by the public sector should be designed to have as few technical dependencies as possible. The interoperability principles of the EIF deliver a good foundation to design public services, procedures, or data standards in an interoperable fashion.

The EIF [1] defines four interoperability layers: legal, organizational, semantic and technical interoperability [29] [4]. These interoperability layers can be mapped to the architectural layers. On the organizational interoperability layer, public entities must ensure that their general business goals, processes, and requirements are in line with each other. This layer corresponds to the business layer in TOGAF [8]. Semantic interoperability addresses the structure, format, semantic, and syntax of the data and information to be exchanged along the business processes. Standards for semantic and syntax data schemata [1] are essential to ensure interoperability of data, and these can be mapped to the data layer and partly the application layer on TOGAF's ADM. Technical interoperability requires that applications, basic service components and technical infrastructures can interoperate. Interoperability assets on this level refer to interfaces, secure and interoperable transport infrastructures and communication protocols [1], and this layer corresponds to TOGAF's technology architecture.

2.4 Standardization

The standardization of processes and semantic assets is an important tool to implement interoperability. The most important standardization aspect is in the information content and semantics, not in the syntax. Semantics define the meaning and context of messages at the business level. Data exchange models thereby define the relationships between multiple information elements, each of which is associated with a business requirement. On the technical level, a syntax is required for the creation, processing and sending of documents. The syntax refers to the format of the electronic message that the machine can interpret and process. Syntax standards use technical specifications to form the actual content of messages. Consequently, business transactions can be mapped to different message standards or syntaxes as long as the standard covers all the necessary information elements required by the semantics [30] [31].

On the messaging level, data standardization [32] uses different concepts such as data schemata [33], data validation and data transformations [34]. These elements allow the processing and storing of structured data assets following a specified and standardized schema. Based on such schema definitions, automated validation and transformations between different data schemata can be implemented. Technologies to support data schemata definitions, validations and transformations are for example XML[16], XSLT[17] and Schematron[18]. Over the last 10 years, XML (and in a certain sense also XSLT und Schematron) has become the essential technology for many data exchange standards. A variety of XML messaging exchange structures have been developed in different application areas. One of them is PEPPOL, using UBL [35] as an XML standard to clearly define and standardize all procurement related data artifacts.

PEPPOL plays an essential role in the future implementation of e-invoicing and other procurement processes. OpenPEPPOL (Pan-European Public Procurement OnLine)[19] is a non-profit organization that aims to standardize cross-border, electronically supported public procurement processes. OpenPEPPOL operates different PEPPOL agreements, components and a defined set of specifications based on international standards. PEPPOL specifications are not bound to any kind of platform but can be implemented on a multitude of procurement systems by using the provided specifications[20]. As a technical messaging infrastructure, the PEPPOL e-delivery network[21] is used.

The standards of data artifacts and transaction points are specified through PEPPOL profiles or PEPPOL Business Interoperability Specifications (BIS). A PEPPOL profile or BIS contains a specification and documentation of a set of procurement transactions between different actors. PEPPOL specifications and solutions offer full support for all procurement phases by providing multiple profiles both for pre-award[22] and post-award[23]. The defined pre-award profiles are based on the results of the e-SENS project[24], which are further maintained by the OpenPEPPOL Pre-Award Community. For defining the syntax mapping of profiles, PEPPOL is basing on UBL 2.1[25] [35]. E-delivery is a component that supports inter-organizational and, in particular, cross-border exchange of electronic data and documents. The PEPPOL e-delivery infrastructure is based on a set of specifications as well as on the operation of a Public Key Infrastructure (PKI) to establish trust between participants and Domain Name System (DNS) Services for dynamic address resolution[26]. By using e-delivery, each participant becomes a node in the PEPPOL network. The use of standardized transport protocols and security policies as well as a logged transmission enable direct communication between the participants in the network without the establishment of bilateral agreements.

PEPPOL e-delivery is illustrated as 4 Corner Model[27] (see Figure 1), where Corner 1 represents the sender and Corner 2 the PEPPOL

[16] https://www.w3.org/TR/xml/
[17] https://www.w3.org/TR/xslt-10/
[18] https://www.data2type.de/xml-xslt-xslfo/schematron
[19] https://peppol.eu/about-openpeppol/
[20] https://peppol.eu/what-is-peppol/
[21] https://peppol.eu/what-is-peppol/peppol-transport-infrastructure/
[22] https://docs.peppol.eu/pracc/
[23] https://docs.peppol.eu/poacc/upgrade-3/
[24] http://www.esens.eu/node/129
[25] https://docs.oasis-open.org/ubl/os-UBL-2.0/UBL-2.0.html
[26] https://Peppol.eu/downloads/the-Peppol-edelivery-network-specifications/
[27] https://en.e-rechnung-bund.de/faq/the-peppol-technical-solution-the-4-corner-model/

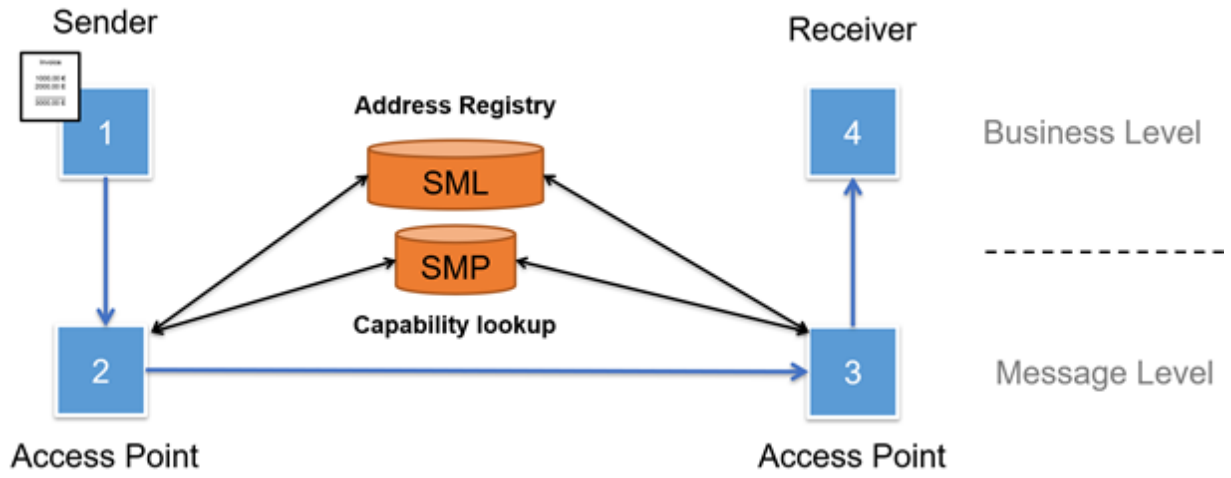


Figure 1: PEPPOL eDelivery - 4 Corner Model[28]

Access Point (AP) of the sender, while Corners 3 & 4 represent the recipients' AP and the recipient. Each AP must be registered in the Service Metadata Publisher (SMP). The SMP is a registry that lists the AP locations and types of documents and processes supported by the participant registered therein. When registering a new user to a PEPPOL AP, the Service Metadata Locator (SML) is contacted. The SML is used to find, add, update, or delete information about the SMP locations of subscribers in the DNS. This dynamic address resolution via the SML is the only centralized e-delivery component (dynamic location discovery).

When exchanging documents via PEPPOL e-delivery network, Corner 2 uses the PEPPOL ID to find the recipients' SMP (Corner 3) within the SML. The data exchange request is only validated and permitted by the PEPPOL infrastructure, if the supported processes and document types are registered in the SMP of Corner 3 (capability discovery)[29] [30]. Once the recipient is found and its capabilities are known, the PEPPOL AP of Corner 2 can send the document to Corner 3 by using a standardized message exchange protocol (message exchange). This general process is performed for all kinds of PEPPOL profiles, enabling a secure and reliable message exchange. PEPPOL service providers enable interactions (submission, receipt of documents) between the APs by providing sufficient interfaces for backend integration.

3 METHODICAL FOUNDATIONS

Besides the foundational concepts presented in the previous section, TOGAF as an enterprise architecture framework and DSRM form the methodical foundations for the proposed methodical framework for designing interoperable public service architectures.

3.1 The Open Group Architecture Framework (TOGAF)

With its "Architecture Development Model" (ADM), the architecture framework TOGAF offers a structured procedural model to methodically develop enterprise architecture specifications and all associated artifacts step by step [8]. ADM defines eight main phases (see the yellow construct in Figure 2), with a preliminary phase and constant requirements management across all phases. A key concept of TOGAF is to work with an initial architecture vision, which defines the objective (Phase A). This leads to the separate analysis of the baseline architecture and the target architecture, fulfilling the architecture vision. The target architecture is then conceptualized on multiple layers, based on the preceding baseline analysis. The business layer describes the higher-level business goals and all related processes to realize these goals (Phase B). The data and application layer are describing the architecture of the used information system (Phase C), while the technology layer elaborates the used technical infrastructures (Phase D). Based on the results of the target architecture specification, an implementation and migration plan for the architecture is formulated. First, the opportunities and solutions are discussed and evaluated (Phase E). Second, the implementation and migration are planned using tools from project management (Phase F), and finally the implementation itself is governed (Phase G). After the completion of phase G, the target architecture is fully developed and deployed, and is categorized as the new baseline architecture. Possible change requests, extensions, and the general management of this new baseline architecture are the objective of phase H. The phases are arranged circularly, allowing a new iteration of the TOGAF ADM to develop further architectural visions.

Enterprise architecture development is an effective and widely used approach to support the digital transformation of the public sector. The comprehensive architectural approach that TOGAF and other enterprise architecture frameworks offer, is highly beneficial for public entities, but also often met with challenges such as lacking financial support or EA capabilities [27]. As illustrated in figure

[29] https://peppol.eu/downloads/Peppolimplementations/
[30] https://en.e-rechnung-bund.de/faq/the-peppol-technical-solution-the-4-corner-model/

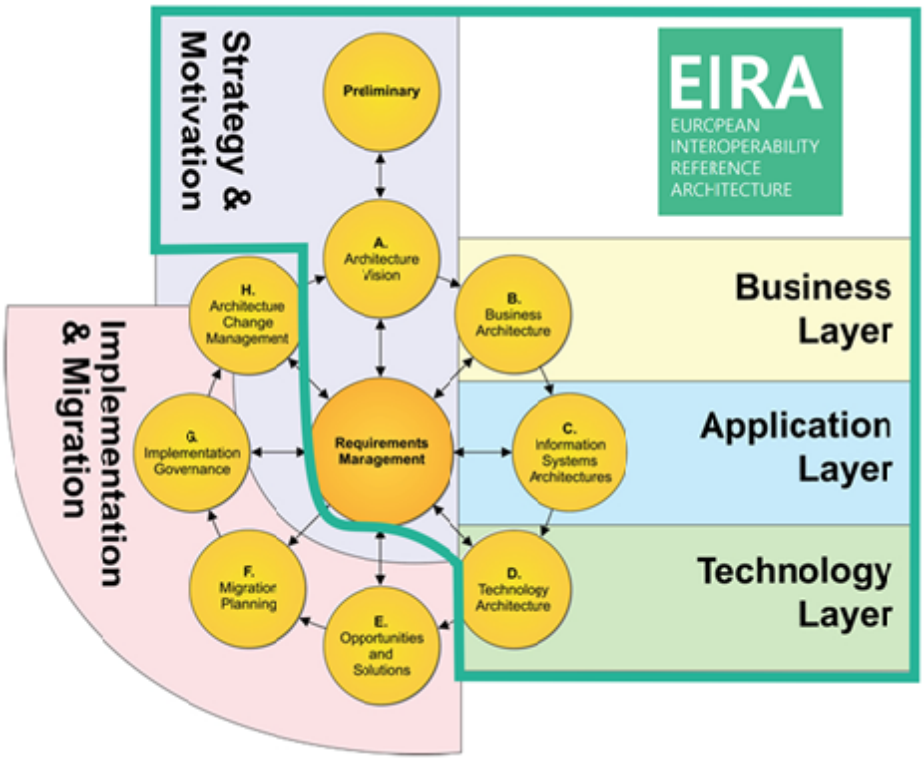


Figure 2: Relationships of TOGAF ADM to other Standards, Specifications, and Frameworks[31]

2, TOGAF ADM can be combined with several related standard notations for conceptual modelling such as ArchiMate, UML, BPMN and the European Interoperability Reference Architecture (EIRA). In the public sector in Europe, EIRA plays a significant role. The four-view reference architecture guides public administrations in their work to provide interoperable European public services to other public administrations, businesses and citizens[32]. This adaption and other examples in literature and practice show the great potential in the use of TOGAF and enterprise architecture for the public sector [28].

3.2 Design Science Research Methodology (DSRM)

The DSRM is based on the concept of Design Science Research (DSR), to which multiple authors have contributed [9][10] [11] [12]. In 2004, Hevner et al have proposed a DSR framework for information systems research, highlighting how a scientific knowledge base and a practical environment are both utilized to develop an artifact with both rigor and relevance [10]. Three years later, Hevner extended this concept by defining three separate cycles that may be iterated throughout the research process. A relevancy cycle formulating requirements based on the real-world environment, a rigor cycle focused on grounding the research with findings from scientific literature, and finally, the design cycle, focused on the constant incremental design, evaluation, and improvement of the research artifacts [9]. Vaishnavi and Kuechler have put these DSR principles into a more streamlined process [11].

The DSRM was developed by Peffers et al. to implement the DSR principles focused on the design and development of information systems-related artifacts [12]. The authors propose a research process with six iterative steps focused on developing and designing artifacts based on findings from literature. First, the problem and motivation behind the research are identified. After the problem scope is clear, objectives for an artifact-based solution targeting this problem are formulated. In the scope of DSRM, such artifacts can range from fully fletched IT-Systems to system-related concepts and architecture specifications on a conceptual level. The next three steps are focused on the constant incremental development of said artifacts. Emphasis here is on iteration. First, the artifacts are developed until a certain milestone is reached, then the artifact is demonstrated in a suitable context. Based on this demonstration, the performance of the artifact is measured, and potential improvements are analyzed. Those three steps are then repeated until the artifact is evaluated as being sufficient to the initial definition of the objective. Finally, in the sixth step, the results of the development of the artifacts are communicated through scientific publications, thus contributing to the knowledge base, and fulfilling the rigor cycle [12]. Other methods can be used in each step of the DSRM to complement the approach and to guarantee relevant and valid results.

[32] https://joinup.ec.europa.eu/collection/european-interoperability-reference-architecture-eira/about

4 FRAMEWORK FOR INTEROPERABLE SERVICE ARCHITECTURE DEVELOPMENT (FISAD)

Based on the theoretical and methodical foundations introduced in the previous two sections, we elaborate the methodical framework for interoperable service architecture development (FISAD). First, the methodologies used as basis (cf. subsections 3.1 & 3.2) for the new framework are further analyzed and mapped with standards. Subsequently, we present the methodological framework.

4.1 Mapping between methodologies and standards

Different interrelations between the listed concepts and methodologies from the background given in sections 2 and 3 can be identified. A mapping between the phases of the DSRM, the phases and layers of the TOGAF ADM, and the interoperability layers from the EIF and their adaption in EIRA is possible as illustrated in section 3. The DSRM and TOGAF ADM can be compared since both methodologies are focused on the development and design of artifacts. While the DSRM has a strong focus on establishing a rigorous foundation and an incremental design process, TOGAF is more focused on creating a comprehensive architecture for a system with all viewpoints represented by different model kinds. Even though both methodologies differ in their focus, they can be mapped to, and complement each other well. The first two phases of the DSRM, where the problem situation and motivation, as well as the objective of the work is established, can be mapped well to the preliminary and architecture vision phases of the TOGAF ADM. In both approaches, a foundation and vision for the further work is established, using mostly literature in the case of DSRM and relevant practical sources for the TOGAF ADM.

After such a foundation is established, both DSRM and TOGAF start with their design and development process. TOGAF splits this design process in the business, data, application, and technical layer, while DSRM focuses on more specific artifacts that are created in a highly iterative manner. This is also the point, where the layers of interoperability become relevant. The legal interoperability can be partially mapped to the architecture vision phase, as the vision must comply to legal grounds. Legal interoperability provides high-level decision-making, a legal frame and boundaries for drafting the architecture vision and subsequent design artifacts. Organizational interoperability maps very well with the business architecture. The business layer creates an architecture for the organizational structures and actors involved, business processes, and use-cases. Therefore, this architecture phase should be designed to support full interoperability between the processes of different actors and the structures of different public entities, precisely following the definition of organizational interoperability. The semantic interoperability coincides with the data layer. While the data layer develops an overview and structure of all necessary data artifacts to fully implement the business processes, it also needs to design them in a semantically interoperable way. This process can be supported by public standards, which offer interoperable semantic data models for different data artifacts and data transactions using a precise syntax. Technical interoperability must be achieved by the application and technical layers. PEPPOL (cf. subsection 2.4) for example also gives concrete instructions about which specifications, application components and technical infrastructures are necessary for its implementation. Altogether, the four layers of TOGAF can be used in junction to cover all layers of interoperability. Furthermore, the design process on all mentioned layers can be conducted in an iterative manner, following the DSRM.

4.2 Framework proposal

Based on the mapping provided in subsection 4.1, a new framework (FISAD) is proposed to optimally combine all mentioned methodologies and concepts. The proposed methodological framework FISAD aligns itself closely to the DSRM and TOGAF but incorporates additional steps to address each layer of interoperability of the EIF. In total, the model consists of six phases as shown in Figure 3 1. Foundation, 2. Business perspective, 3. Data perspective, 4. Application perspective, 5. Technical perspective, and 6. (a) Reference architecture or (b) Solution architecture to communicate or implement the architecture designed.

The four different perspectives are linked to the corresponding TOGAF architectures and provide the respective viewpoint. Additionally, each phase covers a layer of interoperability. The foundation is established based on legal frameworks and high-level decisions, ensuring legal interoperability in the architecture vision. Subsequently, the business perspective ensures organizational interoperability, the data perspective coincides with semantic interoperability, while the application and technical perspective are covering technical interoperability. Furthermore, each of the phases 2 to 5 contains the cycle of design, demonstration, and evaluation as featured in the DSRM to allow for an incremental approach supporting continued validation and improvement of results through the direct interaction with the relevant stakeholders. The final communication of results in phase six can either result in a reference architecture that is then communicated or specify a solution architecture for subsequent implementation (see e.g. TOGAF ADM phases E – G). To cover the respective layer of interoperability, each phase in FISAD consumes different additional inputs. The business perspective requires inputs from actors from relevant organizations or experts from this field of research. These can be collected in the form of interactive methods, such as workshops or interviews. The data perspective needs to use standard specifications, such as the transactions specified by PEPPOL. The application and technical perspectives need to adopt the available specifications and standards to implement useable software components and technical infrastructures. In the case of PEPPOL, this could include the 4 Corner model and particular PEPPOL BISs implemented by a service provider. Besides legal frameworks and high-level decisions from public entities, the foundation should also rely on scientific literature to ensure the rigor of the methodology, as demonstrated in the DSRM. Additionally, all phases besides the communication of results should be externally verified, either through experts in the field, a proof of concept or through application in a respective case study. This verification can also make use of interactive methods, like workshops and interviews.

The following subsections explain each phase of FISAD in more detail.

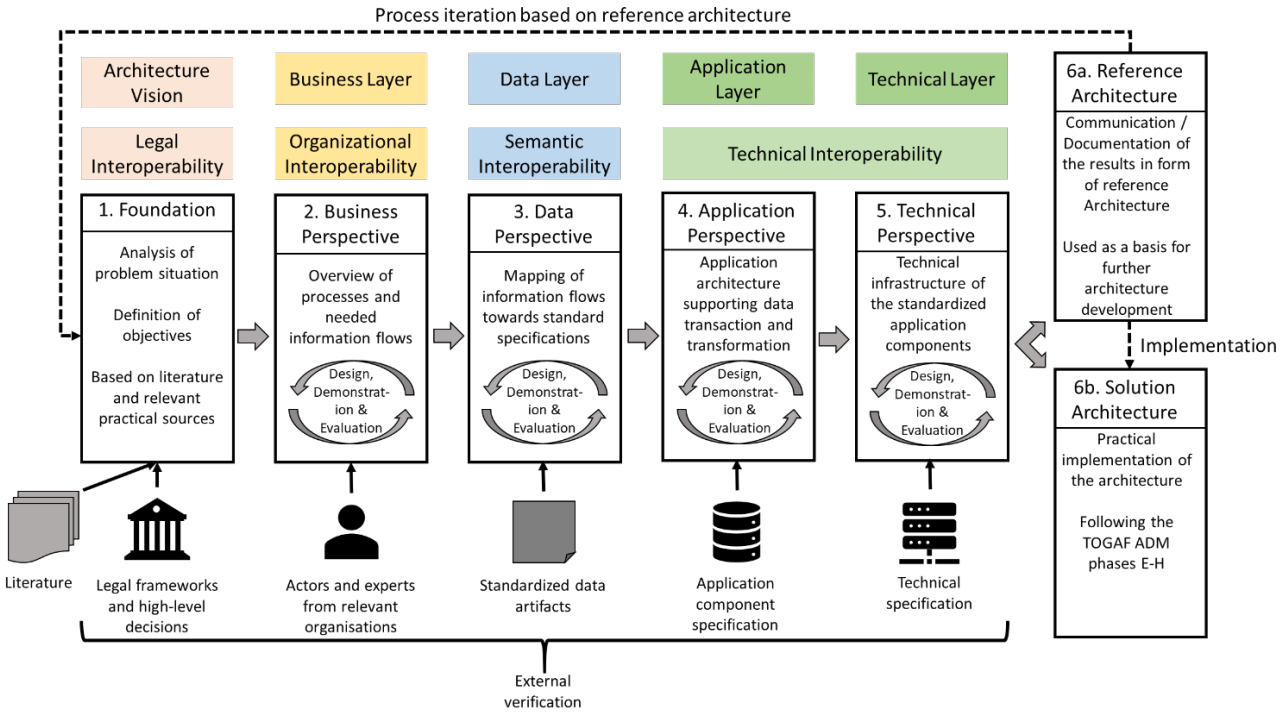


Figure 3: Framework for interoperable service architecture development (FISAD)

4.2.1 Foundation. Similar to the first two DSRM phases "Identify Problem & Motivate" and "Define Objectives of a solution", as well as the preliminary and architecture vision phases in TOGAF's ADM, the foundation phase of FISAD has two main goals: a) define the problem scope and b) develop a vision on how to solve the problem spotted in a). The foundation phase should create a clear picture of the current situation and in which direction it should be changed and improved. Both the analysis of the current success factors, challenges, problems, and feasible options to improve them, should be based on systematic literature research of related concepts and desk research of related sources, such as existing system documentations, EU reports, and legal frameworks. The approach needs to tackle three objectives: First, to ensure legal interoperability by aligning the defined objectives towards official high-level decisions and legal frameworks. Second, to enable a rigorous foundation for all related concepts that are vital for the creation of the architecture vision. Third, to define a feasible and relevant target architecture based on current challenges and success factors taken from different sources. Beside the desk research of existing sources, interactive methods can be applied to receive practical and relevant insights of the problem scope (interacting with the relevance cycle of DSRM). Interactive methods should be further used to verify the feasibility and relevancy of the proposed objectives with experts and actors from real organizations in the problem scope.

4.2.2 Business perspective. The business perspective phase generally covers similar steps to the business layer of TOGAF. Based on the established foundation, a baseline and target architecture for the procedure is created. From the business perspective, this is focused on all relevant business use-cases, processes, and organizational structures. Relevant model kinds for this can be UML use-case diagrams and sequence diagrams, BPMN, or process maps. As a first step, the current workflows and processes need to be documented and analyzed. To establish this baseline procedure, inputs from experts or actors in the scope of the procedure are usually necessary. These inputs can be gathered through interactive methods like questionnaires, interviews, workshops, or action research. The baseline should then be extended by applying the identified success factors to it, in order to create a target business architecture aligned towards the set objectives. The creation of this target architecture and its extended processes follows the design, demonstration, and evaluation cycle set by the DSRM. Each created target process should be demonstrated, discussed, evaluated, and improved until it is approved by internal and external stakeholders. While these steps suffice to create a comprehensive business architecture, additional steps are necessary to ensure organizational interoperability.

An overview of all information flows in the procedure should be analyzed and included in the target architecture. These information flow related points are vital elements in the process, since they determine which data artifacts, transformations, and transactions need to be analyzed on the later data architecture. To create a clearer structure, the information flows are divided into two categories:

1. Information processing (Data transformation)

This category illustrates the internal information processing. Information processing describes a change of information (data

transformation), which takes place within a single actor. The documentation of these data-driven transformation steps is important to:

- Create an understanding of which information assets are needed, when and where, and which information becomes available at which point of the process
- Enable the conceptualization of defined data transformations for each necessary step
- Enable the next information transaction

2. Information Exchange (Data transaction)

This category is focused on the primary information exchange between the actors. The data artifacts created in the previous process are defined as data transaction. These data transactions are later used to define:

- Which standardized profiles and specifications can be used for the transactions?
- Are the defined data transformation points sufficient to create the needed transaction artifacts?
- Is all needed information available at this point of the process?

Altogether, the business perspective should first document all current use-cases and processes in close collaboration with relevant actors. Second, improved target processes should be designed following an incremental approach. For both baseline and target processes, all information flows with view on information processing and information exchange should be documented. The results should contain optimized processes covering the whole intended procedure, a concrete list of all needed information flows and transactions.

4.2.3 Data perspective. The data perspective is focused on covering all identified information flows, both internal transformations and external transactions, with interoperable standardized data artifacts. As the main foundation for the data perspective, the lists of information transactions and transformations enabled on the business perspective are used. Additionally, interoperable specifications of data artifacts and transaction profiles must be used as input. A mapping between all identified information assets and standardized data specification is the intended result. This way, it is also possible to detect potential gaps in the standard specification, when essential information flows in the process cannot be expressed through the existing standard. To accomplish this mapping, first, an analysis of all relevant standard specifications should be conducted. In the case of public procurement, these would be PEPPOL, EHF, and CEN for example. Individual data specifications from each standard should be evaluated towards their suitability to cover information flows of the business perspective. Second, after a general overview of potential data specification is established, interrelations between the chosen standards should be analyzed. This way, the feasibility of certain internal data transformations can be checked. To accomplish this data analysis, data mappings should be conducted, first on a semantic and afterwards on a syntax level. For the semantical analysis, UML class diagrams usually are a good tool, while the syntax analysis must be conducted on the specific syntax binding used by the chosen standard, for example, UBL 2.0 for PEPPOL. This way, full semantical interoperability between the chosen standards and business information flows can be established. The final result in this phase consists of an extended list of information flows, where each flow is mapped towards an interoperable data specification.

4.2.4 Application perspective. After the needed processes and all data artifacts needed to cover them are established, the application perspective must provide an architecture of application components to cover all of these processes and artifacts. As a primary input, standard specifications of software components, supporting the transaction of data artifacts should be used. Based on these components, a general architecture for the transport of standardized data assets should be established first. In the second step, more specialized architecture models for each process step can be created. These should contain more detailed information about components needed for processing and transforming individual data transformation, from one interoperable format into another. ArchiMate models are a good tool to design and demonstrate these architectural views. Technologies commonly used to implement data standardization, transformation, or validation are e.g. XSLT and Schematron validation.

4.2.5 Technical perspective. The technical perspective should establish a technical infrastructure to support the application architecture. In most cases, technical infrastructure specifications of the used standard can be used as an initial input (for example, the 4 Corner model of PEPPOL). The result should be an extension to the application architecture, where all network and infrastructure components, as well as used technologies, are clearly stated. Similar to the application perspective, ArchiMate models can be used here. Together with the application perspective, the technical perspective covers the entire layer of technical infrastructure by providing an architecture fully capable of supporting the interoperable processes and data points.

4.2.6 Communication of results. The final sixth phase includes a case distinction of whether the framework was used to create a solution architecture or reference architecture. In the case of a reference architecture, phase 6a is executed, while a solution architecture triggers phase 6b.

Phase 6a mostly follows the communication phase of the DSRM. The results of the reference architecture development are published and added back to the knowledge base to support further research. This approach also follows the Architecture Continuum as introduced by TOGAF[33] by providing a generic Common Systems or Industry Architecture, useable for further architectural works. It can be used to create further service architectures, using a full iterative circle of the framework. Furthermore, the reference architecture can be used as a baseline to develop a more concrete solution architecture, feeding in the end phase 6b.

Phase 6b is concerned with all necessary steps to implement and migrate a concrete solution architecture. As such it can follow existing methodologies focused on the execution of solution architecture, such as the TOGAF ADM phases E-H. Based on the

[33] http://www.opengroup.org/public/arch/p3/ec/ec_ac.htm

Architecture Continuum, most solution architectures provided in this step should be concrete Organization Architectures[34].

In the next section, we provide a proof of concept of the proposed methodical framework for interoperable service architecture development (FISAD).

5 USE-CASE: COMPREHENSIVE ARCHITECTURE FOR PUBLIC SMALL-SCALE PROCUREMENT SERVICES

To demonstrate the applicability of the methodical framework for interoperable public service development, the use-case of small-scale procurement standardization in Germany is used. Below, concrete examples of the methods and results of each phase of FISAD are given, as well as small showcases of the developed core artifacts. Each subsection is focusing on one phase of the methodology.

5.1 Foundation

As part of the KleBe.digital project and the cooperative project for the digitization of procurement in Germany[35], interoperable standards were to be developed specifically for small-scale procurement. In order to develop a solution-oriented architecture for the comprehensive interoperable standardization of procurement services, the methodical framework developed in section 4 was used. To establish the foundation, literature research [15] [36] was conducted. It focused on the key concepts: public procurement, e-procurement, interoperability, and standardization. A total of 63 literature concepts were defined and analyzed using a total of 118 sources, including literature, legal frameworks, and EU reports. Additional to this literature research, multiple workshops with experts from the Landesbetrieb Mobilität Rheinland-Pfalz / Rhineland-Palatinate State Mobility Service (LBM) as a contracting authority were conducted to get practical and relevant insights towards the problem situation. The workshops were also used as an external source of validation for the established literature foundation. As a result, the following list of current challenges was identified:

- Enabling a high level of automation and process efficiency, reducing the administrative load for both contracting authorities (CAs) and economic operators (Eos) [22]
- Incentivizing and enabling the participation of SMEs [13]
- Ensuring interoperability between different public authorities and EU member states [2] [1]
- Identifying and reducing complex procurement subprocesses not needed for small-scale procurement [22]
- Enabling easy reusability and repeatability of procurement procedures [1]
- Allowing an efficient transition from pre-award to post-award

Additionally, the following success factors were identified to directly target these challenges:

- Usage of DPS processes to increase the efficiency of the procedure and incentivize participation of SMEs (targeting challenges 2, 4, 5) [25]
- Integrating qualification systems into the process to allow the creation of a supplier pool, thus increasing the reusability of procurement procedures and enabling DPS processes (targeting challenges 1, 2, 5) [25]
- Increasing the efficiency and standardization of the management of procurement documents and information by using e-catalogues (targeting challenges 4, 5, 6) [26]
- Ensuring interoperability on all layers by implementing and using standards such as PEPPOL, EHF, CEN (targeting challenge 3) [1]
- Increasing data standardization and process efficiency by developing data schemas and transformations (targeting challenges 1, 6) [32] [33]

Based on these success factors, next the different architecture perspectives were developed.

5.2 Business perspective

The business perspective was focused on clearly documenting how the current processes are actually conducted and how they could be extended in order to implement the success factors of the foundation. Primary inputs were further workshops with different contracting authorities, like the LBM and Ministerium für Wirtschaft, Innovation, Digitalisierung und Energie des Landes Nordrhein-Westfalen / Ministry for Economic Affairs, Innovation, Digitalization and Energy of the State of North Rhine-Westphalia (MWIDE)[36]. Based on these inputs, all baseline processes were modeled in detail, showcasing the challenges identified in the first phase. Along several further workshops with the LBM, solution processes realizing all success factors were defined. According to the framework, a list of the necessary information transactions and transformations to support the target process was generated. The resulting list of information flows and all corresponding process models were discussed, evaluated, and improved in further workshops until these were fully accepted by the stakeholders, as described in the DSRM. Table 1 shows a structured list of the identified information flows, with the main flows highlighted in blue, additional supporting flows in green, and further optional flows in orange. Based on the order of predecessor's necessary information, transformations can be concluded.

5.3 Data perspective

The data perspective focused on finding interoperable data specifications to cover all business level information flows defined in Table 1. To accomplish this, a mapping between several PEPPOL, EHF, and CEN profiles were conducted. At first, this analysis was done on a semantic level, comparing the structure and data elements of UML class diagram representations of the profiles. Based on the semantical analysis, a detailed syntax mapping between all relevant data specifications was conducted. This way, fitting and interoperable data specifications for most information flows could be found. Two main gaps were identified: The initial specification of demand cannot be mapped to any standardized PEPPOL artifact, and the PEPPOL standard itself has a gap with the pre-Award catalogue request not being defined. Else all information flows could be clearly mapped to PEPPOL. Table 2 shows how the information

[34] Ibid

[35] https://www.xoev.de/ueber-uns/projekte-und-gremien/digitalisierung-der-beschaffung-21415

[36] https://www.wirtschaft.nrw/ministerium

Table 1: Business perspective information flows

ID	Artifact	Predecessor
1	Specification of demand	-
2	ESPD	1 | 3
3	Contract notice	1 | 3
4a	Call for Tender metadata	1
4b	pre-Award Catalogue request	1
5a	Procurement question	4
5b	Procurement answer	5a
6a	Tender metadata	4a
6b	pre-Award Catalogue	4b
7a	Tender Question	6
7b	Tender Clarification	7a
8	Contract award notice	-
9	Catalogue	6b
10	Order	6b
11	Invoice	6b

Table 2: Data artifact mapping

ID	Artifact	Predecessor
1	Specification of demand	-
2a	ESPD Request / Response	1 | 3
3	PEPPOL P008 - Publish Notice / PEPPOL P006 - Search Notice	1 | 3
4a	PEPPOL T004 - Call for Tenders	1
4b	PEPPOL pre-Award Catalogue request	1
5a	PEPPOL T007 - Procurement question	4
5b	PEPPOL T008 - Procurement answer	5a
6a	PEPPOL T005 - Tender	4a
6b	PEPPOL pre-Award Catalogue	4b
7a	PEPPOL T009 - Tender Clarification Request	6
7b	PEPPOL T010 - Tender Clarification	7a
8	PEPPOL T017 - Award Notification	-
9	PEPPOL Catalogue	6b
10	PEPPOL Order only (XBestellung)	6b
11	PEPPOL Billing (XRechnung)	6b

flows from Table 1 can be mapped to PEPPOL as an interoperable standard. Again, multiple internal and external workshops were conducted to improve and accept the created artifacts iteratively, according to the DSRM. The results of the business and data perspective were further externally verified using an expert interview with Jan Mærøe, who is an expert in the field of e-catalogues, such as the PEPPOL or EHF pre-award catalogue.

To further illustrate the mapping of interoperable data transactions and data transformations, BPMN models focused on such data points were created. All used PEPPOL transactions are modelled as message flows, while data transactions are visualized by input and output elements attached to a task. Figure 4 shows a snippet of the generated overview process showing the transaction of the Call for Tenders and its subsequent transformation to the tender on the bidder side.

5.4 Application perspective

The application perspective was used to pick and arrange software components capable of performing the defined PEPPOL transactions and services to transform PEPPOL artifacts into their succeeding PEPPOL artifact according to the order specified in Table 2. As a primary input, specifications of reusable application components, suitable as building blocks for the architecture, were used. To put these components together into a comprehensive application architecture, ArchiMate models were used. At first, a general application architecture for the interoperable data transaction and communication between actors was created. This generic application architecture for communication among contracting authority and economic operator is a substantial building block for the realization of all specified processes and can therefore be reused in all detailed and use-case related models. Individual detailed models

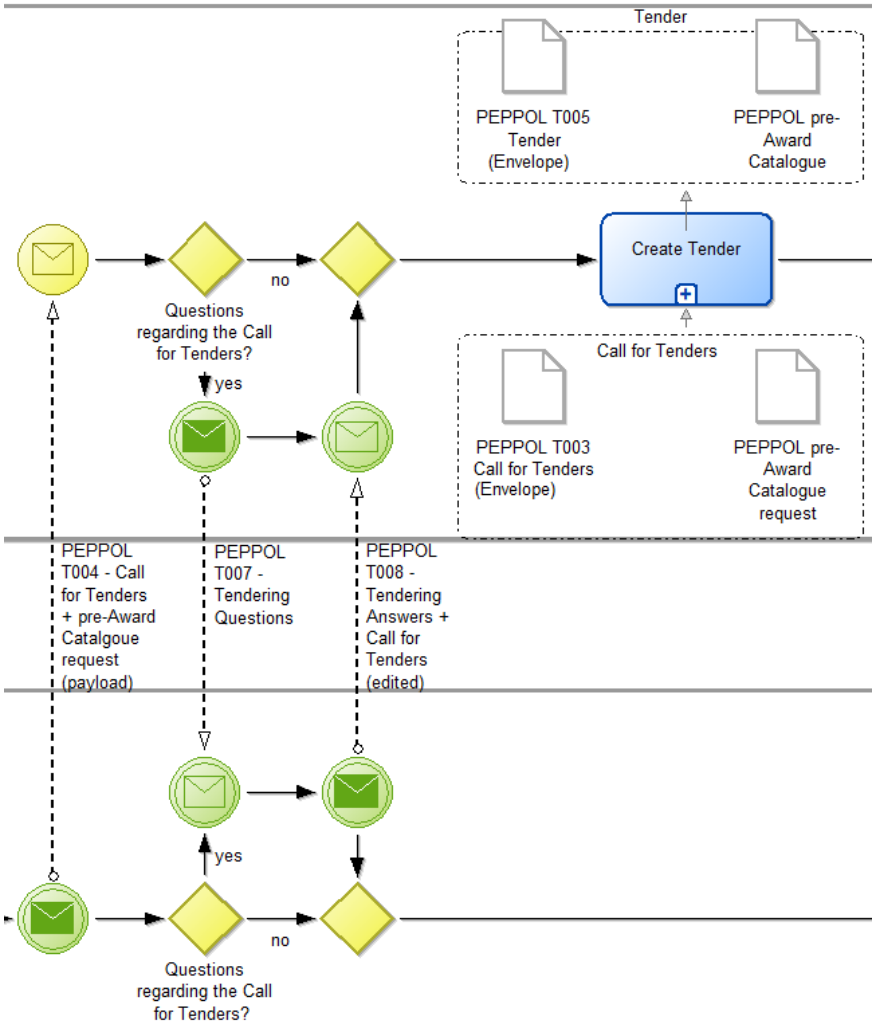


Figure 4: Data point BPMN collaboration process

were then created based on the transport architecture. Figure 5 shows the model of the application architecture. All artifacts were evaluated and improved iteratively in smaller development workshops until full maturity of the artifacts was reached, following the DSRM procedure. The architecture for the German public procurement context enables a multi-channel approach, where the contracting authority (CA) can solely use a XÖV Transport Adapter (XTA)[37] interface to communicate with a component called Governikus Multimessenger (GMM)[38], which enables legally compliant communication to several channels. This way, economic operators (EOs) can use channels such as PEPPOL, XTA, or a virtual mail service (VPS) that are all automatically translated into a central XTA interface for the CA. Following this approach, the procedure is very flexible for economic operators and easy to implement for contracting authorities, while also ensuring interoperability. The usage of a publicly provided user account service (ELSTER Unternehmenskonto / Nutzerkonto)[39], enables also SMEs without own PEPPOL or XTA solution to participate in the procedure.

5.5 Technical perspective

On the technical perspective, the target application architecture was extended by infrastructure components, using specifications like the PEPPOL 4 Corner model or XTA[40] as primary inputs. Instead of just modelling the application components and interfaces, technical networking components are also displayed. Figure 6 shows how the XTA transport infrastructure and the already discussed PEPPOL e-delivery network are used in the context of the application architecture. The modelling uses ArchiMate like on the application perspective. For the design, development and evaluation cycle,

[37] https://www.xoev.de/osci-xta/xta-4835
[38] https://www.governikus.de/governikus-multimessenger/
[39] Identification and communication service for enterprise by the German Tax Office https://www.elster.de/eportal/login/softpse
[40] https://www.xoev.de/osci-xta/xta-4835

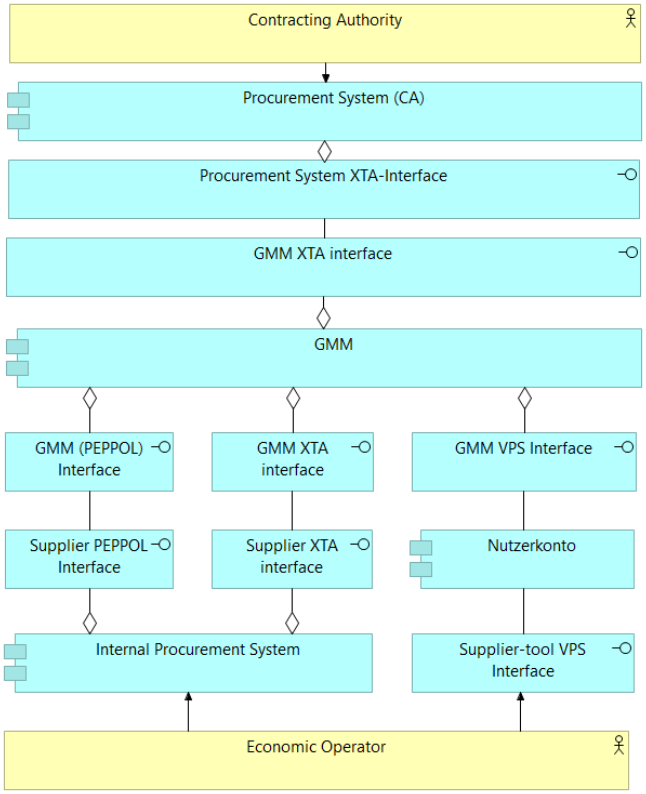


Figure 5: Application architecture for interoperable communication among actors in public procurement

development workshops similar to the application layer were conducted.

6 DISCUSSION AND FURTHER RESEARCH NEEDS

The evaluation of the proposed FISAD yielded good results on the mentioned use-case. The structured approach to include each layer of interoperability enables a streamlined process to evaluate and choose suitable interoperable specifications to cover the entire procedure, allowing to develop a service architecture that is both in the scope and compliant to all interoperability principles. Furthermore, FISAD is flexible since it allows to develop both reference and solution architectures. Its strong alignment toward both, TOGAF ADM and DSRM, support a tested procedure that ensures both rigor and relevancy. On the flipside, the methodology is highly dependent on already specified standards in the relevant field of the appliance. In the case of procurement, several established and overarching standards such as PEPPOL, EHF, and CEN are available, enabling the methodology to be effectively executed. However, in research fields with less sophisticated and numerous standards, this might be a challenge for the usage of the methodology. An initial TOGAF ADM iteration of developing an initial system architecture could be the solution to overcome this drawback of FISAD.

Furthermore, gaps in the standard will also always produce gaps in the architecture, as is the case with the specification of demand and PEPPOL pre-award catalogue request. In both cases, it would be necessary to first add profile specifications for the gap before the architecture can be fully implemented. However, this can also be used for proactively checking the completeness of a given standard in a specific research field and its capability to cover entire real-world procedures. In any case, the methodical framework requires further research to verify its effectiveness in developing different interoperable cross-border public service specifications.

The proposed methodological framework for the development of interoperable public services is based on DSRM and TOGAF ADM. FISAD was used on the use-case of small-scale procurement in

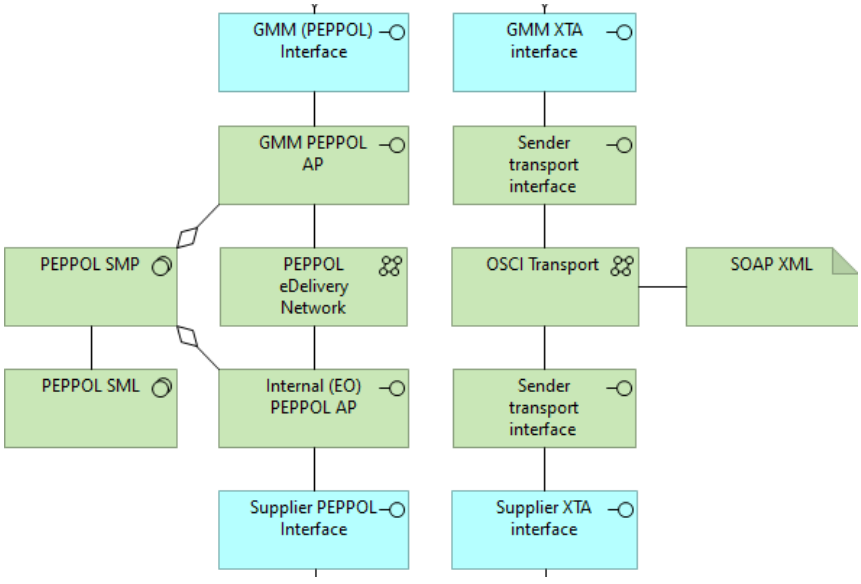


Figure 6: Technology architecture for the interoperable communication among actors in public procurement

Germany to validate its effectiveness. Overall, the framework could achieve the intended results successfully during its practical usage. Especially in the field of e-procurement, where standards such as PEPPOL cover most of the procedure, the framework delivered effective results. However, a few gaps and potential weaknesses in the frameworks were identified, such as a high dependence on available standard specifications. To gather more rigor on the mostly deductively developed methodical framework, it needs to be tested on further use-cases to validate its effectiveness and verify it sufficiently. This should include application to use-cases outside the scope of PEPPOL.

Further research on small-scale procurement needs to be conducted, in particular how cross-border interoperability for the participation of SMEs can be assured through the created architecture development framework. Finally, since a mostly specific solution architecture was developed in the scope of this paper, a general reference architecture to enable SME cross-border activities is a further research objective to evaluate the methodical framework presented in this paper.

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Fostering Data Collaboratives' systematisation through models' definition and research priorities setting

Federico Bartolomucci
Polytechnic University of Milan, Department of Management, Economics and Industrial Engineering

Gianluca Bresolin
Polytechnic University of Milan, Department of Management, Economics and Industrial Engineering

ABSTRACT

Data collaboratives (DC) [12, 18] have gained increasing attention in recent years benefitting and nurturing the momentum around the use of Data for Good [11]. However, research on the topic, derived and built upon the fields of collaborative governance, information sharing, and open data [9, 17] is still unmature, lacking a systematic body of knowledge, grounded in empirical evidence [11]. Except few studies, specifically referred to DC [31, 36, 37, 40, 42] [15, 18, 19, 24], most of the literature used in the field is encompassing broader concepts as such DataSharing, DataforGood, or Cross Sectoral Partnership.

Given that the empirical field has matured sufficiently to permit more quantitative analysis, the research seeks to go beyond existing qualitative classifications and inductively define data collaborative archetypes, emphasizing their distinctions and peculiarities as a foundation for future research on the topic.

The research started from a literature review on DCs, their definition and the dimensions identifying different DC's models. The dataset provided on datacollaboratives.org has been filtered based on the literature review, excluding those instances that do not meet the DCs criteria or for whom online data collection is not feasible. Once the empirical setting was defined, a phase of variables selection and population has been conducted according to different variables. The evaluation of different clustering solutions, using both qualitative and quantitative methodologies, brought to identify five mutually exclusive clusters.

Each cluster is described according to 18 variables, allowing the emergence of cluster's specific peculiarities and challenges. Findings are consistent with prior classifications and taxonomies [18, 29] with additional views afforded by a larger number of instances, the use of quantitative methodologies and the analysis of additional variables. Findings demonstrate the coexistence of quite different entities under the concept of DC, each of whose challenges and progress should be examined independently by researchers.

Responding to the objective to foster DCs long term sustainability, different research priorities are specified according to identified clusters and an empirical setting for conducting this research is made available. From a practitioner perspective, research's findings may enable those interested in the topic to obtain more comprehensive information about benchmark examples, which is a valuable resource for industry growth. Additionally, the research illustrates the efficacy of categorical variable clustering analysis for inductive exploratory studies in a novel field of research.

KEYWORDS

Data Collaboratives, Data for Good, Cluster Analysis

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1 INTRODUCTION

Our society is undergoing a rapid shift as a result of the widespread use of digital technology and data. Big data, as defined by Gandomi and Haider (2015) [7], is mostly created by digital technology (social media, cellphones, wearables...) or gathered by gps, satellites, and sensors.

Nowadays, data value is primarily exploited by large digital corporations for commercial interests. These players control the data, the financial resources, and the capabilities necessary to leverage its value and generate a competitive advantage. This perception of data as a competitive and rivalry asset brought private actors to be hesitant to share their data and knowledge [10], resulting in a massive gap in terms of data access and data-leveraging capacity between larger economic actors, the public sector, and the not-for-profit sector [13].

Increasing public and non-profit actors' capacity to use data for public good [4] entails overcoming several organizational, technological, ethical, and economic barriers.

To overcome these limitations, numerous efforts [1, 4, 5] have converged on the necessity of establishing cross-sectoral partnerships involving the private, public, and social sectors, with each sector contributing unique assets, resources, and expertise to bolster the collective capacity to use data to address specific social needs.

These forms of partnerships have been called Data Collaboratives [12] and defined as "new organizational forms in which government agencies, non-profit organizations, and private firms share specific datasets, including private datasets, with the purpose to address an important societal problem and thereby create public value" [12, 18].

Although well-defined theoretically, the DC field is still in its first phases of development. Numerous efforts have been made to

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establish an unified research strategy (100 Question Initiatives[1], Susha et al., 2018), and some of these initiatives have undoubtedly contributed to the topic's increased visibility (see datacollaboratives.org[2]). However, the discipline remains immature, lacking a structured body of knowledge [20]. The basic reasons of this scenario may be traced back to a variety of factors, including the topic's novelty and the overlap between the notion of DC and comparable concepts (i.e. open data, data spaces). This gap makes scaling Data Collaboratives challenging and leaves the collaborations and their impacts generally unexplored, frequently not progressing beyond the pilot stage [30].

To fulfil these gaps, the research will inductively develop, through the analysis of an extensive dataset of DC from around the world, a DC's classification that is grounded in the literature and thus serves as a bridge between the practitioner and academic worlds. Developing a DC's categorization that is theoretically sound, takes into account multiple variables, and is backed up by a big dataset might be a significant asset for future study on the topic. Particularly it will help in better focusing research on specific DC models and progressing it through different objectives as the one to foster their long-term sustainability.

To accomplish the research goals, a preliminary literature review was conducted to ascertain the distinction between data collaboratives and other forms of data sharing. Additionally, the review generated a list of characteristics identifying various forms of DC; this step was largely informed by the work of Susha et al. (2017). The dataset accessible on datacollaboratives.org has been filtered to exclude those instances that do not meet DC's definition based on the features provided in the literature review. The remaining observations were then clustered in order to identify recurrent patterns that might reveal DC research streams that could help ensure the organization's long-term sustainability and impact generation.

2 LITERATURE REVIEW

The concept of data collaboratives was developed relatively recently and was initially articulated by Verhulst and Sangokoya (2015). Following their work the definition was tweaked and refined by other authors, arriving at the most recent definition as "new organizational forms in which government agencies, non-profit organizations and private firms share specific datasets, including private ones, with the purpose to address an important societal problem and thereby create public value" [25]. A concept that clearly defines the basic aspects of these collaborations: cross-sectorality, defined as the involvement of actors with diverse backgrounds; the data centrality and the social purpose of creating public value through addressing a societal problem.

2.1 Existing classifications

Data Collaboratives exhibit endogenous variability, which results in a variety of configurations based on the factors detected. Susha, Rukanova, and colleagues (2019) attempted to categorise various configurations of data sharing initiatives, focusing on the motivations behind voluntary data sharing. Verhulst and Sangokoya (2015) introduced a DC classification in their Medium[3] article for the first time, distinguishing six distinct types of collaboratives: Research Partnerships, Prizes and Challenges, Trusted Intermediaries, Application programming interfaces, Intelligence products, and Corporate Data cooperatives or pooling. The categorization, produced at the outset of the DC phenomenon and widely regarded as a foundational work in the area, has undoubtedly contributed to the sector's definition, despite its imperfection, as seen by the categories' inhomogeneity. While it is recognized as a legitimate high-level categorization, it does have significant limitations: the classification is based on only two variables from those previously discussed; some categories refer to the manner in which data is shared, others to the actors involved in the collaboration, or to the scope of the collaboration, and others to a type of incentive; it includes initiatives based on open data access or initiatives of a single enterprise, which according to literature are outside the DC's perimeter; no clear classification methodology has been reported, making it a qualitative and practitioner based classification.

2.2 Research Objective

Due to the lack of a robust classification that incorporates the variables previously discussed and is capable of capturing and detailing DC's endogenous variability, the research's objective is to inductively develop, through the analysis of an extensive dataset of DC from around the world, a DC's classification that is grounded in the literature and thus serves as a bridge between the practitioner and academic worlds. The research might be particularly significant and relevant in light of the degree of attention and development given to the issue by the European Commission's Data Governance Act. The research also aims at providing a consistent empirical framework for future research on data collaboratives, helping researchers interested on the topic to better focus their future efforts.

3 METHODOLOGY

3.1 Building the dataset

The research began with the dataset accessible on datacollaboratives.org; the 203 projects available (as of March 2021) were filtered according to DC's previously disclosed conception. Through a study of online documents, DC projects in which data is available to the public (i.e., conforming with Open Data logics), projects that do not involve participants from different sectors, and projects in which the intention to create social effect is unclear were excluded.

These criteria, and poor data quality (e.g. duplicates, no websites), resulted in the exclusion of 68 projects from the online repository, resulting in a dataset of 135 DC.

After compiling a dataset of DC-compliant projects, a thorough list of potential variables was produced. Thus, variables previously discussed in the literature review section were combined with variables already listed on the collaborative's online repository datacollaborative.org. A list of 18 variables and their possible values was generated that could be used to characterize a DC from numerous viewpoints. All values (excluded those already listed on the repository) were deductively constructed from the literature and

[1] https://the100questions.org/
[2] www.datacollaboratives.org
[3] https://medium.com/internet-monitor-2014-data-and-privacy/mapping-the-next-frontier-of-open-data-corporate-data-sharing-73b2143878d2

populated with secondary data sources (i.e. websites and documents available online).

All variables found are given in Table 1, along with the possible values for each variable and the rationale for their removal, which will be discussed further in the data analysis section. For analytical purposes further discussed, the variable Actors was transformed into four Boolean variables, each of which denoted the presence of one of the four recognized categories of actors in the partnership.

3.2 Data Analysis Methodology

Clustering analysis was determined to be the most effective methodology for extrapolating data from the dataset. [35, 2, 18, 30].

After several rounds of debate among the author and numerical tests, nine variables out of eighteen were omitted, mostly because of redundancy with other variables; inadequate data due to their granularity and quality; variables resulting non-correlated with the clusters. Although these variables are omitted from the clustering analysis, their distribution among the clusters will be evaluated subsequently on a descriptive basis.

The remaining 9 variables are: Data Collaborative Type, Data Purpose, Continuity of collaboration, Clear Objective, Clearly Social, Clear Profitability Model, Extension, Macro Impact.

After deciding on the variables to include in the analysis, it was necessary to design the clustering algorithm. Five methods were chosen to be examined from the several similarity measures offered by Boriah et al. (2008) [3]: Smirnov, Gower, Goodall1, Goodall3, Occurrence Frequency. Additionally, a choice has to be made between two clustering approaches namely hierarchical and partitioned clustering [14, 27]. Hierarchical clustering was chosen [27] as the best option for this exploratory study. The decision between the four most used linkage methods (linkage, single linkage, average linkage, and Ward method) [27] and use of an agglomerative or divisive logic were deferred to the analytical phase.

Finally, the Bayesian Information Criterion (BIC) was used to evaluate the quality of various clustering models. After performing numerous iterations of hierarchical clustering the correlation of variables with the discovered solutions was determined using the Cramer's V test [6]. The test resulted in the identification of three variables that could be omitted.

After multiple discussions among the authors and interpretation cycles, the solution with 5 clusters was chosen, table 3 summarizes the parameters used to find this solution.

4 RESULTS

Cluster 1 Long term research projects

The cluster is defined by DCs that aim to enhance research in a variety of areas, with a particular emphasis on international initiatives that provide novel solutions to health problems through the pooling and reuse of data from diverse sources. 88 % of the projects are international, while only 11% have a clearly defined objective. Although the project purpose is predefined in just 11% of cases, compared to a dataset average of 52%, this does not preclude the establishment of explicit social purposes. The data utilized in this cluster is frequently secondary. This is especially true for health-related projects: Twelve out of thirteen make use of secondary data, which are data obtained from (or given by) patients and then used by researchers to advance medical research. A low presence of local and national government institutions (5,5 percent compared to an average of 47,5 percent) is observable.

Cluster 2: Emergencies' response

The second cluster offers a clear interpretation, indeed 22 out of 23 projects are born to provide urgent responses to humanitarian crises caused by natural disasters or more recently by the COVID-19 pandemics. Numerous variables analysed support this interpretation: their social aims, as well as the duration of their programs, are closely linked to the emergency situation. The majority of projects (56.5 %) use as collaborative framework "Research and Analysis Partnerships," while the second most popular approach is called "Intelligence Generation," in which one partner conducts the analysis and the others use the output to improve their operations (for example, aids distribution); additionally, all of the cases in this cluster use tertiary sources of data that are not directly related to the phenomena they are used for.

Not-for-profit and civil society groups participate rarely, although all DCs in the cluster involve the business sector.

Cluster 3: Structural effort to improve quality of life

The third cluster is the most varied, and its interpretation may be less obvious as a result; yet, certain parts appear to be distinctive. The majority of the initiatives in this cluster are continuous in nature (92.7% respect to an average of 65%). The public sector is involved in the 85 % of DC, compared to an industry average of 47.4 %. The areas touched by these projects vary in size, but the majority span a city (17%), a nation (41.5%), or a continent (29.3 %).

Indeed, 12 of the 13 projects in the dataset that fall under the category "implement cities smart management" are part of this cluster and they constitute almost one-third of the collaboratives in the cluster. Intelligence generation initiatives (31.7 % of the cluster's total), data pools (17.1%), and public interfaces (12.2%) all exceed the dataset's average (respectively, 15.6 %, 13.3% and 9.6%).

Finally, over one-third (29,3%) of the cluster's projects have a clearly defined profitability model, an occurrence that is 9 percent higher than the average and consistent with the cluster's goal of continuing collaborations.

Cluster 4: Data-driven innovative studies

The fourth cluster is motivated by the availability of data rather than the resolution of a social need, and hence is classified as "data driven."

In terms of collaborative frameworks, the cluster is mostly constituted of Research Partnerships, Prizes and Challenges, and Public Interfaces, with the last two abundantly more frequent than the dataset's average. Collaboratives in the cluster are event-driven (40.6 %, compared to the dataset's average of 26.7 %), and they aim to have a global influence on a variety of issues. Indeed, upon examination of the impacts, the majority of data collaboratives in the fourth cluster fall under the category of "Multiple social goals" (56.3%).

Finally, it's interesting to note how the cluster's initiatives incorporate a diverse range of actors, with a strong presence of civil society actors (87.5% respect to an average of 68,8%).

Cluster 5: External responses to structural problems

The fifth cluster is defined by multinational initiatives that have been undertaken to address structural issues mostly in less developed countries. This interpretation is supported by the fact that

Table 1: Variables in the dataset and details on those used for the analysis

Macro dimension	Variable name	Description	Possible values	Exclusion criteria	Literature
Organizational	Data collaborative type	The type of governance used by the data collaborative, defined by engagement and accessibility	Public Interfaces, Trusted Intermediary, Data Pooling, Research and Analysis Partnership, Prizes and Challenges, Intelligence generation	Included	Verhulst, Young et al. (2019)
	Main Sector	The main sector to which the project belongs	Agriculture, Criminal Justice, Crisis Response, Digital Society, Economic Development, Education, Environment, Health, Infrastructure, Transportation, Telecommunications	Redundant with the "Data collaborative type" and "Macro Impact" variables, less structured and informative	datacollaborative.org
	Multiple sectors	If the project spans multiple sectors, this attribute accounts for their number	Numbers going from 2 to 11 (the total number of possible sectors)	Considered of low value for a clustering analysis, both for the information it embeds, both for the lack of a properly formalized method used to analyse the sectors of a project in the repository	datacollaborative.org
	Status	What is the present status of the project	Ongoing, Concluded, Failed	Not adding valuable information to the analysis	-
	Clear Link with Profitability	Whether the project has a potential to be profitable for the data sharing organization outside of image effects	Yes, No	Excluded in the data analysis phase because of a low correlation with the clustering labels (Cramer's V test < 0,2	Klein, Verhulst (2017)
	Clear Objective	Whether the project has a clear and specific purpose, or if it has a more flexible (or unspecified) objective	Yes, No	Included	Gil-Garcia et al. (2007) Susha et al. (2017, taxonomy)
	(Actors involved) Public	Whether the public sector participates in the data collaborative	Yes, No	Included	Adapted from Susha, Grönlund, Van Tulder (2019)
	(Actors involved) Private	Whether the private sector participates in the data collaborative	Yes, No	Excluded in the data analysis phase because of a low correlation with the clustering labels (Cramer's V test < 0,2)	Adapted from Susha, Grönlund, Van Tulder (2019)
	(Actors involved) Not-for-profit	Whether the Not-for-profit organizations participate in the data collaborative	Yes, No	Excluded in the data analysis phase because of a low correlation with the clustering labels (Cramer's V test < 0,2	Adapted from Susha, Grönlund, Van Tulder (2019)
	(Actors involved) Civil society organizations	Whether the civil society organizations (international organizations, researchers, universities, citizens and their representative) participates in the data collaborative	Yes, No	Included	Rasche et al. (2019)
Technological	Data Purpose	The difference between the purpose for which data was initially collected and the one for which it is used in the collaborative	Primary, Secondary, Tertiary, Multiple data sources	Included	Susha, Janseen, Verhulst (2017)
	Type of data used	The type of data used by the collaborative, based on four non-exclusive categories of data	Disclose personal data, Observed personal data, Disclosed non-personal data, Observed non-personal data	Excluded because of missing data in the dataset	datacollaborative.org
Technological and Organizational	Continuity	How data are released and accessed by partners on a time dimension	Continuous, Event-Based, On demand	Included	Susha et al. (2017, taxonomy) Van de Broek, Van Veenstra (2018)

Table 1: (*Continued*)

Macro dimension	Variable name	Description	Possible values	Exclusion criteria	Literature
Contextual	Region	Geographical location of the project	Either the country in which the project has effect, its continent or worldwide	Excluded because of different granularity of data and unclarity to the subject to which it is referred (promoters, beneficiaries, data owners)	datacollaborative.org
	Extension	What is the geographical extension of the project impact	City, Area, Country, Continent, Worldwide	Included	-
Outcome	Clearly Social	Whether the generation of social impact is the primary goal of the project or it coexist with other actors' personal interests.	Yes, No	Included	Adaptation of Susha, Rukanova et al. (2019)
	Impact categories	The specific impact of the project	One of the 30 impacts identified by the inductive content analysis (see table 2)	Many different values possible, and redundant with the "Macro impact" attribute	Inductive content analysis Verhulst, Sangokoya (2015)
	High level impact dimension	The social impact domain of the project	One of the 10 categories identified by the inductive content analysis (see table 2)	Included	Inductive content analysis Verhulst, Sangokoya (2015)

this cluster is the most reliant on international collaboration, with 71.4 percent of initiatives involving players from various countries and more than half of programs affecting low- and middle-income nations (based on 2021 data, per World Population Review[4].

In comparison to other clusters, a higher proportion of projects seek to have an impact at the country level (62% against an average of 32%), a finding that contrasts with the almost non-existent participation of public institutions in these collaboratives, which is partially offset by the 92.2 percent of projects involving civil society institutions. 66.7 % of projects are research and analysis partnerships and 14.3% involve intelligence generation, demonstrating the popularity of exploratory initiatives. Additionally, the great majority of initiatives rely on tertiary data sources, with only two utilizing secondary and primary sources, respectively. It's also worth noting that collaboratives in this cluster are nearly entirely focused on generating social impact, nearly to the exclusion of other types of interests.

5 DISCUSSION

The research contributes to literature in several ways.

The identification of five clusters, each corresponding to a different archetype of DC, using quantitative methods and a refined DC database, added new evidence to existing classifications [18, 29]. Given the attention received by the topic at research and institutional level, and considering the initial advocacy phase on DC accomplished, findings suggest that future studies should vertically focus on one or more of the identified clusters, on the basis of their scope and research objectives.

DC may be based on a temporary agreement, as is the case with clusters 2 and 4, their origins, as well as their outcomes, remain restricted to emergency situations or the intent of a single player to create a data analysis challenge. Given their temporary nature, it is difficult to conceive models and development paths that could transform these partnership in long-term sustainable organizations, which would probably denaturize them.

Other clusters, such as 1, 3, and 5, are built on more stable types of collaboration, although only a few collaboratives have a defined business model [23]. Business models may be based on entirely commercial revenues or a combination of different income sources (i.e. revenues, grants, donations). The research community should develop new governance and business models that are compliant with the incoming legal framework in order to speed not just data sharing across different players, but also economic transactions based on data.

Demonstrating the impact of DCs was not within the scope of this research and was not possible using secondary data; however, we recognize its importance in legitimizing DCs and promoting their adoption and creation [15, 26, 28] and thus call for additional effort in this area. This proof may be especially useful in engaging the public sector and legitimizing DC's role as suppliers of public services.

Additionally, the study has methodological implications, demonstrating the efficacy of categorical variable cluster analysis in extracting common patterns of organizational evolution.

6 CONCLUSION

While the data sharing movement and the use of data for social objectives have gained significant attention in recent years, researchers have struggled to sustain theoretical studies with empirical data. The research began therefore with a review of the literature in order to determine features that may be used to filter an existing dataset on DC. Filtering on four dimensions resulted in the creation of a dataset of 135 DC. Secondary data gathering was used to identify and populate variables that characterize DC. Data were analysed using a categorical variable clustering technique, which resulted in the identification of five clusters, each of

[4]https://worldpopulationreview.com/country-rankings/median-income-by-country)

which corresponds to one DC's archetypes. These archetypes were characterized using 18 variables, which resulted in the emergence of peculiarities, constraints, and difficulties throughout their development. Their capability to engage the public sector, to establish business models capable of sustaining their operation over time, and to show the impacts achieved by devoted analysis are all critical to their development and long-term sustainability. Research should deliberately focus its efforts on one or more of the data collaborative archetypes, depending on the nature and scope of the study.

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Enhancing European Interoperability Frameworks to Leverage Mobile Cross-Border Services in Europe

Andreea Ancuta Corici
andreea.ancuta.corici@fokus.fraunhofer.de
Fraunhofer FOKUS Institute
Germany

Thomas Zefferer
thomas.zefferer@a-sit.at
A-SIT
Austria

Blaz Podgorelec
blaz.podgorelec@iaik.tugraz.at
Graz Technical University
Austria

Detlef Hühnlein
detlef.huehnlein@ecsec.de
ecsec GmbH
Germany

Jordi Cucurull
jordi.cucurull@scytl.com
Scytl
Spain

Hans Graux
hans.graux@timelex.eu
Timelex
Belgium

Stefan Dedovic
stefan.dedovic@ut.ee
University of Tartu
Estonia

Bogdan Romanov
bogdan.romanov@ut.ee
University of Tartu
Estonia

Carsten Schmidt
carsten.schmidt@ut.ee
University of Tartu
Estonia

Robert Krimmer
robert.krimmer@ut.ee
University of Tartu
Estonia

ABSTRACT

In times where personal contacts must be reduced and in-person meetings and appointments have become difficult, electronic services are continuously gaining relevance. This especially applies to the public-sector domain, where e-government services have become a main pillar for the interaction between citizens and public administrations. In the European Union (EU), such service must not only be provided on national level but must be made accessible to all EU citizens, in order to satisfy the needs of a converging European society. The EU and its legal bodies support the provision of pan-European e-government services by means of various legal and technical frameworks. Two relevant frameworks in this context are the Single Digital Gateway Regulation, which facilitates cross-border retrieval of user data, and the eIDAS Regulation, which enables authentication of users across borders by federating the EU Member States' national identity management systems. While each framework has already successfully proven its potential individually, challenges arise when both frameworks are combined and jointly used by e-government services. This effect is even aggravated, if these e-government services do not follow a classical browser-based paradigm, but instead make use of and rely on mobile technologies. The Horizon 2020 project mGov4EU tackles these challenges. It develops technical solutions to help e-government services employ the full potential of the SDG and the eIDAS Regulation. Thereby, it especially focuses on mobile, i.e., app-based services. Technical solutions developed by mGov4EU will be evaluated by means of several mobile pilot applications. This paper identifies and describes the challenges addressed by mGov4EU and introduces mGov4EU's solutions to overcome them. This way, this paper proposes a strategy to leverage the full potential of SDG and eIDAS also in mobile application scenarios, and hence paves the way for future successful mobile cross-border services.

CCS CONCEPTS

• **Security and privacy** → **Domain-specific security and privacy architectures**; • **Information systems** → *Specialized information retrieval*.

KEYWORDS

eGov, SDGR, eIDAS, eSignature, Digital Wallet, Access Control, OAuth2.0, iVoting

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1 INTRODUCTION

The EU Regulation on electronic identification and trust services for electronic transactions in the internal market ("eIDAS Regulation") [2] provides the legal basis for federating national electronic-identity management systems ("eID systems") from EU

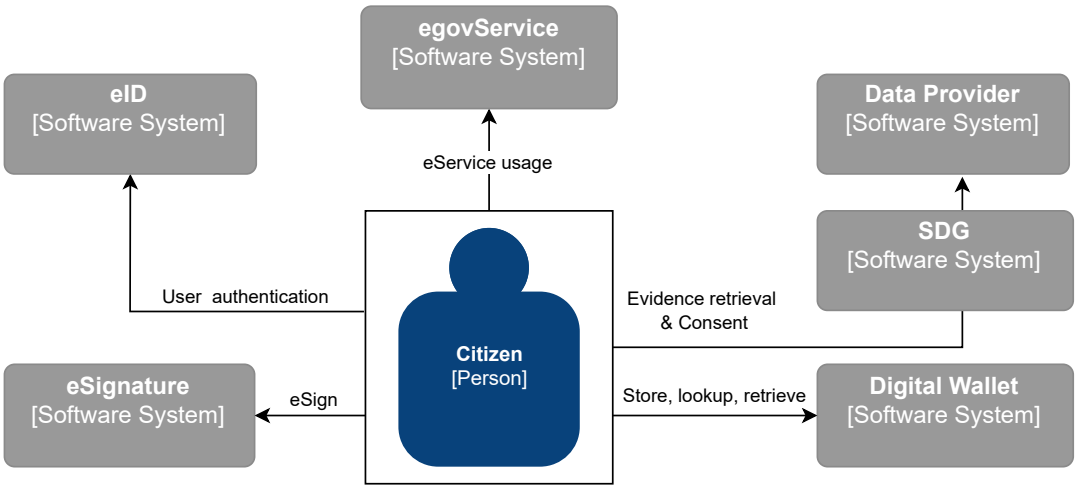


Figure 1: eGov general cross-border usecase targeted by mGov4EU project

member states (MS) and for using electronic signatures and seals across the EU.

The technical interoperability system that has been developed on that legal basis enables citizens of an EU MS to authenticate with their personal national eID to authenticate at governmental bodies and service providers applications from other EU MS (see Fig. 1).

The Single Digital Gateway Regulation (SDGR) [33] aims at "facilitating online access to the information, administrative procedures and assistance services that citizens and businesses need" in a cross-border context, in order to enable the citizens "to trade, establish themselves and expand their businesses in another Member State". One of the procedures is the Evidence retrieval, where Evidence defines an official, governmental document.

With the Proposal for a European Digital Identity (EUid) [6] and Revision of the eIDAS Regulation, the European Commission aims to give users direct control of their identity data by means of digital wallets. While most technical details are yet to be defined, the foreseen revision of the eIDAS Regulation and the introduction of a European Digital Identity will cause a paradigm shift and will extend existing eID systems by wallet components that enable offline scenarios.

To enable third party agencies, coming from business and eGov, to make use of the Evidence and relieve the citizen from the burden of providing the data as a copy, supporting the EU data protection regulation (GDPR) [1] is necessary. Thus, citizens need to be empowered to manage the access to their data, in this case eGov Evidences, through user-friendly (mobile based) access control interfaces.

The mGov4EU project is focusing on leveraging these evolving technologies and initiatives for building a platform for online eGov services that citizens can access from a mobile device in a cross-border context due to moving to another Member State or having multiple citizenships, eIDs and residencies.

This article presents the system design of mGov4EU platform that brings together the domains of eID, SDG and eSignature. The building blocks associated with these domains are aligned with the recently proposed regulation for the trusted and secure European e-ID [6] introducing the European Digital Wallet empowering both natural and legal persons to use cross-border digital identity solutions. The following sections are structured as following: Section 2 introduces the background, Section 3 presents the system requirements, Section 4 describes the system design based on the description of an overall architecture and domain specific building blocks and Section 5 depicts one of the project's pilot usecases related to Internet voting. Section 6 analyzes the potential sustainability of the project results and Section 7 provides the conclusion and outlook towards the future work.

2 BACKGROUND

Over the last decade the EU has been initiating and investing in the development of the cross-border e-services within the EU through several policies, funding programmes and political communications. In 2015 one of the main initiatives related to enabling the cross-border digital public services was the adoption of the Digital Single Market (DSM). This Initiative aims to create an ecosystem in which citizens and businesses can access the online services irrespective of their place of residence [25].

The main regulations that the EU has adopted to enable DSM for cross-border e-services are eIDAS and Single Digital Gateway Regulation (SDGR) [33]. The eIDAS regulation aims to enable the mutual recognition of the nationally issued eID means, e-signatures and trust services across the EU, while SDG regulation aims to facilitate the online access to administrative procedures through a central point of access to public administration, thus fostering cross-border digital public services. The implementing act specifying more details of the SDGR conform system is planned to be released by the end of 2021. In this dynamic context, the requirements analysis against the background in terms of eID, cross-border data exchange, access control, eSignature and Digital Wallet play a major role in the design of the mGov4EU platform.

One of the initiatives that is currently running in parallel is GAIA-X, from the German Ministry of Economy and Climate Protection

(BMWK, formely known as BMWi), with a suite of projects focusing on different areas of digital services, e.g. eGov and eHealth. The GAIA-X technical architecture [28] presents similarities regarding the concepts of Data Consumer and Data Provider, the resulting discover-ability of services as well as the transition to self-sovereignty through verifiable credentials. At the same time, the mGov4EU tackles a very specific domain of eGov and mobile identity that has to stay interoperable with the eIDAS/eIDAS 2.0 (proposed) regulation. From this constraint, a major difference emerges, as mGov4EU is a project targeting cross-border scenarios between two Member States and the GAIA-X is only on the side touching this point.

2.1 Identity Management

EU member states had started to roll out national eID systems long before the eIDAS regulation came into force. These national eID systems have enabled citizens to securely authenticate at service providers in online applications. Early implementations of national eID systems have typically relied on **smart-card technologies**. Citizens have been issued with personalized smart cards, which they could use for securely logging in to online services. Mainly for usability reasons, user acceptance of smart card based solutions remained low in most countries. In recent years, **mobile eID solutions** have hence emerged in various countries as alternative to smart card based approaches.

For many years, the use of national eID systems has been limited to the own country, preventing authentication at foreign service providers. For instance, a German citizen was unable to authenticate at an Austrian service provider using her German national eID. The eIDAS Regulation has tackled this issue by defining a legal and technical framework to achieve interoperability between the various national eID systems of the different EU member states. The current implementation of the eIDAS interoperability framework relies heavily on the identity-management protocol SAML2 [11] and implicitly assumes the use of web browsers on classical end-user devices like desktop computers or laptops. This raises challenges when the technical interoperability framework needs to be used in mobile-only scenarios, where mobile end-user devices such as smartphones are involved, mobile apps are used instead of web browsers, and Open-ID Connect [31] replaces SAML2 as the preferred identity-management protocol, due to its easier applicability on mobile environments. The solution presented in this paper addresses this issue by enhancing the current technical eIDAS interoperability system such that it can support mobile-only scenarios as well.

In offline scenarios, identity information is not fetched from a central identity provider but exchanged directly between the user and the requesting service provider using a user-controlled wallet, which stores required attributes. By excluding the central identity provider from the authentication process, the user's privacy is enhanced, as the identity provider cannot learn at which service providers the user has authenticated.

2.2 Single Digital Gateway

On the technical level, the Single Digital Gateway Regulation of EU wide cross-border digital public services has its roots on the eDelivery building-block [12] and the Once-Only Principle (OOP) [15] stemming from the Connecting Europe Facility (CEF) funding programme. Unfortunately the understanding of the Once Only Principle varies. In some countries, for instance in Estonia, it means that all data needs to be stored in only one database, while in France, the term is more general and means that citizens and businesses need to provide personal data only once [26]. The main goal EU wide agreed consists in reducing administrative burdens on citizens and businesses.

The eDelivery framework includes specifications based on OASIS standards like the AS4 Profile message protocol for secure and payload-agnostic exchange of data and the Service Metadata Protocol (SMP) [3] for dynamically discover the capabilities of the nodes, that can be used for finding the appropriate server storing a specific document type.

The eDelivery architecture is based on a four-corner model, as can be seen in Fig. 2. This means that the Evidences (eGov documents) pass through four layers - the backend of the sender (C1), the senders' Access Point (C2), the receiver Access Point (C3) and the backend of the receiver (C4). The communication between these layers is enabled by the AS4 messaging protocol. The Access Points are the nodes that enable the technical interoperability between the heterogeneous IT systems in the EU.

With the Single Digital Gateway Regulation (SDGR) [33], the requirements for the EU cross-border communication system of digital public services for retrieving governmental documents were defined. The regulation clarifies the need for the system to support national nodes per Member State (MS) and EU central nodes that communicate in order to enable exchange of governmental documents between the Data Consumer and the Data Provider. The Data Consumer (DC) acting as the communication end hop on the Evidence requester (citizen or business) can use the SDG infrastructure for enabling retrieval of a citizen evidence from a Data Provider (DP) - the software component of the Evidence provider (the national authority).

2.3 Access Control

The User Managed Access (UMA) extension of the OAuth2.0 authorization framework [22] was defined by the Kantara initiative [4] and enables a requesting 3rd Party agent to use a permission token to request an OAuth 2.0 access token, e.g. JSON Web Tokens [24], for gaining access to a protected resource, in other words consent management. A very important aspect is that the process is asynchronous: the resource owner receives a notification of access request and only after the owner adds/modifies the access policies will then be an access token generated for the 3rd Party to access the data resource.

The access-right type defined by the data regulation GDPR [1] and considered by mGov4EU regarding a citizen Evidence is the right of reading, more exactly download. Several initiatives and projects have analysed the GDPR from the Semantic-Web point of view. We limit the list of the resulting descriptions to one of the most relevant: the Data Privacy Vocabulary (DPV) [5] from W3C. Such a vocabulary is meant to be implemented on an authorization server in order to encode the access policies.

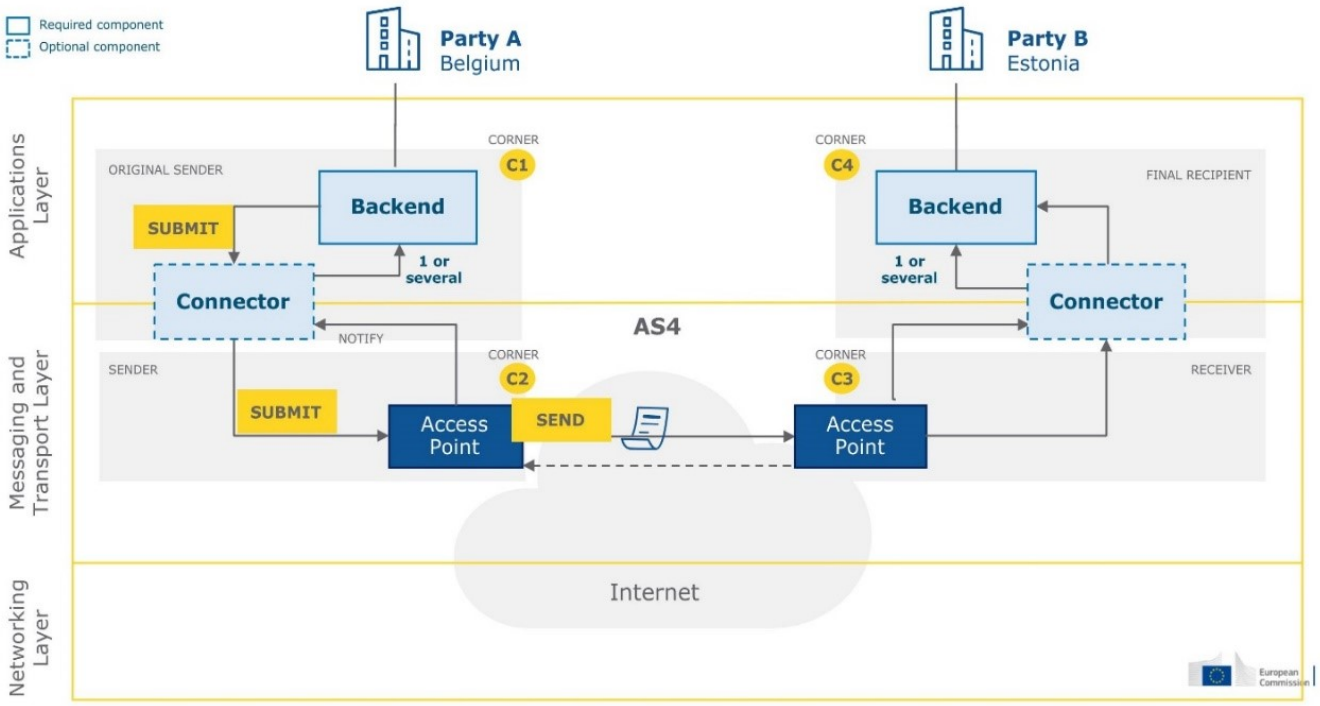


Figure 2: eDelivery 4 corner model [21]

2.4 eSignature

The eIDAS-Regulation [8] provides the legal framework for trust services for electronic transactions in the internal market. The regulation defines the legal effects of electronic signatures and seals, as well as requirements for advanced and qualified electronic signatures and seals. Art. 26 (b) of the eIDAS-Regulation [8] requires that an advanced electronic signature "is capable of identifying the signatory". While this requirement is typically implemented using digital certificates based on the X.509 standard [23], the legal framework of the regulation is technology-agnostic and independent of the specific implementation and hence allows other technical implementations as well. An alternative approach for creating advanced electronic signatures, which is in line with pertinent European norms [18–20] and applied within mGov4EU, is to combine electronic identification with an advanced electronic seal in which the result of the identification is embedded as SAML2 assertion [11] for example. This approach is especially attractive for eID means which are not capable of creating digital signatures itself, like the German eID ("Personalausweis") for example.

2.5 Digital Wallet

The term Digital Wallet has been used in different contexts over the past few decades. In the past, digital wallets have been mainly mentioned in the context of finance technology (Fintech) [9]. There, digital wallets were primarily associated with digital payments. Only recently, concepts behind digital wallets have also found their way to the identity-management domain.

With the latest advancement of the user-centric identity management model, including Self-Sovereign Identity (SSI), the term digital wallet has also been adopted from a digital identity perspective [29]. The already mentioned European Commission [6] proposal of a European Digital Identity (EUid) relies on the term Digital Identity Wallet to support citizens in maintaining control of their identity data when performing online interactions. In this context, Digital Wallets can be compared with physical wallets, which people use to store, manage, and use identity data in physical format (e.g., identity cards, student cards, etc.). In such a physical setting, the use of identity data (e.g., identity card) refers to the presentation of this data to a third party, who can assess the data holder's identity based on the presented identity data (e.g., identity card). In a digital setting, the identity data is present in electronic form and stored within a digital wallet. Thus, using the identity data refers to electronically transmitting the identity data to a receiver [30].

3 SYSTEM REQUIREMENTS ANALYSIS

This section identifies relevant system requirements that must be considered during design and implementation of the proposed solution. The mGov4EU project mainly focuses on combining the SDG and the eIDAS frameworks. Accordingly, relevant requirements can be derived directly from the respective legal bases.

When analyzing the Single Digital Gateway Regulation (SDGR) [33], on the side of the evidence requester (the citizen or the third party organization), the information system:

- Must inform users on the procedure steps and necessary identification

- Must allow users to request evidences that could be submitted directly too
- Must rely on eIDAS eIDs
- Could rely on eID Attributes or evidence provided from the digital wallet
- Only one identification process may be required (federation), unless required Level of Assurance (LoA) changes
- Explicit request requires the name of the provider and the evidence type
- Evidence request elements are defined (logging and accountability)
- Portal of the evidence requester must provide a preview space

Regarding the interaction with the evidence providers (including intermediaries), the information system:

- Must support eDelivery Access Points
- Must be able to receive and pass on evidence or evidence references
- Could be able to provide evidence or evidence references to be stored to Digital Wallet

Relevant system requirements for the proposed solution's eID part can be derived directly from the eIDAS Regulation and its related legal provisions. These requirements can be summarized as follows:

- Users must be able to authenticate at foreign service providers using their respective national eID means.
- User authentication takes place in the user's home country, i.e. the user must be redirected through the eIDAS framework from the service provider located in a foreign country to the eID system in her home country.
- The cross-border authentication process must be widely transparent to the service provider, i.e., the process for the server provier should be the same irrespective whether authentication is done nationally or delegated to another country.
- The user must be able to select her home country during the authentication process.
- The system should also support to use of identity wallets for providing required identity attributes. This means that during authentication user identity data can also be fetched from a digital wallet instead of the eID system in the user's home country.

For supporting the European Digital Identity, in the course of being regulated by the European Commission [6], the digital wallet is required to store and manage eID attributes for identification and authentication purposes towards online services.

The mGov4EU project aims to provide solutions especially for mobile usage scenarios, in which users access e-government services via a mobile app instead of web browsers. Accordingly, the above-mentioned requirements can be amended by the additional requirement that the proposed solutions must be compatible with purely mobile usage scenarios. Furthermore, they need to integrate tightly into existing mobile infrastructures. For instance, the resulting solution must provide support for those platforms and protocols that are already established and broadly used in mobile scenarios.

4 SYSTEM DESIGN AND INNOVATIVE ASPECTS

This section shows how the presented solution, with the architecture depicted in Fig. 3, combines various building blocks from the related domains for enabling citizens mobile cross-border services in order to meet the system requirements defined in Section 3.

4.1 Overall Architecture

Some of the mGov4EU project's innovations are related to integrating SDGR and eIDAS related building blocks, supporting Single Sign On across EU Member States and introducing user-managed access control for downloading eGov evidences. Considering the SDGR, another innovation of mGov4EU is to use the citizen's digital wallet for storing downloaded eGov evidence in a predefined digital format and thus allow the citizen an user-controlled management over the usage towards online services.

The resulting software architecture of the mGov4EU project depicted in Fig. 3 has been developed following the C4 modelling approach [10]. Following the established terminology of the C4 modelling method, each relevant (in our case innovative) building block denotes an individual System and is marked in blue and the legacy (e.g. National eID System, SDG infrastructure) and general building blocks (e.g. Data Provider and Service Provider) are marked in grey. The overall architecture contains the following five systems related to: eSignature, eSignature Interoperability, SDG Interoperability, eID Interoperability and Digital Wallet.

The entry point for the user is the Service Provider System, which implements and provides to the user a specific service, e.g., by means of a web application or a mobile app. In most cases, the Service Provider System asks the user to authenticate before access to provided services is granted. The user hence is routed to a suitable identity provider that can assert the user's identity. This routing can be challenging especially in technically heterogeneous cross-border settings, where specifics of national identity providers are typically unknown to the Service Provider System. The required routing functionality is implemented and provided by the proposed solution's eID Interoperability System, which redirects the user to a suitable national eID System acting as identity provider and asserting the user's identity. Alternatively, the role of the identity provider can also be assumed by the proposed solution's Digital Wallet System, which can store the user's identity information and can provide this information to the Service Provider System. This can be especially relevant in mobile use cases and usage scenarios, which the proposed solution is mainly targeting.

The role of the eSignature Interoperability System is similar to the eID Interoperability System in the sense that it routes the user to an intended system. However, in the case of the eSignature Interoperability System the routing target is not an identity provider but a suitable eSignature System, which enables the user to create (qualified) electronic signatures when requested by the Service Provider System. Note that in most cases the eSignature System, which the user is routed to, requires identification and authentication of the user. This is carried out in the same manner as identification and authentication at a Service Provider as described above. Hence, in this context the eSignature Systems assumes the role of a Service Provider System. After successful user authentication (either via

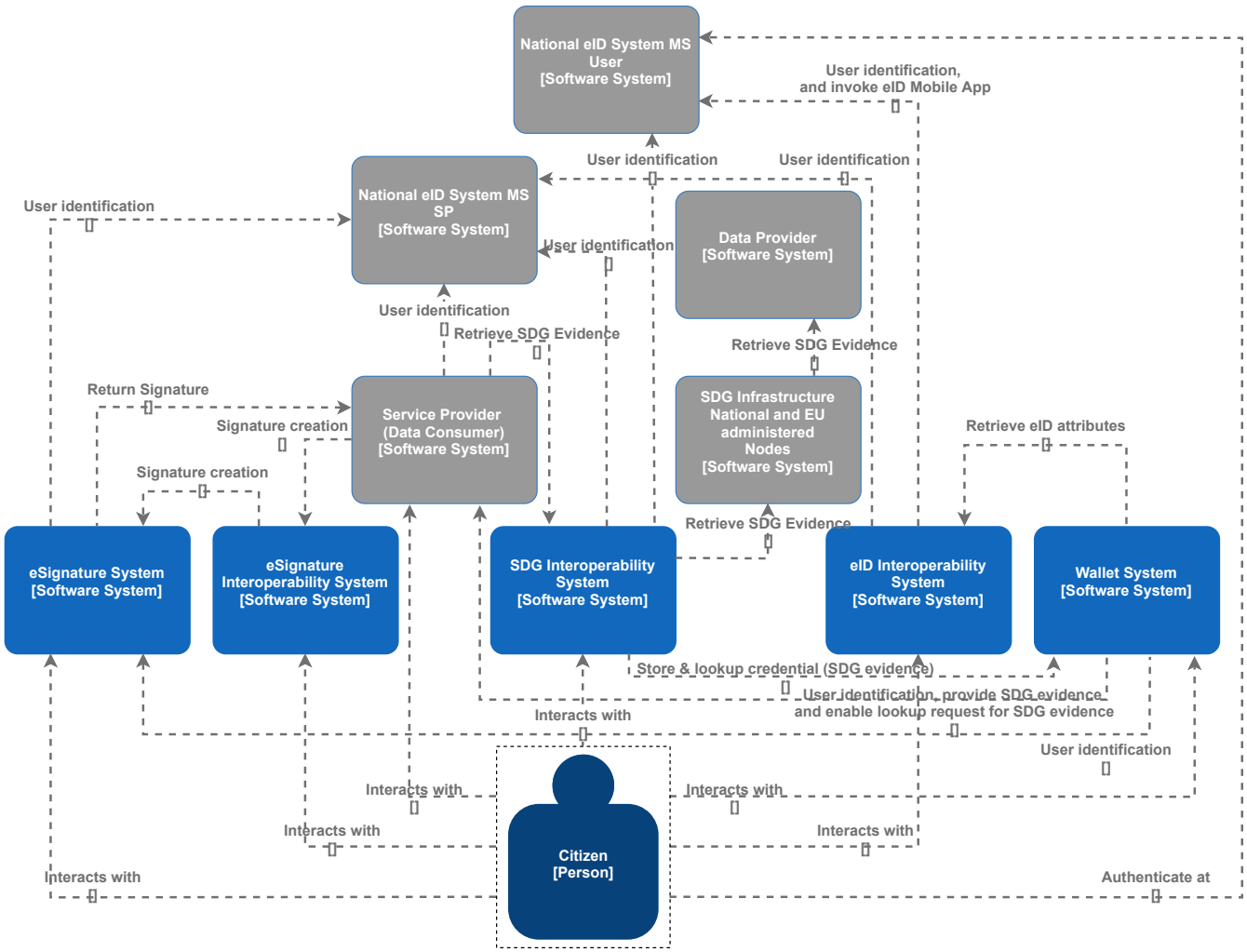


Figure 3: mGov4EU System Landscape diagram.

a national eID system or a digital wallet), the eSignature System creates the requested electronic signature on behalf of the user and returns it to the requesting Service Provider System.

Finally, also the SDG Interoperability System can be utilized by the Service Provider System (i.e., a Data Consumer in SDG terminology), if cross-border retrieval of any SDGR-related evidence is needed. Thus, the SDG Interoperability System provides a feature to retrieve requested evidences through existing SDG Infrastructure from an Data Provider. Retrieved evidences can then be forwarded to the Service Provider System and optionally also be stored in the user's Digital Wallet. If the SDG Interoperability System requires user identification and authentication, similar considerations apply as for the eSignature Interoperability System. The SDG Interoperability System assumes the role of a Service Provider System and employs necessary eID-related Systems to authenticate users or validate that the service request is part of a Single Sign-On session.

The subsequent subsections focus on the overall solution's various Systems and explore their internals.

4.2 eID Interoperability System

The eID Interoperability System, depicted in Fig. 4, provides components that enable cross-border authentication processes based on national eID solutions in mobile-only scenarios. It relies on components of the eIDAS technical interoperability framework but enhances these components to make them mobile-enabled. Thereby, the System supports two basic cross-border authentication scenarios.

In both scenarios, a User from Country A aims to authenticate with his National eID at a Service Provider from Country B (which can also be the SDG Interoperability System or the eSignature System) using an eID issued by Country A.

- In the first scenario, the eID Interoperability System forwards the User from the Service Provider in Country B to the User's National eID System in Country A, where the User is authenticated. The User's identity data is obtained

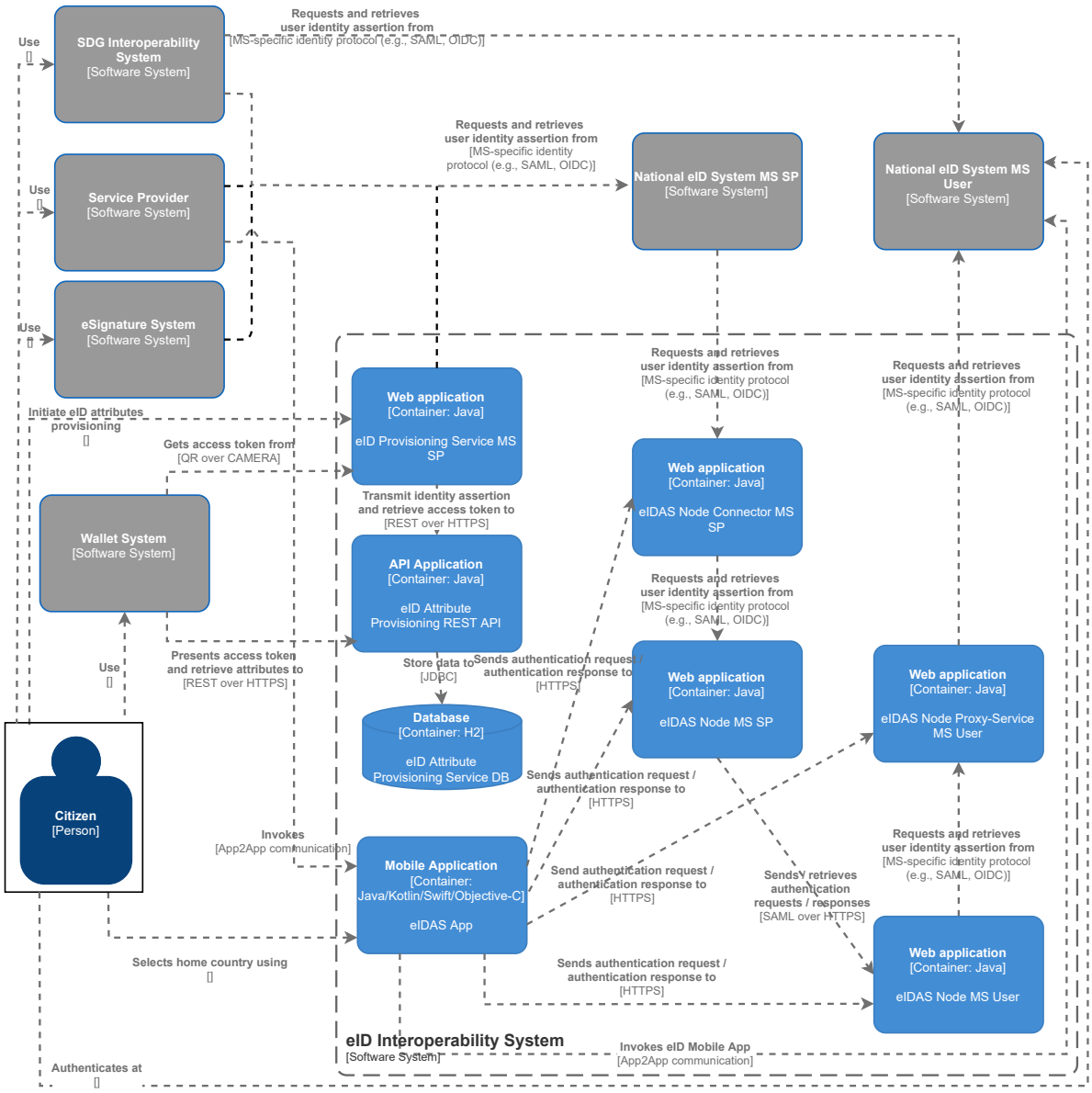


Figure 4: eID interoperability system components and interfaces

from the respective eID System and transferred back to the Service Provider in Country B.

- In the second scenario, the eID System in Country A is not contacted, but required identity data is fetched from the Digital Wallet (i.e., through Digital Wallet System) and transmitted directly from that System to the Service Provider in Country B.

In general, the following variants on how eID attributes could be provided to the Digital Wallet and how later users could use those eID attributes from Digital Wallet for cross-border identification and authentication towards Relying Party (i.e., Service Provider) can be identified:

- Variant A: eID attributes of User from Country A are to Digital Wallet provisioned via National eID System from Service Provider Country B using eIDAS Interoperability Framework. [*Provisioning-SP-Country*]
- Variant B: eID attributes of User from Country A are to Digital Wallet provisioned directly from National eID System from User Country A, i.e., eIDAS Interoperability Framework is not utilized. [*Provisioning-User-Country*]

For both variants, it is assumed that the User already possesses a valid (notified) eID means that can be used to authenticate at foreign Service Provider based on the eIDAS Interoperability Framework.

As shown in Fig. 4, the proposed solution applies [*Provisioning-SP-Country*] to avoid potential identity matching issues in the cross-border context, which may appear if the User Country is not the same as Service Provider's Country.

Identity matching becomes necessary, when the Service Provider Country receives eID attributes from another country via the eIDAS interoperability framework and needs to map these attributes to the user's existing attributes already stored in the SP country. This can be challenging as the set of required and stored eID attributes typically differs between different countries. The eID attributes are provisioned to the User's Digital Wallet through the newly introduced eID Provisioning Service, located in Service Provider Country and thus connected to Service Provider's National eID System. The eID Provisioning Service is a web application via which the User initiates provisioning of eID attributes. If the User is not from the same country as the service provider, authentication is performed by using the eIDAS Interoperability Framework as described before. After the User is authenticated, eID attributes are forwarded to the eID provisioning service and a QR code is displayed to the User, which encodes an access token. The access token is collected using a mobile device camera and used to establish an authenticated channel to the eID Attribute Provisioning REST API. eID attributes can then be fetched into a digital wallet through this channel. Users can later use those eID attributes to identify and authenticate themselves towards Service Providers from which country the eID attributes were provisioned. Focusing on cross-border aspects, if Service Provider national eID System provides eID attributes after a user was identified and authenticated via the eIDAS Interoperability Framework, the eID attributes are already in the format that Service Providers in that Country expect. In contrast, if the User national eID System provides eID attributes after identification and authentication through the User national eID System, eID attributes in Digital Wallet are not in the format that Service Provider from the non-user Country could expect. In that case, identity-matching problems may occur since some presented eID attributes are likely not in the same format fitting for Service Provider Country.

4.3 Digital Wallet System

In the scope of Digital Wallet, the identity-related data is here named Credential. This naming was mainly inspired by the Verifiable Credential Data Model [7], a W3C recommendation for expressing verifiable information on the Web, and an essential requirement that all identity-related data stored in the Digital Wallet should be verifiable. Thus, the term Credential could be described as a placeholder for any identity-related data and, in our case, annotates eIDAS (i.e., eID attributes) and SDGR (i.e., SDG evidence) related data.

As depicted in Fig. 5, a Digital Wallet is a mobile application that empowers Users to manage their Credentials in a user-controlled manner. Therefore the user can view, delete, store, and present credentials using this application. At the same time, all transactions, including credentials in the scope of the Digital Wallet, should be transparent to the user, i.e., with every transaction that includes identity-related data from the Digital Wallet, a user should be notified. Moreover, the user must consent before any credential is stored (i.e., provisioned) into a digital wallet or presented (i.e., used) outside the Digital Wallet.

Focusing on eID attributes, whose provisioning has been described above (see section 4.2), different variants on how eID attributes from a Digital Wallet in the cross-border setting could be provided towards Service Provider can be identified:

- Variant A: eID attributes are provided to the Service Provider via the existing eIDAS Interoperability Framework. [*Wallet-Auth-eIDAS*]
- Variant B: eID attributes are provided to the Service provider via a partially adopted eIDAS Interoperability Framework. [*Wallet-Auth-eIDAS-adopted*]
- Variant C: eID attributes are provided to the Service Provider directly, i.e., from a Digital Wallet to the Service Provider System. [*Walet-Auth-SP-direct*]

[*Wallet-Auth-eIDAS*] and [*Wallet-Auth-eIDAS-adopted*] foresee usage of the existing eIDAS Interoperability Framework. They could be relevant if the eID attributes have been provided to Digital Wallet as described in [*Provisioning-User-Country*] before. Cross-border identity matching is thus achieved via authentication towards Service Provider using eIDAS Interoperability Framework, i.e., eID attributes are in the expected format for Service Provider. However, direct authentication from the Digital wallet towards the Service Provider system is not possible, as this would bypass any component of the eIDAS Interoperability Framework, and thus, identity matching in a cross-border context cannot be achieved.

In contrast, the [*Wallet-Auth-SP-direct*] entirely drops the existing eIDAS Interoperability Framework when eID attributes from a digital wallet are used for authentication towards the Service Provider. But, [*Wallet-Auth-SP-direct*] is possible only if the eID attributes have been provided to the Digital Wallet by the Service Provider's national eID System, i.e., cross-border identity matching has been already performed within the eID attributes provisioning process - i.e., [*Provisioning-SP-Country*] has been applied for eID attributes provisioning. We chose to follow [*Provisioning-SP-Country*] (for details, see Section 4.2) for eID attributes provisioning, [*Wallet-Auth-SP-direct*] on how eID attributes are used for identification and authentication is applied. With [*Wallet-Auth-SP-direct*], the Service Provider could request eID Attributes directly from the Digital Wallet, thus enabling User authentication without interaction between intermediaries, i.e., national eID Systems or eID Interoperability Framework. In the same manner, as described in the Service Provider case, the Users can, with the usage of the Digital Wallet, authenticate themselves to any other system (e.g., eSignature or SDG Interoperability System).

Concerning the SDGR layer's relation towards the digital wallet, no system exists yet to the best of our knowledge, which combines two different concepts on how identity-related data should be managed. The mGov4EU Digital Wallet building block will enable that once the SDG evidence is obtained through the SDG Interoperability System, it could be stored via the SDG Infrastructure into the Digital Wallet. Moreover, the Digital Wallet also enables Service Providers to perform a lookup of stored SDG evidence against user approval. This feature prevents unnecessary evidence retrieval via SDG Infrastructure of an evidence stored in the Digital Wallet. This functionality increases the usability of the system and at the same

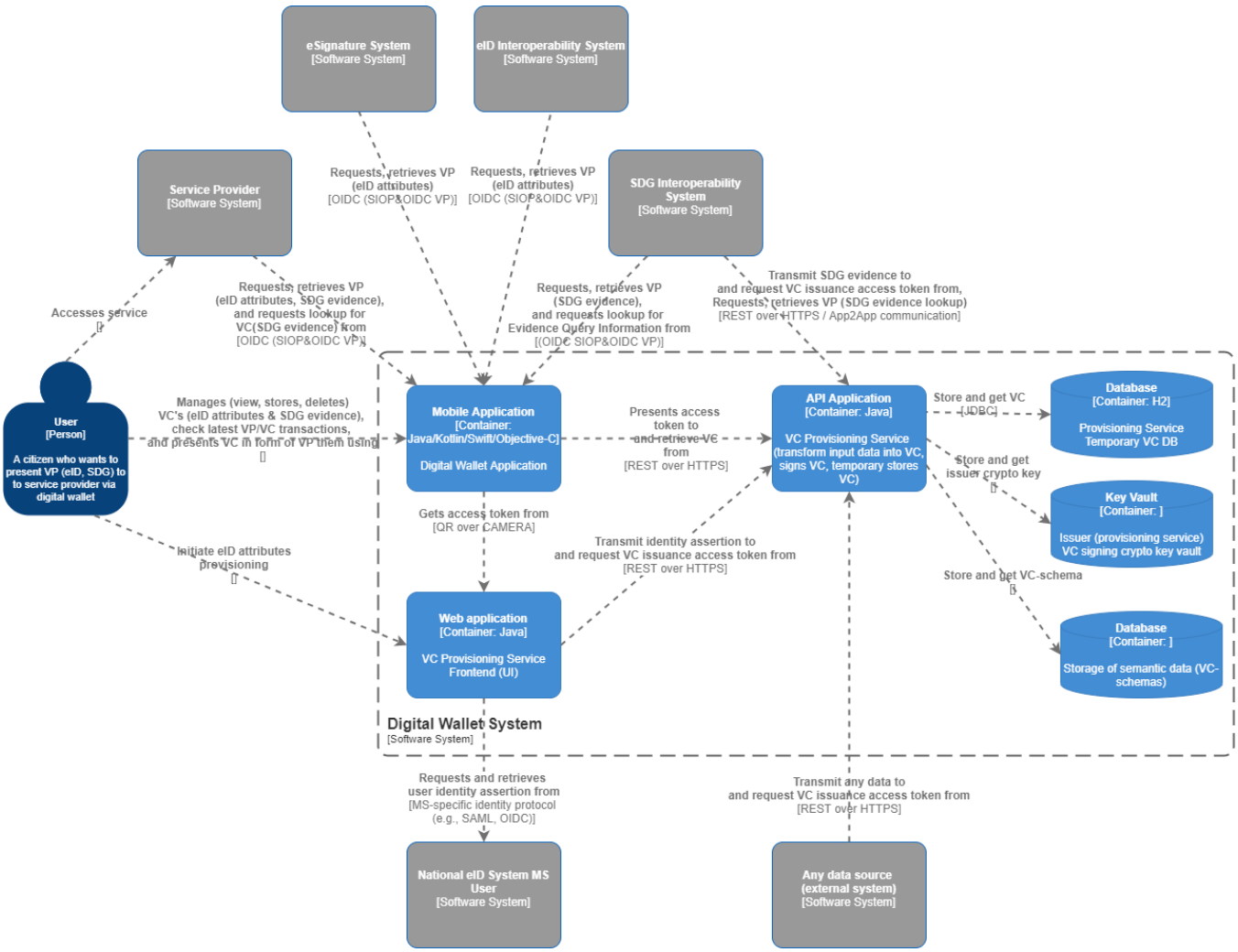


Figure 5: Digital Wallet System components and interfaces.

time it avoids overloading of the SDG infrastructure and of the Data Provider.

4.4 SDG Interoperability System

The main functionality of the SDG Domain is to enable a Data Consumer (the citizen owning the data or a third party organization) to retrieve an Evidence from the Data Provider with the Consent of the Evidence Owner (the citizen). The SDG nodes between the Evidence Requester and the Evidence Provider constitute the SDG infrastructure administered by MS national and EU authorities, e.g. the AS4 Access Points forwarding the AS4 messages, and the Data Provider Discovery Service (SMP Server).

The components and exposed interfaces of the SDG interoperability system are depicted in Fig. 6. Once an evidence is generated for an owner, the Data Provider will register the evidence at the Authorization Server. When a request to retrieve an evidence is received from the Service Provider App (e.g. the one from iVoting use case), the mobile SDG App, running on the Data Consumer (DC) side, will first check the Authentication status and the authentication credentials provided from the Service Provider App. After this, the Data Provider matching the required evidence type is discovered using the SMP protocol. Before sending the request to retrieve the evidence, an authorization token will be retrieved from the Authorization Server using User Managed Access profile of OAuth2.0. When the token is received, it will be included in the "Retrieve evidence" request, which will reach the Data Provider (DP). The DP will check the validity of the token and reply with the evidence.

For supporting the case in which the evidence is retrieved by a 3rdParty and not by the evidence owner, the Consent Management functionality from the Authorization Server will match the access policies in order to check which access (if any) to grant. When there are no matching policies, a notification will be sent to the data owner registered device and the data owner can asynchronously edit the policies.

After receiving the evidence, the Data Consumer is presented with an evidence preview in order to decide the next steps regarding

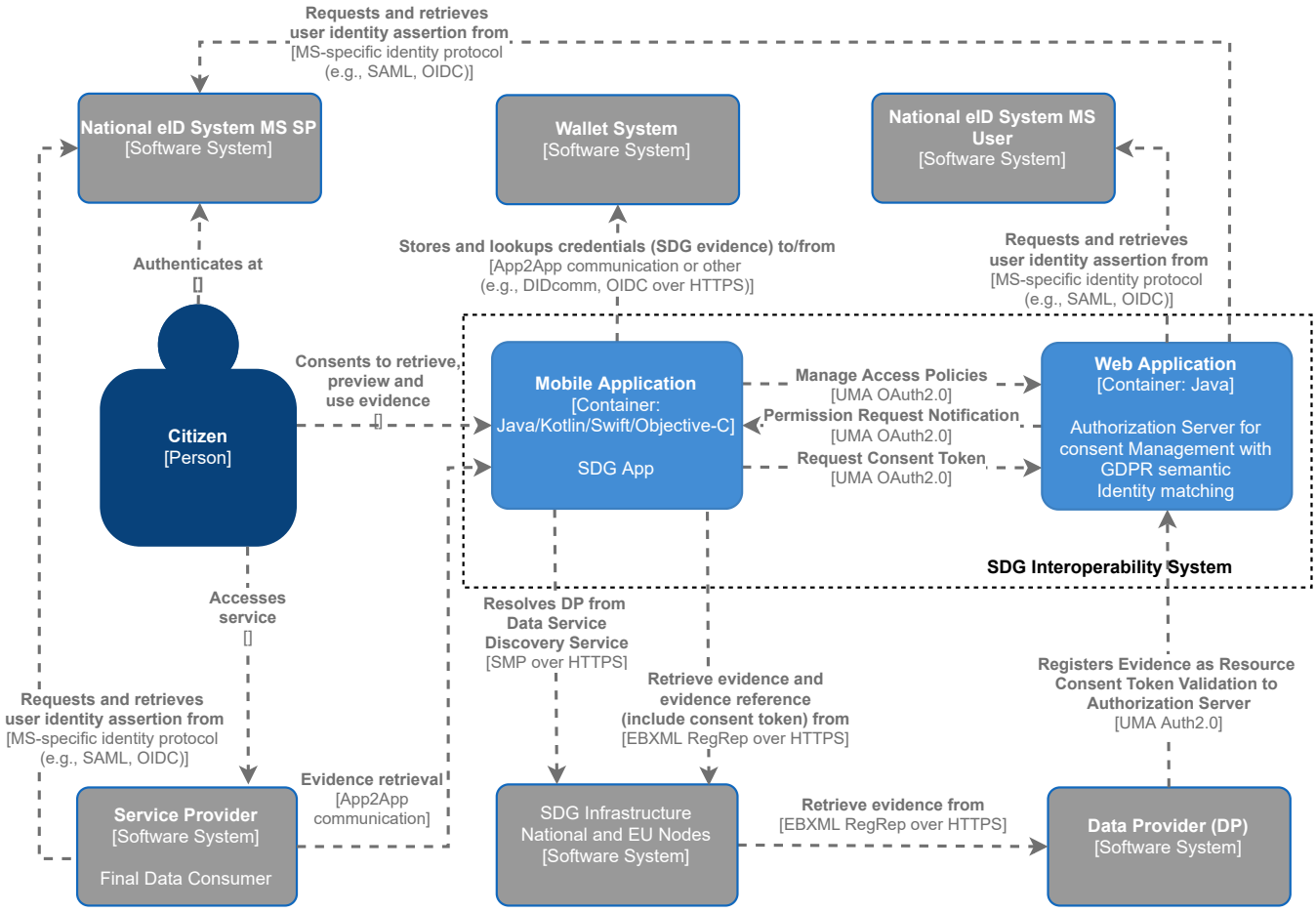


Figure 6: SDG interoperability system components and interfaces

the further usage of the evidence, e.g. store it in the Digital Wallet System with an annotation of evidence type and Data Provider identifier or forward it to the initiating Service Provider App.

Regarding the possible variants of the SDG interoperability system, a notable variant comprises of adding a history of matched policies in order to allow the evidence owner to track the exchange log.

4.5 eSignature Interoperability System

The eSignature building block (cf. Fig. 7) aims at demonstrating cross-border interoperability with respect to electronic signature technology supporting a variety of different eID means with different degrees of mobile support ranging from completely mobile signing solutions (Austria) via contactless eID means supporting NFC (Germany) to derived credentials stemming from contact-based eID means (Estonia, Belgium). It consists of an eSignature App and an eSignature Frontend which allow the User to interact with the eSignature Interoperability System and the eSignature Client, which makes appropriate API calls at the eSignature Backend, which finally takes care about the creation of signatures and seals.

5 IVOTING USECASE

In Internet voting solutions, it is necessary to ensure the principle of data privacy for the voters as well as the integrity and secrecy of the votes. Violation of uncoercibility and secrecy-security prerequisites could lead to the loss of trust and consequent abandoning of the technology since the electorate would be vulnerable during the election procedure. In order to ensure these core principles are intact, when translating the iVoting use case for mGov4EU project piloting purposes, state of the art tools of encryption will be employed.

Additionally, it is also essential to ensure the authenticity of the voters and their eligibility in the election process, i.e., they are authorized to vote in a particular process. Otherwise, the election outcome could be manipulated by tallying votes from non-eligible voters, thus posing the election integrity at risk. The iVoting use case will make use of the eID and SDG building blocks to get cross-border mobile eIDAS authentication and evidence retrieval with user consent for obtaining voter authorizations (see Fig. 8).

The mGov4EU iVoting pilot will start in the year 2023 and will validate the architecture in a cross-border setting having the University of Tartu, Estonia, as one of the piloting sites. The goal is to

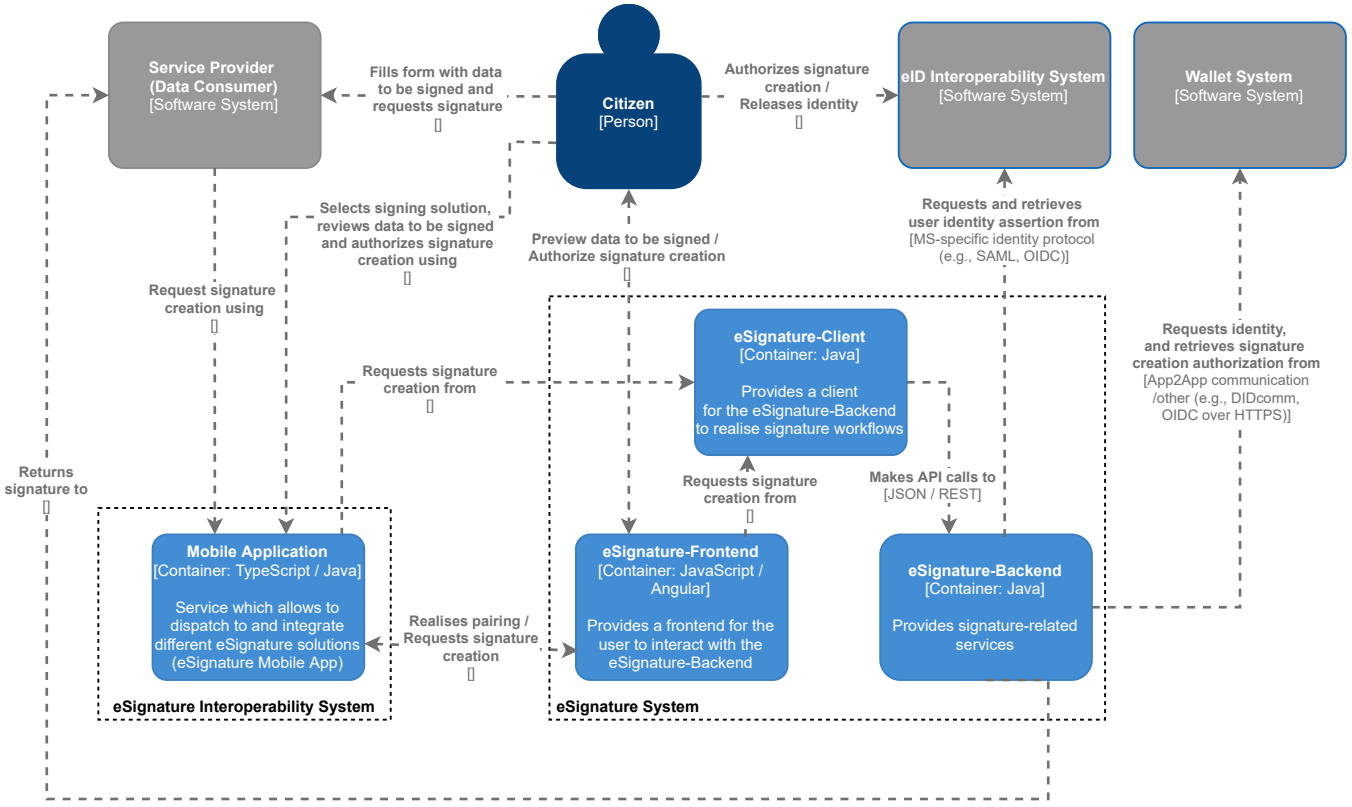


Figure 7: eSignature Interoperability System

build a pilot similar in requirements to an online European EU Parliament election, in which evidences (eID and/or citizen attributes obtained via SDG) will be used to demonstrate the right to vote and the fact that the citizen did not vote or did not request vote by post, and propose the resulting demonstrator to the regulating authorities.

In terms of the use case development, the first step is to provide a unique mapping between a person (e.g. a voter) and their identifiers, which could be obtained from various EU MSs. The second step is then to incorporate the mapping into a solution (e.g. a web-based application) that can be used by the platform for i-voting. As the issue was already identified in the context of the amendment of the eIDAS regulation it is expected that a general solution will be provided as part of the new eIDAS regulation and can be reused for the mGov4EU project. This architecture would provide additional safeguards for personal data privacy and ballot secrecy since it will be based on already tested and proven systems.

Complementary subtasks will be the gathering of voter authorizations, issued by one or more entities that will have the function to authorize voters to vote for a given election. These voter authorizations will be obtained by requesting the voter's consent to access them using the SDG-Layer. Another possible, optional, subtask is the signature of the vote using the signature services provided by the project. Finally, the last aspect is that since the pilot has far-reaching goals, information about the electorate's overall perception of the interface and/or voting process would benefit the establishment of the final product.

6 SUSTAINABILITY ASPECTS

Regarding the cross-border online services in EU, the third pillar of the Digital Single Market (DSM) [16] on overall growth of digital economy specifies the need for enabling interoperable cross-border e-services that should be included in the e-Government action plan. Thus, the e-Government Action Plan for 2016 – 2020 set up the goals and strategic objectives on enabling cross-border e-services and easing public sector interactions with citizens [17].

Furthermore, in the mid-term review of the DSM in 2017 it is stated that there is need for further progress on, inter alia, European public services which are result of the increased demand of businesses and citizens. The latest initiative by EC is the Digital Europe Programme for the period of 2021-2027 which aims to reinforce set up goals and impact of the Digital Single Market policy achievements ([32]).

Other initiatives that aim to enable (mobile) e-services across the EU is also the European Interoperability Framework (EIF) and European Inteorperability Reference Architecture. These initiatives provide a framework and architecture for designing interoperable and digital-by-default e-services. From the legal perspective, several regulations have been adopted to ensure the cross-border e-services in the EU.

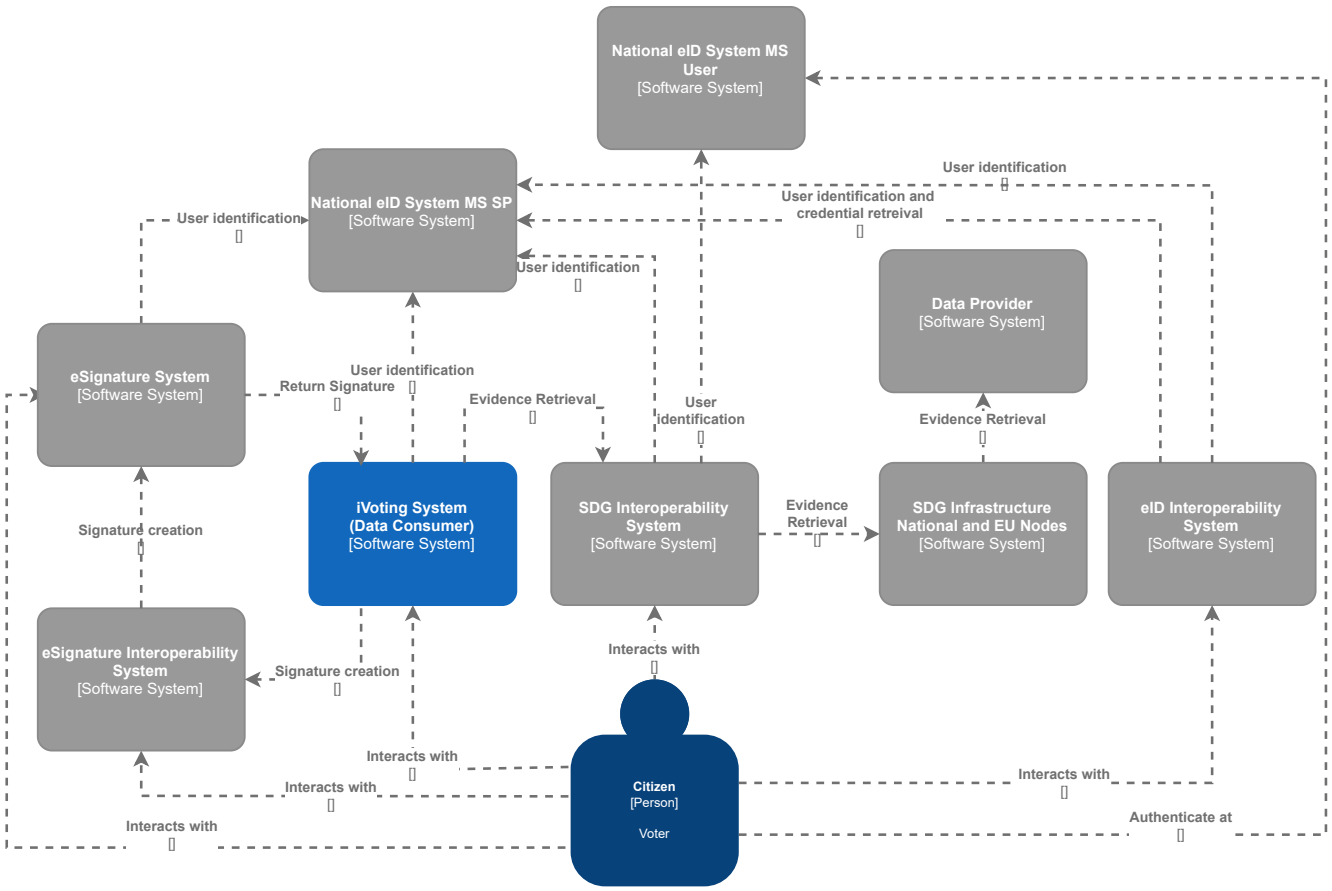


Figure 8: iVoting usecase derived functional architecture

The work that is developed within the project of mGov4EU, the building blocks and deployed systems that are fully cater to the eIDAS and SDG regulations, aim to enable the mobile access to cross-border e-services. The pilots that are focusing on iVoting, smart mobility and mobile signing provide results, e.g. the underlying architecture and technical building blocks have to be sustained.

The mGov4EU Project results must be managed so that the needed solutions are available and continuously developed, and so they both continue to contain the needed components and to use the architecture. The ultimate goal is to ensure that the assets produced by mGov4EU will continue to be alive when the project has finished. The mGov4EU Project has decided to use the GOFA (Governance, Operations, Finance, Architecture) Model [14], already used by several other European projects, to identify the best possible sustainability solutions for the project outcomes. There are four (4) main dimensions of the GOFA model: 1) Governance, 2) Operations, 3) Finance, and 4) Architecture. The GOFA model provides a useful framework for classifying activities and assessing needs and requirements. The analysis for each project outcome to feed this study looks at the different needs and requirements of each project outcome from each of the GOFA perspectives. Using the GOFA model makes it possible to identify sustainability solutions (including procedures, organisational structures, etc.) that can ensure adequate governance, operations, financing and architectural coordination for each project outcome as well as across project outcomes.

7 CONCLUSION AND FUTURE WORK

In this article the system design of the mGov4EU project platform providing cross-border eGov services was presented after analysing the background and requirements.

The work will continue on the implementation and validation of the design and architecture through piloting covering multiple use cases. The iVoting pilot aims at providing a blueprint on a system that can be used for voting over the internet as an alternative to voting in presence and by post for the European election system.

There are also foreseen challenges, for example related to the Single-Sign-On for eGov services and evidence retrieval through SDG, identity matching as currently the identifier stored in the eIDAS national nodes is not the same. At the same time, the authors are contributing to the eIDAS 2.0 [13] that aims to specify the solution for this. The project results and solutions for the mentioned challenges constitute the subject of follow-up scientific papers.

ACKNOWLEDGMENTS

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Translating Human Values to Design Requirements: The Case of Developing Digital Government Collaborative Platform (DGCP) for Environmental Sustainability in Sri Lanka

Mohamed Sapraz
Department of Computer Science & Software Engineering, NSBM Green University, Homagama 10200, Sri Lanka &
Department of Computer and Systems Sciences, Stockholm University, Kista, Sweden
sapraz@dsv.su.se

Shengnan Han
Department of Computer and Systems Sciences, Stockholm University, Kista, Sweden
shengnan@dsv.su.se

ABSTRACT

This paper aims to translate human values to the design requirements for developing a Digital Government Collaborative Platform (DGCP) for environmental sustainability in Sri Lanka. In the study, van de Poel's value hierarchy guides the value translation process. The human values are thoroughly reviewed and converted into norms and subsequently into design requirements with the consultation of information system design experts and environment-related government authority officers in Sri Lanka. As a result, thirty-one design requirements are identified for the design of DGCP. The study contributes new knowledge to the Value Sensitive Design literature in translating human values to design requirements, especially in an e-government system for a developing country. Further, the study emphasizes the importance of considering legal acts, policy, and other regulations in designing e-government artifacts such as the DGCP for environmental sustainability.

CCS CONCEPTS

• **Information systems**; • **Information systems applications**; • **Collaborative and social computing systems and tools**;

KEYWORDS

Value Sensitive Design, Digital Government Collaborative Platform, E-government, Environmental Sustainability

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1 INTRODUCTION

Digital government or e-government is an innovative approach adopted by government organizations in producing and providing better interactions with citizens [14]. Recently, digital platforms have been developed and implemented for improving the collaboration between government to citizen (G2C) and citizen to government (C2G) services [2, 9, 23]. The studies in e-participation provide two modalities of government and citizen collaboration. One is the outside modalities where interactions occur through social media platforms (Facebook, Twitter, etc.).The other is the inside modalities which is a government-designed formal platform for collaboration [1]. The current study proposes the inside modalities, called Digital Government Collaborative Platform (DGCP), dedicated to improving citizen and government collaboration to address Sri Lanka's environmental sustainability issues.

This study focuses on a human values-centered digital platform design The DGCP is designed to resolve many pressing environmental issues with the collaborative efforts of the citizen and government. In the Sustainability Development Goals (SDG), seven goals out of seventeen are closely associated with citizen participation and environmental issues [18] (SDGs 10,3,8,4,13,15,14 [22]). Generally, Digital government and its technologies play a pivotal role in achieving the SDG [13]. This provides strong evidence and justifies the importance of designing DGCP and involving citizens' participation to address environmental issues and find solutions for achieving environmental sustainability.

Sri Lanka as developing country, currently experiences and has undergone many unsolved environmental issues caused by human activities and uncontrollable natural disasters. The development of industrialization and agricultural practices has resulted in many environmental problems in the country, including deforestation, loss of biodiversity, soil erosion, habitat degradation, and water and air pollution [8]. The DGCP platform has been proposed as one of the solutions to cope with the environmental issues in Sri Lanka [16]. There are some unique contextual and other factors to consider and design customized solutions when designing e-government services for developing countries [11]. We have identified 15 human values for designing the DGCP by applying the Value Sensitive Design (VSD) method [17]. This study aims to translate the 15 human values into design requirements that will act as a guide to designing a prototype and developing the DGCP. Moreover, van de Poel's (2013) value hierarchy is followed as it provides clear guidelines for the value translation in VSD literature [15].

This paper is structured as follows: commencing with a research background by introducing VSD as a design method, the process of translating values into design requirements, and the human values



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for designing the DGCP. Followed by the method section explaining the data collection and analysis of the study, the subsequent results, discussion, and conclusions.

2 RESEARCH BACKGROUND

2.1 The human values for designing the DGCP

Value Sensitive Design (VSD) is a theoretically grounded systematic design method to include human values with ethical importance in technological innovation. Pioneers of the approach, Batya Friedman and her colleagues, define the approach as "theory, method, and practice to account human values in a principled and systematic manner throughout the technical design process" [3].VSD is built on an iterative and integrative approach of conceptual, empirical, and technical investigations[6]. The focal point in VSD revolves around 'Human Values.' These human values are mostly related to individuals or groups of people who consider these select values as a necessity in their lives [4]. A recent study [17] has identified the 15 human values for designing DGCP for environmental issues using VSD as a design approach. These values are transparency, safety, universal usability, feedback, authenticity, fairness, representativeness, accountability, legitimacy, informed consent, autonomy, awareness, human welfare, attitude, and trust.

2.2 Translate human values into design requirements

Although VSD is a widely accepted method of identifying human values in system design, there are no concrete guidelines on translating human values into design requirements. van de Poel [15] has introduced a 'Values hierarchy' method as a systematic approach to convert human values into design requirements. There are six aspects to consider in translating values into design requirements. First, van de Poel (2013) pointed out that converting new values into design requirements is a time-consuming and challenging process [15]. In his discussion, he justifies his point via the analogy of an aircraft emphasizing that it took nearly 25 years to identify design requirements to accurately complement the expected flying qualities. Second, for value conversion, we need the inputs of different domain experts relevant to the design. This design proposed a digital platform as an e-government solution for environmental issues, especially the policy developers and environmentalists required and the government officers and citizens. Third, the e-government solution or the artifact proposed is ingrained with policies, procedures, and other legislations. Therefore, certain external conditions affect the value translation (e.g., government policies and acts such as the environmental protection act, legislation such as data protection, human rights law). Fourth, a value can mean differently in different disciplines. Hence, decisions are taken on values and design requirements by considering the feasibility of practically implementing the values and trade-offs. Fifth, value translation is correlated and varies with the context of deployment. The value considered in the study provides different meanings under different contexts. The sixth point is deriving design requirements from values that exhibit a hierarchical structure. In the current study, a list of identified values is converted into norms by information system designers and later into design requirements with the same designers and the inputs of policies and procedures.

The hierarchical structure possesses three basic layers that can be constructed as a top-down or bottom-up approach during value translation [15]. The first step is to identify the core values, which can be completed by following the VSD methodology. The second step is to convert these values into design norms. A norm is defined as a property, capability, or attribute that fulfills the design objectives, goals, or constraints. The third step is to elicit the design requirements which must be fulfilled in system development. Here, value hierarchy is always bundled with two relations: 'specification' and 'for the sake of'. In the top-down approach, specification associates higher-level value levels into lower levels by considering many aspects such as the context of use and other factors. Conversely, the bottom-up approach identifies lower-level elements such as design requirements and norms and derives values (in other words, lower-level elements are defined for the sake of high level).

With this theoretical hierarchical structure, in implementing this into practice, van de Poel [15], in his paper, suggests five practical steps (described in detail under Table 1 in the method section) to convert the values into norms and subsequently to design requirements.

2.3 How to align design requirements with government policy?

Any e-government solution cannot be designed alone without focusing on the aspect of public administration [12]. System designers must incorporate public policies and acts which are salient in designing any e-government solution. Hence, the proposed DGCP must follow the related public policies and include them as design requirements in the solution. In addition to public policies, laws, regulations, strategies, authorities' work practices, and value statements are closely associated with the e-government [10]. Goldkuhl (2016) stresses the importance of producing policy-ingrained artifacts in e-government design research. Therefore, designers must take the necessary steps to conduct policy analysis and incorporate the findings in the design requirements. Conversely, any design requirements derived from the study, should adhere and match the findings[10].

3 METHOD

We adopt Van de Poel's five steps in converting values into design requirements and steps carried out in the research process.

3.1 Data Collection

The data collection is carried out using interviews and feedback from information system design experts and reviews conducted by environment-related government authorities' officers regarding design requirements against the published policy and related acts. In the first phase, eight Information System Design experts with experience in various Software design and development stages are involved in the study's vital step of converting values into design requirements. All these eight participants are selected using the Snowball sampling technique (See Table 2). As participants are expected to engage in a qualitative study, they are consulted individually through virtual meetings (Zoom and Skype) and explained the expected task in detail. Initially, twelve potential respondents were selected, but only eight (all of them are locals and six working

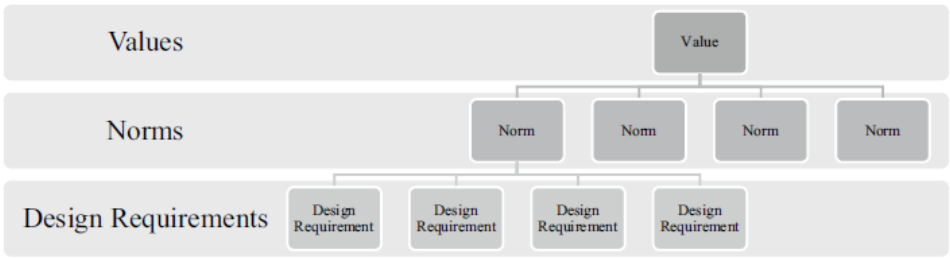


Figure 1: Values hierarchy (van de Poel [15], p. 264)

Table 1: van de Poel's steps and the. tasks carried out in value translation

Steps	Tasks followed in the research process
1. Give a conceptualization of each of the values. A conceptualization is like a definition. It describes what is meant with the value and why it is important. It can be typically one or two sentences long. There are roughly three ways to conceptualize each of the values: 1) use existing literature on these values, e.g., from VSD or philosophy, 2) ask experts or stakeholders for their conceptualization 3) come with our own.	Respondents are requested to understand the identified values and value hierarchy. The existing VSD related literature and other relevant literature is provided to the respondents. Individual virtual meetings are held as further discussions and to answer their questions.
2. Distinguish (if applicable) between instrumental and final values; put the final values above the instrumental values in the hierarchy. This step may not always be necessary (we can sometimes skip it).	This step is not carried out as the fifteen human values are already fixed from the previous study.
3. Associate with each of the (instrumental) values one or more norms. We can do it in three more specific ways 1) use existing relevant literature (for this translation, this may be more technical literature depending on the value), 2) ask experts or stakeholders for their translation of values into norms, 3) come with our own.	Each of the respondents individually worked on translating values into norms.
4. Translate the rules into design requirements. Again, we can use literature, experts, or our own ideas. If we require excellent design requirements, we probably need to consult literature and/or experts (preferably both).	In the same way, respondents converted the identified norm in the above step to design requirements. After analyzing respondents' datasheets, design norms and design requirements are identified.
5. Check whether the resulting values hierarchy meets the quality requirements. If not, try to improve it by revising.	The published policy documents and acts are reviewed against the design requirements for validation, inconsistencies, mismatch etc. Review is done with the above inputs to finalize the norms and design requirements. Meanings with similar design requirements are merged to finalize the design requirements list.

for multinational companies) committed to engaging in the study after understanding the type of work and their personal and work commitments.

Further, written consent was obtained before proceeding with the survey. In the second step, each respondent is given a thorough understanding of the fifteen values identified and van de Poel's method -value hierarchy and two relations of 'specification' and 'for the sake of'. We also shared the two research articles ([15, 17]) to support them to understand better the human values and value hierarchy method. On average, the respondents spent nearly two weeks reading and understanding the key concepts. Subsequently, a virtual meeting (Zoom & Skype) was held with the respondent to discuss the research objectives further and answer their questions. Once they felt confident enough, a table was provided with three columns (Value, Norm, Design requirement). Respondents were requested to fill the table in point form and share their ideas. Each of the respondents, on average, took a month to submit the results. Moreover, data were collected from May 2021 to August 2021. Table 3 provides a sample record received from respondent 5 for translating the value 'Transparency' to design requirements.

In the second phase of the data collection, interviews are conducted with twelve environment-related government officers (Table 4) (Seven virtual interviews -Zoom and Skype and five in-person interviews, During the period of November 2021 to December 2021). Prior to the interviews, the finalized design requirements received

Table 2: Details of the respondents: Information System Designers

Respondent	Gender	Age group	Current Job position	Type of organization	Years of work experience
1	Female	30-35	Senior Business Analyst	Software Solution Provider	8
2	Male	35-40	Product Program Manager	Software Solution Provider	9
3	Female	25-30	Lecturer–Software Engineering	Higher Education Provider	6
4	Male	30-35	Web Designer & Developer	Entrepreneur	7
5	Male	30-35	Senior Business Analyst	Software Solution Provider	8
6	Female	25-30	Web Developer	Software Solution Provider	5
7	Male	30-35	Quality Assurance Engineer	Software Solution Provider	6
8	Female	35-40	Senior Quality Assurance Engineer	Software Solution Provider	8

Table 3: Response of participant 5 for the value translation of 'Transparency'

Value Category	Norm	Design requirements
Transparency	Internal processes (decision making, responsible officers, etc.) are visible to the stakeholders. Related data/information is accessible to the stakeholders. Not only the decisions, responsible persons but also the outcomes and the progress of the decisions should be visible in long term Information should be available for everyone, and a human right.	Implement an inquiry function to the system. Users must be able to log in and track the status of the process flow. When tracking the process, users can see which officer /department is working on their request and relevant contact information, and the current progress of the request (state of the request at the current time) Make most of the information available to access by the stakeholders. The result of the processed request should be sent to relevant parties. Users should be able to identify the process flow without any issues.

Table 4: Details of the respondents: Environment-related government authorities' officers

Organization	No. of respondent	Summary of profile
Central Environmental Authority (CEA)	3	Male, Age – 51, Work experience – 22 years Male, Age – 48, Work experience – 16 years Female, Age – 49, Work experience – 22 years
Ministry of Environment	4	Female, Age – 47, Work experience – 15 years Female, Age – 48, Work experience – 18 years Female, Age – 61, Work experience – 20 years Female, Age – 54, Work experience – 22 years
Information Communication Technology Agency (ICTA)	1	Male, Age – 62, Work experience – 25 years
Department of Wildlife Conservation (DWC)	1	Female, Age – 51, Work experience – 23 years
Department of Forest Conservation (DWC)	2	Male, Age – 51, Work experience – 22 years Male, Age – 58, Work experience – 25 years
Waste Management Authority (WMA)	1	Female, Age – 49, Work experience – 14 years

after analyzing the inputs of IS design experts and the policy documents and related acts are provided to them prior to review and suggest non-conformities, changes, or improvements of the design requirements. Once the officer is ready, after obtaining the written consent for the study, the interview is conducted (an average of 30 minutes), and feedback is documented. The review of public policy and acts provide some additional evidence to strengthen the design requirements. Table 5 provides the list of documents reviewed in the study.

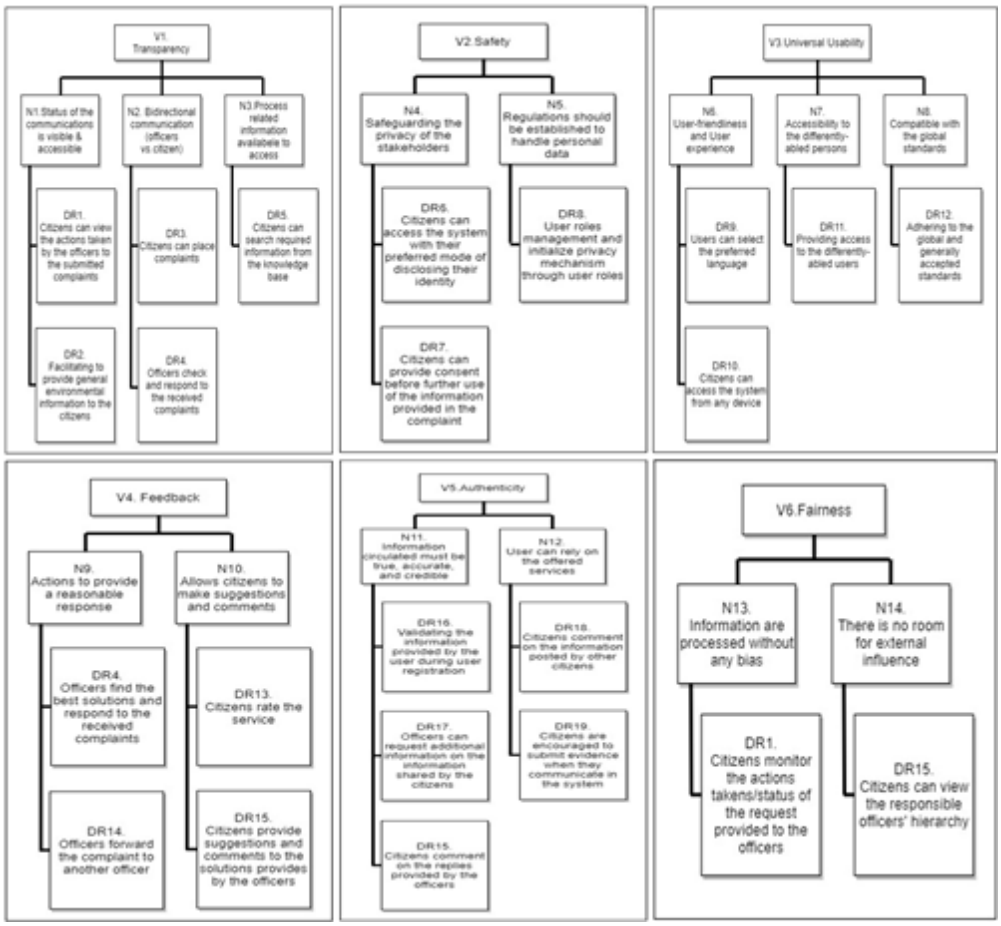


Figure 2: (Part A) Identified Values, Norms and with finalized 31 Design requirements

Table 5: Reviewed public policies and acts

Type of public document	Source
National Environmental Policy and Strategies (2003) [27]	Ministry of Environment and Natural Resources (https://www.env.gov.lk/)
National Environmental Act (Year 1980) [24] and its amendments (1988, 2000) [25] [26]	Central Environmental Authority (http://www.cea.lk/)
The Constitution of Sri Lanka (Revised edition, the year 2021) [29]	The Parliament of Sri Lanka (https://www.parliament.lk/)
Right to Information Act (2016) [28]	Government Information Center (https://www.rti.gov.lk/)

3.2 Data Analysis

At the beginning of the analysis, the norm and design requirement statements received from eight design experts were further examined. Information system design experts as respondents provided eight data sheets with norms and design requirements for fifteen values (e.g., refer to table 3 for a row of points shared by a respondent to the value transparency's norms and design requirements). Most of the answers provided by the information system design experts are comprised of one to four norms and two to five design requirements per an identified value. From the eight datasheets related norms and design requirements are extracted into a single data table with the value, norm, and design requirements for each of the values. Each of the statements are carefully analyzed, and data coding is performed by repeatedly reading the extracted norms and design requirements. We follow the guidelines provided in the Friedman et al.(2005) (p.250) to code data (explicate, interpret, code) in a qualitative study[5]. The coding is carefully carried out to finalize the norm and design requirements. Based on the

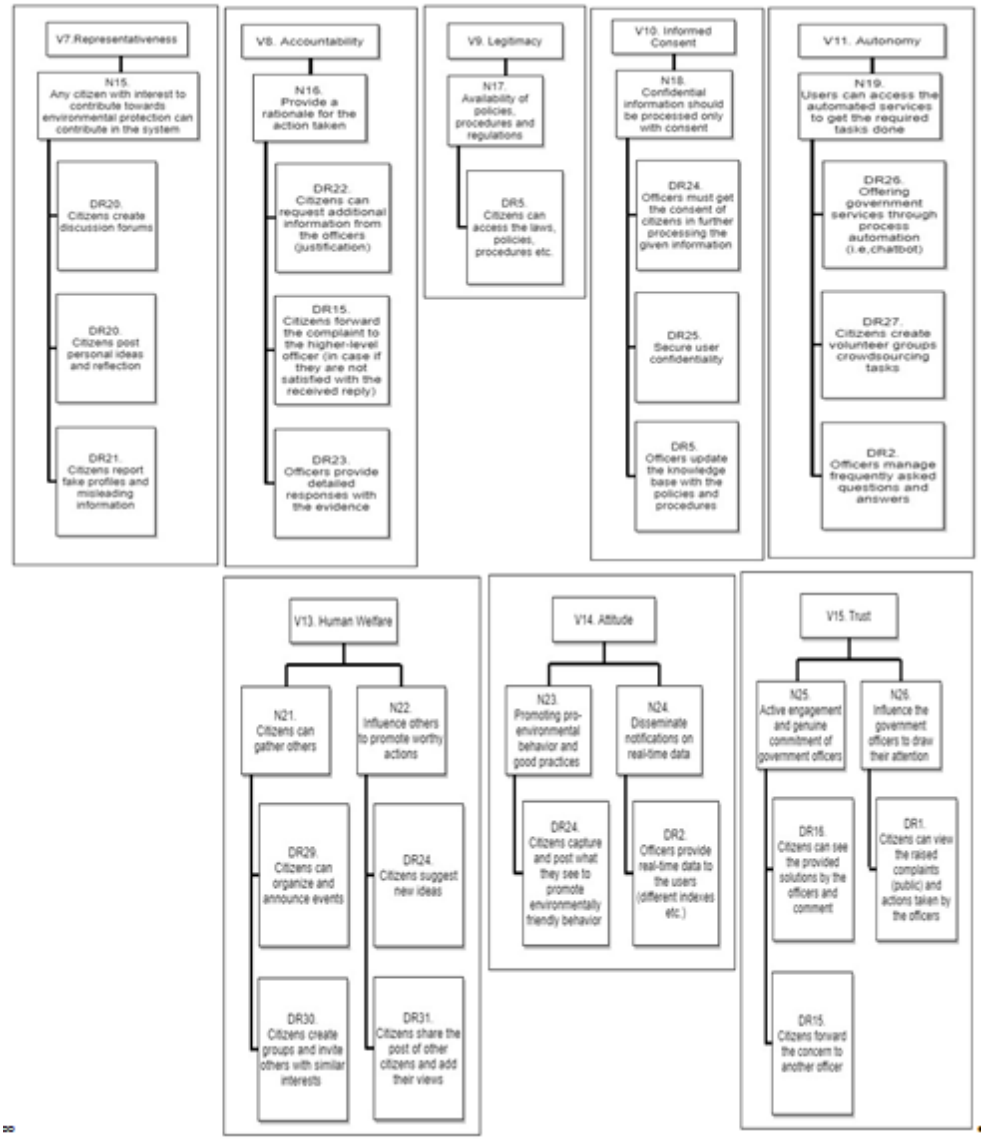


Figure 3: (Part B) Identified Values, Norms and with finalized 31 Design requirements

data from eight information system design experts, we defined 174 norms and 197 design requirements at the initial stage. However, most of the norms and requirements provided by eight experts are closely related, which can be merged, and a few of them are not associated with the context, thus were removed from the list. After following these further steps in the data analysis, 26 norms and 48 design requirements are identified. Government authorities' officers then revisit the 48 design requirements to align with policy documents and other related legislation. They found that all the design requirements adhere to the policies. However, this policy analysis provided some inputs to consider when developing the DGCP. Moreover, the officers and the authors reviewed and found some design requirements with similar meanings, which can be further merged. Finally, we define the 31 design requirements. An external moderator (a well-trained individual with coding used and the process of the study) is used to review the whole process and ensure the reliability of the data analysis and generated results. After explaining the whole process, the external moderator took nearly two weeks to review. A few of the doubtful points for the external moderator were brought up in a discussion, and both parties agreed to make specific minor changes.

4 RESULTS

Figure 2 shows the value hierarchy of the 15 human values, their norms and the identified design requirements of the DGCP. In Figure 2, the human values (numbered from V1 to V15) are converted into norms (numbered from N1 to N26) and subsequently the norm into design requirements (numbered from DR1 to DR31) (i.e., In

Table 6: Finalized design requirements (31)

Design Requirements (DR) No	Design Requirements (DR) of the DGCP
DR 1	Citizen's view and monitor the status and actions taken by the officers for the submitted complaints.
DR 2	Officers frequently update the general information required to the citizens.
DR 3	Citizens can place complaints.
DR 4	Officers provide solutions for the received complaints.
DR 5	Citizens can search for information in the knowledge base managed by the officers.
DR 6	Citizens can access the system with their preferred mode of disclosing their identity.
DR 7	Citizens can provide consent before further using the information provided in the complaint.
DR 8	User roles management and initialize privacy mechanism through user roles.
DR 9	Users can select the preferred language.
DR 10	Citizens can access the system from any device (Hardware and Software independent).
DR 11	Providing access to the differently-abled users.
DR 12	Adhering to the global and generally accepted standards.
DR 13	Citizens Rate the service
DR 14	Citizens can view the organization hierarchy and forward the complaint to another if they are not satisfied with the solution received.
DR 15	Citizens' comment on the solutions provided by the officers.
DR 16	Validating the information provided by the user during the user registration.
DR 17	Officers can request additional information on the information shared by the citizens.
DR 18	Citizen's comment on the information posted by other citizens.
DR 19	Citizens are encouraged to submit evidence when they communicate in the system.
DR 20	Citizens create and post in the discussion forums.
DR 21	Citizens report fake profiles and misleading information.
DR 22	Citizens can request additional information from the officers (justification).
DR 23	Officers provide detailed responses with the evidence.
DR 24	Officers must get the consent of citizens in further processing the given information.
DR 25	Secure user confidentiality.
DR 26	Offering government services through process automation (i.e., chatbot).
DR 27	Citizens create volunteer groups for crowdsourcing tasks.
DR 28	Officers add new information to the existing knowledge base
DR 29	Citizens can organize and announce events.
DR 30	Citizens create groups and invite others with similar interests.
DR 31	Citizens share the posts of other citizens and add their views.

the figure V1: Transparency is divided into three norms, namely, N1, N2, N3 and under each of the norm, design requirements are presented as, N1: DR1, DR2, N2: DR3, DR4 and N3: DR5). In Figure 3, some of the design requirements under different values from V1 to V15 possess the exact design requirements since we merge some of the similar requirements in the data analysis. For example, value' V1. Transparency' design requirement of 'DR1. Citizens' view and monitor the status and action taken by the officers for the submitted complaints' which overlap with the meaning of 'V6. The Fairness design requirement of Citizens monitors the action taken/status of the request provided to the officers' and another value of 'V15. Further, the Trust design requirement of Citizens can view the raised complaints and action taken by the officers. Hence, DR1 is used as the requirement for these three values.

Table 6 further lists the 31 design requirements. These 31 design requirements will be used as the base when designing the DGCP. This DGCP is primarily accessed by citizens, government officers, and a system administrator as direct users. From the list (Refer to Table 6), eighteen design requirements (DR1,3,5-7,9,13-15,18-22,27,29-31) are associated with user category, citizens. Another six design requirements (DR2,4,17,23,24,28) focus on the government officers. As another user category, the System Administrator directly manages three design requirements (DR8,16,25). The remaining four design requirements (DR10-12,26) are general system design requirements for any user.

5 DISCUSSION AND CONCLUSION

This paper has identified the thirty-one design requirements for designing the DGCP by adapting van de Poel's value hierarchy method. The study contributes new knowledge to the Value Sensitive Design literature in translating human values to design requirements, especially in designing an e-government system by considering unique contextual factors [11] for a developing country – Sri Lanka. Further, the study emphasizes the importance of considering legal acts, policy, and other regulations in designing e-government artifacts such as the DGCP for environmental sustainability. Additionally,

the approach and new knowledge created here can be generalized and adopted in similar e-government service designs.

The study adopts van de Poel's (2013) value hierarchy to convert human values into design requirements [15]. The study strongly suggests focusing more on the domains (i.e., in the current study, e-government and environmental sustainability) of the proposed solution to be implemented and including different views of the domain experts. There are a few studies that illustrate how value hierarchy is applied in an information system design to derive design requirements [7, 19–21]. Interestingly, in the study, there were many design requirements that were closely associated with each other. This led to merging them to produce a concise list of design requirements. The study contributes to van de Poel's value hierarchy by applying it to this new research context, i.e., developing an e-government system for environmental sustainability.

E-government is highly interwoven with public policies, legal acts, and regulations. This emphasizes the need of developing a policy-ingrained artifact whenever we design or propose an e-government solution [10]. Hence, during the value conversion, the government officers revisit identified design requirements with the review of policies and acts to enrich and further verify and validate the results. Especially when eliciting design requirements for e-government artifacts, referring to the policies and acts is pivotal to meeting its objectives. This affirms that the proposed DGCP does not cause any practical challenges or violations in public policies. The study contributes to the e-government design research by proposing a DGCP - A digital artifact designed using VSD as a design strategy that includes environmental policies considered as a part of the design process.

Future studies will be carried out to convert the identified design requirements into design features, accommodate policy and changes in the requirements, and develop a prototype. With the stakeholders' feedback, upon the refinements of the prototype, the system must be designed by fulfilling the requirements. Moreover, the study would be further enhanced with feedback obtained from government officers of related authorities and citizens as direct users to share their views on the usability and user experience of the DGCP. Furthermore, and most significantly future studies would evaluate if the human values are embraced in the DGCP.

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From requirements to a research agenda for governments governing reuse of critical raw materials in the circular economy

Selinde Van Engelenburg
Delft University of Technology
S.H.vanEngelenburg@tudelft.nl

Boriana Rukanova
Delft University of Technology
B.D.Rukanova@tudelft.nl

Jolien Ubacht
Delft University of Technology
J.Ubacht@tudelft.nl

Siu Lie Tan
Circular Symbiosis
siulie.tan@circularsymbiosis.com

Yao-Hua Tan
Delft University of Technology
Y.Tan@tudelft.nl

Marijn Janssen
Delft University of Technology
M.F.W.H.A.Janssen@tudelft.nl

ABSTRACT

Governmental organisations use a diversity of policy instruments for sustainability goals. In the field of materials, they aim to advance the reuse of materials on the one hand. On the other hand, they also want to control critical raw materials (CRMs) to protect society against scarcity. Information sharing is required to monitor for both objectives. Research into information sharing for the circular economy mainly focuses on using ICT to follow entire products, such as digital product passports. However, research into information sharing for reuse flows and monitoring at the level of materials is limited so far. Therefore, in this paper, we derive the following requirements for information sharing to support the monitoring of materials and CRMs in particular: 1) businesses and government organisations should have access to the complete history of materials; 2) businesses should be able to share information on materials between different supply chains and industries; 3) information on materials should be reliable and tamper-resistant; 4) governments should be able to obtain a complete overview of the pool of CRMs in circulation and of who is responsible for them; 5) the system supporting the information sharing on materials should be highly robust and should not have a single locus of control. Based on this overview of requirements, we present a research agenda in which we identify challenges and related future research questions.

CCS CONCEPTS

• **Applied computing** → Computers in other domains; Computing in government; E-government; Operations research; Industry and manufacturing; Supply chain management; • **Information systems**;

KEYWORDS

Circular Economy, Interorganisational Information Systems, Business-to-Government Information Sharing, Critical Raw Materials



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1 INTRODUCTION

Governmental organisations often monitor compliance in supply chains by following entire products (see, e.g., [30]). Yet, monitoring materials from which these products are made in a circular economy (CE) is also vital for governmental organisations [25, 26]. Without the proper monitoring of materials, policy measures to stimulate circularity and protect safety may be subject to abuse and thus fail to achieve their intended goals. A lack of information for government and businesses can harm the safety of recycling and reuse processes and resulting materials and make it more challenging to maintain their value [28]. Monitoring of materials is particularly important for *Critical Raw Materials* (CRMs) that are essential for the functioning of society while, at the same time, are at risk of becoming scarce [33]. Monitoring can support the prevention of scarcity or inform the choice and deployment of strategies to address scarcity.

Digital technologies are vital for creating visibility in a CE for businesses and government, but research in this area is limited [40]. Information systems often align with the structure of linear (i.e., non-circular) supply chains. As such, information sharing starts at the producer and is enriched by different parties in the supply chain involved in the production or transportation of the product (see, e.g., [15, 18]). Usually, information sharing ends when the product arrives at the consumer. Likewise, public monitoring usually follows the same model, starting with the producer and ending with the consumer.

This linear information sharing and supervision model is suitable for following products downstream from the producer to the consumer. Yet, in a CE, materials remain in circulation such that nature tolerates the throughput flow [19]. Therefore, products' components and materials need to be repaired, remanufactured, reused, recycled, or upcycled at the end of their life cycle. Subsequently, they re-enter the economy in an upstream materials flow. Supply chains in a CE are thus structurally different from those in a linear economy. The linear model of information sharing and supervision leaves out of sight the upstream processes and does not support a

robust way of following materials through several cycles. Hence, our research objective is to explore how information sharing on raw materials flows needs to be (re)designed to support the circularity of raw materials and to monitor the scarcity of CRMs. We do so by discussing the requirements for information sharing on raw materials in a CE in section 2. Next, discuss the challenges to meeting these requirements in section 3. In section 5, we present our research agenda.

2 REQUIREMENTS FOR MONITORING MATERIALS IN A CIRCULAR ECONOMY

Information sharing for tracing goods in a CE is essential (see, e.g. [1, 12, 20]). Information sharing is necessary for several objectives and stakeholders, which calls for a diversity of requirements for the information sharing process. In this section, we present these objectives and based on them, we formulate requirements.

We did not perform a complete, systematic literature review for this study, as our paper aims to develop an initial research agenda. Our perspective was to identify important examples of requirements in literature and policy reports giving rise to new challenges that need addressing. To this end, we used the referenced sources in this section. Hence, we do not claim to be exhaustive but rather present an initial holistic overview of challenges to which other perspectives can be added.

Materials can deteriorate over time, and contamination negatively influences materials' quality and value [23]. Whether reuse of materials is possible in certain products (e.g., food packaging) depends on their quality and history. Therefore, information on the history of the actual use is necessary to enable reuse and recycling, as it supports sorting and harvesting and helps to understand potential hazards and contamination [20, 32]. For the government, ensuring compliance with laws and regulations for promoting and ensuring safe circular processes also requires such a history. Furthermore, information is necessary to evaluate the effectiveness of policies like extended producer responsibility schemes promoting the uptake of secondary raw materials in production processes [5]. In some cases, relevant properties of materials (e.g., purity) can be measured. However, loss of history makes it challenging to act when new insights arise on harmful effects of materials later (e.g., in the case of PFAS) [2]. Therefore, *the first requirement is that businesses and government organisations should have access to the complete history of materials.*

In upstream processes, materials from a product can end up in the same or a different supply chain of other products or even in other industries. For example, metal from machinery can be reused in the construction of buildings [10]. When materials can cross the boundaries of industries, the options for reuse increase, which extends their market and thus market value. Furthermore, the prices of upstream processes can be reduced by creating economies of scale [22]. Therefore, *the second requirement is that businesses should be able to share information on materials between different supply chains and industries.*

To protect against (artificially created) scarcity and ensure safe reuse and recycling, governmental organisations need to detect potentially fraudulent behaviour, such as exporting materials to evade regulations and so-called 'greenwashing'. Ensuring compliance is especially important when recycling costs are high and the quality and price of recycled materials low [26, 27]. *The third requirement is thus that the information on materials should be reliable and tamper-resistant.*

Establishing a CE is necessary to protect against resource scarcity and price volatility for CRMs [31, 33]. Monitoring these materials is vital to prohibit undue dependency for their supply on other regions, countries, or sources where, e.g., the fair treatment of workers or sustainability is not guaranteed [33]. Furthermore, it needs to be ensured that no artificial scarcity is created to increase prices, e.g., due to geopolitical conflicts or private business objectives. Both government and businesses need to be able to anticipate scarcity. When it is known that a CRM is scarce, businesses can eco-design with substitutes, and governments can introduce extra taxes to discourage their use [33]. In addition, governments may need to prioritise the application of CRMs with higher social value. For example, suppose a shortage of batteries arises due to the scarcity of its components. Then, the government might want to prioritise their use in life-saving medical systems over gaming computers. Detecting scarcity and the ability to act upon it can be facilitated by an overview of the materials in circulation and parties to be held accountable when materials disappear or are reused inefficiently. However, data on the quantity and whereabouts of materials are often unstructured and scattered amongst various institutions and industries [14]. Therefore, as a *fourth requirement, governments should be able to obtain a complete overview of the pool of CRMs in circulation and of who is responsible for them.*

If a system supporting information sharing on materials fails, this could severely impact upstream processes and government supervision. We thus need to avoid a single point of failure or a single point of attack. Simultaneously, considering the scale of such a system, it is unlikely that stakeholders will accept a dominant stakeholder having extensive power over the system. *The fifth requirement is thus that the system supporting the information sharing on materials should be highly robust and should not have a single locus of control.*

Information sharing at the level of products is still necessary for a CE; this is at least as necessary as for a linear economy. However, existing solutions, such as digital product passports, focus only on the level of products or a particular industry (see, e.g., [4, 6, 24, 39]). When materials are tracked, it is typically only in the first part of the downstream process until they end up in a product (see, e.g., [38, 41]). As such, they do not meet the requirements formulated. Thus, alternatives for information sharing supporting the monitoring of materials in a CE are required.

3 CHALLENGES FOR MONITORING MATERIALS IN THE CIRCULAR ECONOMY

Based on the requirements in section 2, we created an overview of challenges for monitoring materials in the CE (see Table 1). Section 4 translates these challenges into research questions for which answering it would contribute to solving them to formulate a research agenda. In the remainder of this section, we discuss each challenge in more detail. This overview is not intended to be exhaustive but

Table 1: Challenges for monitoring materials in the CE, based on the requirements

Related Requirements (R)	Challenges (C)
R1. Businesses and government organisations should have access to the complete history of materials.	C1. Making the information necessary for supporting circular processes and monitoring materials available for a long period of time (at least decades).
R1. Businesses and government organisations should have access to the complete history of materials. R3. The information on materials should be reliable and tamper-resistant.	C2. Tagging and identifying materials so that the tags cannot be tampered with and do not harm the environment, and such that materials can be followed through different cycles, in various states and when mixed and converted.
R1. Businesses and government organisations should have access to the complete history of materials. R2. Businesses should be able to share information on materials between supply chains and industries. R3. The information on materials should be reliable and tamper-resistant.	C3. Identifying incentives for businesses to share reliable and up-to-date information on materials with all businesses and government organisations needed to support circular processes and monitoring.
R1. Businesses and government organisations should have access to the complete history of materials. R2. Businesses should be able to share information on materials between supply chains and industries.	C4. Appropriately balancing the risks of information sharing for businesses with the benefits of information sharing for supporting circular processes and monitoring.
R4. Governments should be able to obtain a complete overview of the pool of CRMs in circulation and who is responsible for them	C5. Determining the appropriate granularity of batches of materials for assigning IDs
R1. Businesses and government organisations should have access to the complete history of materials. R2. Businesses should be able to share information on materials between supply chains and industries. R5. The system supporting information sharing on materials should be highly robust and should not have a single locus of control.	C6. Appropriately balancing the scalability of the information sharing with the information sharing needs of businesses and government.
R1. Businesses and government organisations should have access to the complete history of materials. R2. Businesses should be able to share information on materials between supply chains and industries. R5. The system supporting information sharing on materials should be highly robust and should not have a single locus of control.	C7. Creating a governance model for the information systems supporting the monitoring of materials.

rather to initiate a discussion and stimulate research to address the challenges or extend this initial overview.

Several challenges are associated with making the complete history of materials accessible (R1). Materials might be in many different cycles, especially when recycling technology improves. Furthermore, some products need to be recycled even after decades (e.g., building materials). However, making information available, even after decades, is difficult as a lot might change over time. The parties making information available might stop doing so. For example, a producer making available information on materials in their products might go bankrupt. Another difficulty is that data formats, information systems, and even the required content might change over time due to new developments. Therefore, *challenge 1 is to make the information necessary for supporting circular processes and monitoring materials available for a long period of time (at least decades).*

Following materials through different cycles to create a history (R1) requires identifying them. For products, this can be done by assigning an ID and tagging them (e.g., using barcodes). However, for materials, this is more difficult. Different materials, e.g., powders and liquids, have different physical properties creating varying (tagging) requirements. Furthermore, materials can be in different states (e.g., window glass, culets/shards), divided, (irreversibly) mixed with other materials (e.g., composites in blades of windmills) or converted into others. This requires flexible tagging and representation. To make matters more complex, tagging methods should not harm the environment. Furthermore, tags need to be tamper-resistant (R3) to connect information and materials securely. Therefore, *challenge 2 is to tag and ID materials so that the tags cannot be tampered with and do not harm the environment, and such that materials can be followed through different cycles, in various states and even when mixed and converted.*

As discussed, sharing information on materials can benefit society. However, obtaining information is also in the direct interest of some businesses. For example, a recycler can use instructions from producers to recycle materials more efficiently, determine their value and weigh this against recycling costs. Sharing can also benefit businesses. For example, a recycler who wants to sell materials finds more buyers if they share reliable information about their qualities. Yet, even in linear supply chains, aligning the incentives for different businesses is often difficult [21]. There is no reason to not expect such misalignment in a CE in which many different

supply chains get entangled as materials get from one to the other. This means that there will be cases in which businesses might not perceive a direct benefit of sharing the history of materials (R1) with the government and businesses in other supply chains or industries (R2). Especially businesses downstream the value chain, such as manufacturers, micro, small and medium enterprises, might not directly benefit from recuperating materials from secondary sources in the upstream value chain, let alone other supply chains or industries. Therefore, they might not be incentivised to contribute to this process. Consequently, governmental organisations cannot use their data. Additionally, facilitating information sharing entails investments for companies into their ICT infrastructure and thus raises their administrative costs. Without a direct benefit, businesses have little incentive to make these investments. Furthermore, without an incentive, they might not be inclined to ensure the quality of information, which harms its reliability (R3). Therefore, *challenge 3 is identifying incentives for businesses to share reliable and up-to-date information on materials with all businesses and government organisations needed to support circular processes and monitoring.*

Even if businesses have incentives to share information, they might still perceive risks. According to the literature, businesses view autonomous control over data and sharing arrangements as key to their competitive position [11, 16, 35, 36]. Businesses may fear that if they open up information, they will be more vulnerable to misuse of the data or opportunism by others, and that sensitive information is not kept confidential [9, 13, 17, 29, 37]. We expect that this fear will be no different in a CE. In fact, it might be worse as additional information sharing is required with a broader set of parties (R1, R2).

Some solutions for keeping information confidential and access control include using encryption or only sharing aggregated information or links to information. However, these measures each have their disadvantages. For example, encrypting data or sharing links harms transparency and means that we need additional processes for sharing keys or the actual information that is linked [7]. On the one hand, aggregated data can be perceived as less sensitive in some cases, making it more challenging to identify a particular business or shipment. However, on the other hand, the possibility of data aggregation might be perceived as a threat, e.g., when data analytics can be applied to it [8]. It is thus imperative to find ways of information sharing that strike an appropriate balance between the risks perceived by businesses and the need for information sharing to support circular processes and monitoring.

There are still a lot of unknowns that make it difficult to find this appropriate balance. For example, it is unclear what information on materials businesses perceive as sensitive and to whom. This information might reveal trade secrets from a commercial perspective, even if it does not reveal how to create the complete product. Businesses might perceive similar businesses in different supply chains as competitors; in contrast, this may not be the case for businesses in different industries. Nevertheless, as they are not involved with these businesses, they might not know them and not trust that they will not share their information with others. From a public perspective, in the case society could be severely harmed by the scarcity of a CRM, one could argue that the prevention of scarcity in the interest of society should prevail over the commercial interests of specific businesses. These are just a few considerations that can play a role and need further investigation. Therefore, *challenge 4 is to appropriately balance the risks of information sharing for businesses with the benefits of information sharing for supporting circular processes and monitoring.*

For the government to have a complete overview of a CRM (R4), information on such a CRM should be stored in a single system, or government should have access to all systems where the information is stored. To discern different (batches of) materials, they will need an ID. However, an issue here is the granularity of assigning these IDs. If IDs are only assigned to large batches, it becomes impossible to identify small quantities used in products. But assigning IDs to small batches can create scalability problems. To illustrate, storing a unique ID for each gram of titanium consumed yearly in the European Union (EU) would require almost 77 Terabytes[1]. This is a lot, especially considering the same needs to be done for all other CRMs and considering that these are only the IDs, not the information about the materials. This makes choosing the appropriate granularity and efficiency of the representation and compression methods of paramount importance. The work on determining granularity is limited and does not address the particular properties of materials [3]. Therefore, *challenge 5 is determining the appropriate granularity of batches of materials for assigning IDs.*

A complete history will need to be shared (R1), which entails a huge volume of information that also threatens scalability. Furthermore, the number and variety of parties involved are large as data must be shared between supply chains and industries (R2). As the information sharing should be highly robust and not rely on a single locus of control (R5) and be tamper-resistant, a centralised system will likely not offer a solution. An obvious solution would be storing the data in multiple places (e.g., using blockchain technology). Consequently, the volume of information stored and shared can become even more considerable, creating more scalability problems.

Strategies for reducing scalability problems have downsides harming the information sharing process. For example, sharing links to information instead of the information itself can reduce the volume of shared information. However, it might harm transparency and robustness and reduce protection against tampering. Therefore, *challenge 6 is to appropriately balance the scalability of the information sharing with the information sharing needs of businesses and government.*

Avoiding a single locus of control is not just a technological problem (R5). It is also about which parties determine the standards and processes. The need for monitoring does not stop at a country's border or the border of industries or supply chains (R1, R2). There are many companies involved, having all kinds of systems. There is a need for governance to involve these parties and standardise data and processes. To this end, there are many options ranging from top-down to bottom-up approaches. Likely, this depends on the context, type of material, actors involved, installed systems, investments needed, etc. Which type of governance is most effective

[1] The average yearly consumption of titanium of the European Union (EU) between 2012 and 2016 is 1,509 kt [34]. 1, 509 kt is 1,509,000,000,000 grams. Uniquely identifying each gram, requires assigning them a string of 7 alphanumeric characters, as this allows for $62^7 = 3, 521, 614, 606, 208$ unique strings. Storing a character in ASCII is 8 bytes. Storing the IDs for all grams, thus requires 84,504,000,000,000 bytes of space, which is 76.8559 Terabytes.

is unknown and needs further research. Therefore, *challenge 7 is to create a governance model for the information systems supporting the monitoring of materials.*The following section formulates research questions based on these challenges and offers a reflection on our proposal for this research agenda.

4 RESEARCH AGENDA AND REFLECTION

Based on the challenges in section 3, we present the research questions as a foundation for a research agenda into the role of information sharing for monitoring materials in a CE, particularly CRMs. Our premise is that information sharing between business and government is necessary to monitor scarcity and develop policy measures to stimulate reuse. The numbering of the research questions corresponds to the numbering of the challenges in Table 1:

RQ1. How can the information necessary to support circular processes and monitoring materials in a CE be made available for a very long time (at least decades)?

RQ2. How can materials be tagged and identified so that the tags cannot be tampered with and do not harm the environment, and materials can be followed through different cycles, in various states, and when mixed and converted?

RQ3. What are incentives for businesses to share reliable and up-to-date information on materials with all businesses and government organisations needed to support circular processes and monitoring of materials?

RQ4. What is an appropriate balance between the risks of information sharing for businesses and the benefits of information sharing for supporting circular processes and monitoring of materials?

RQ5. What is the appropriate granularity of batches of materials for assigning IDs?

RQ6. What is the appropriate balance between the scalability of information sharing with the information sharing needs of businesses and government for supporting circular processes and monitoring materials?

RQ7. What governance model is suitable for information systems supporting the monitoring of materials?

This overview is not exhaustive but is meant as a starting point for discussion and additional research from other perspectives. Some of the questions proposed are generic for business and government information sharing, and others are specific to a CE. To illustrate the needed contribution from other perspectives, we can mention the privacy risks of the data related to the phase in which citizens use products/materials before they are returned for recycling. Another example is the required sustainability of the information sharing itself. With this discussion paper, we want to inspire other researchers to address the current challenges and uncertainties in the transition toward a CE and how digital technologies/information sharing can be designed to support this transition.

5 CONCLUSIONS AND FURTHER RESEARCH

This discussion paper presents a research agenda for monitoring materials, particularly CRMs in a CE. First, we discussed the need for monitoring materials in a CE and its requirements. Next, we analysed the requirements. Based on these, we identified the challenges. For each of these challenges, we formulated a research question. These research questions can serve as a foundation for a research agenda for information sharing between businesses and governments to monitor the CE's reuse of critical raw materials.

The list of requirements, challenges, and related research questions presented in this work is a starting point. It is meant to start a discussion and additional research on this topic. Further research should focus on refining and extending them based on further in-depth analysis of literature and reports and discussions with experts and policymakers involved in implementing a CE in practice. And from taking other perspectives than a systems requirements perspective into account.

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Digital Government and the Circular Economy: Towards an Analytical Framework

Rony Medaglia
Copenhagen Business School, Denmark
rm.digi@cbs.dk

Boriana Rukanova
Delft University of Technology, The Netherlands
b.d.rukanova@tudelft.nl

Yao-Hua Tan
Delft University of Technology, The Netherlands
y.tan@tudelft.nl

ABSTRACT

Circular economy is high on the political agenda, with governments at all levels setting ambitious goals to move away from traditional linear production models, where goods are used and disposed as waste, towards a future with less use of virgin raw materials, and where valuable materials at a product end-of-life are returned as raw materials or in an environmentally-friendly way to the biosphere. While circular economy is gaining a lot of attention on a policy level, the role that digital government can play to facilitate the circular economy transition is largely unexplored. We carry out a review of existing literature in the fields of digital government and Information Systems (IS) to identify the roles played by digital government in the circular economy. Based on an analysis of 54 empirical research articles, we identify foci and gaps in relation to the different types of roles played by government (*nodality*, *authority*, *treasure*, and *organization*), to stages of the Product Life Cycle (*pre-use*, *in-use*, and *post-use*), and to types of digital technology focused on. Based on these findings, we present an analytical framework to guide future research on digital government in relation to the circular economy, and exemplify the use of the framework drawing on examples from circular economy initiatives in the automotive industry.

CCS CONCEPTS

• **Circular Economy**; • **Digital Government**; • **Sustainability**;

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1 INTRODUCTION

Governments across the world are setting ambitious goals to move towards a more sustainable future, in line with the United Nations' Sustainable Development Goals (SDGs) [1]. Within this context, the concept of circular economy (CE) is gaining increasing attention in national and international political agendas. CE is referred to as "a sustainable development initiative with the objective of reducing the societal production-consumption systems' linear material and energy throughput flows by applying materials cycles, renewable and cascade-type energy flows to the linear system" [2]. The vision behind the concept of CE is of a future where we step away from the traditional linear production mode, where goods are used and disposed as waste, towards a future where there is less use of virgin raw materials; instead of waste, at the end of life of products the valuable materials are returned as raw materials or in an environmentally-friendly way to the biosphere. Benefits of CE include tackling climate change, and reducing pollution and biodiversity loss.

Digital technologies are developing at a high speed and allow for more and more opportunities. In recent years we see advances in blockchain-based applications that allow for immutability of data, Internet of Things (IoT) and Physical Internet (PI), that allow to capture data on item levels, digital infrastructures, and platforms, as well as data analytics and Artificial Intelligence (AI) that can be used to provide further insights from data. Research in the Information Systems (IS) field calls for more attention by scholars to the circular economy and to what these technologies have to offer [3]. However, existing research does not specifically focus on the role of government in investigating the relationship between digital technologies and the circular economy. Similarly, in the digital government research literature, the role that government can play to facilitate the CE transition is largely unexplored.

This leads us to the main research question that we set to explore in this paper, namely: *What is the role of digital government in the circular economy (CE)*?

We carry out a review of existing studies in the digital government field focusing on circular economy initiatives, in order to map what type of role the government takes in the circular economy ecosystem; what actors other than government are involved; and which digital technologies are used in circular economy ecosystems. Based on the findings, we propose a framework and a research agenda for further research on the topic of the role of digital government in the circular economy.

The remaining part of this paper is structured as follows. In Section 2, we present the broad policy context and discuss current policy developments in the area of circular economy, also in relation to digital government. In Section 3, we illustrate the methods used for our literature review. In Section 4, we present the findings of the literature review . In Section 5 we discuss the findings and present a framework for investigating the role of digital government, illustrate the framework with examples from the automotive industry, and identify inputs for a research agenda on digital government and the circular economy. In Section 6, we summarize the study and discuss its limitations.



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2 CIRCULAR ECONOMY POLICY DEVELOPMENT

Looking at the policy developments in the recent years, we see that circular economy and sustainability are gaining increased attention. At an international level, the Paris agreement is seen as a landmark in the multilateral climate change process as it is the first binding agreement of nations to make ambitious steps to combat climate change, including limiting global warming to below two degrees Celsius, compared to pre-industrial levels, and to achieve a climate neutral world by mid-century [4]. The formulation of 17 Sustainable Development Goals (SDGs) by the United Nations [1] aimed to redefine the concept of sustainability in the digital age. In particular, SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) focus on the need to rethink production inputs in order to reduce waste outputs.

Within this framework, governments of different regions set up their strategic agendas. For example, China's 14th Five Year Plan (2021-2025), which provides the overall strategic blueprint for the country's economic development, provides for numerous initiatives in the areas of energy transition (e.g., moving away from coal), new urbanization (e.g., reducing energy use and carbon emission in cities), and investment priorities (e.g., investing in digital technologies to promote energy efficiency across sectors), in line with the country's ambition to achieve carbon neutrality by 2060; within the Plan, CE is indicated as a national priority [5]. Key targets linked to CE initiatives to be achieved by the end of the Plan period include: utilizing 60 million tons of waste paper and 320 million tons of scrap steel, producing 20 million tons of recycled non-ferrous metals, and increasing the output value of the resource recycling industry to 5 trillion RMB (US$773 billion) [6].

In the United States, one of the latest policy initiatives has been spearheaded by the US Environmental Protection Agency (EPA), which has published a National Recycling Strategy to be part of a series on building a circular economy for all [7]. Circularity as a principle had been already embraced in the Sustainable Materials Management (SMM) Program that the United States has pursued since 2009, aimed at decreasing the disposal rate, via source reduction, reuse, recycling and prevention, and reducing the environmental impacts of materials across their life cycle [8].

In Europe, the European Green Deal is an important effort that sets the targets and directions for EU countries, which represents "a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use" [9, p. 2]. The Green Deal pays special attention to mobilizing industry for a clean and circular economy, highlighting also that CE allows for new opportunities for jobs. Digital technologies are acknowledged as a critical enabler for attaining the sustainability goals of the Green Deal in different sectors. In March 2020, the European Commission adopted the Circular Economy Action Plan [10], which captures elements such as the sustainable product policy framework, looking at design, empowerment of consumers and public buyers, as well as circularity in the production process. The plan identifies key product value chains such as plastics, batteries and vehicles, electronics and textile, as deserving specific attention. Specific legislative developments to promote circularity or to regulate CE in specific sectors are being developed. For example, a lot of attention is put on batteries, as they can be reused and recycled for new raw materials and the environmental damage from their disposal needs to be limited. The European Parliament is currently preparing a new batteries directive [11]. The Circular Economy Action Plan highlights that research, innovation, and digitization will play an important role in this transition.

On a national level, governments also make specific plans, like the Circular Economy Plan in the Netherlands [12]. The role of government is crucial in such national contexts. The Carbon Border Adjustment Mechanism in Europe, which is aimed to create a level playing field for companies related to products the production of which is very carbon-intensive, including steel and cement, provides for carbon border adjustment tax to be collected at the border when goods are imported into the EU, in order to stimulate circular flows and discourage flows that are less circular and environmentally-friendly. Other instruments that governments use are subsidies to stimulate citizens and businesses to use more circular or environmentally-friendly products. For example, subsidies for electric cars [13] are aimed to stimulate the transition from fossil fuel towards electric vehicles.

While more measures will be introduced in the future to stimulate the transition towards a circular economy, for these measures to work, proper monitoring of the implementation of these measures in practice will be very important. Lack of proper monitoring may jeopardize achieving circular economy targets and goals. This is visible in cases such as plastics that have been exported from the EU for recycling and ended up being disposed as waste [14]; issues with used cars exported to Africa [15], or eWaste [16]. As the flows are global, it is often beyond the jurisdiction of a single country or region to oversee these flows and take the appropriate measures.

Information infrastructures and digital tools, such as digital product passports, are gaining attention as means to allow for visibility and better monitoring of the circular economy flows. However, these developments are still in the early stages, requiring further research on the use of digital innovations for circular economy monitoring [17], [18].

3 METHODS

3.1 Research literature selection

In order to map existing research on the role of digital government in the development of the circular economy, we have analysed research publications in the fields of Information Systems and of digital government. For research in the Information Systems field, the departure point was the review on circular economy carried out in Zeiss et al. [3].

The search was performed in April 2021 using the Scopus search engine, using the following search string: (TITLE-ABS-KEY (government) AND TITLE-ABS-KEY (circular AND economy) AND TITLE-ABS-KEY (information) OR TITLE-ABS-KEY (technology) OR TITLE-ABS-KEY (digital)) AND (LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "ECON") OR LIMIT-TO (SUBJAREA , "ARTS")) AND (LIMIT-TO (DOCTYPE , "ar")).

The 68 papers resulting from the search were then manually scanned to ensure both text accessibility and relevance of the content – in alignment with the research question of this study: *What is the role of digital government in the circular economy (CE)*? As a result, one paper was excluded as it was not available in English, three papers were excluded as the full-text document was not accessible, and ten papers were excluded as their focus was considered as not related to the research question of this study. For example, one of the papers that was deemed not relevant for this study was a paper published in 2019 about government and foreign entrepreneurs from the 1920s to the 1940s with no link to circular economy, let alone digital government focus. The scan resulted in a pool of 54 papers.

3.2 Research literature analysis

The 54 papers were then coded in the following four dimensions:

1) Role of government

In order to identify the role that digital government has in each study on circular economy, we have drawn on the well-established framework by Hood and Margetts [19], which categorizes the roles that government can take in digital government initiatives by looking at the type of resources that governments leverage. The framework is frequently referred to through its acronym 'NATO', based on the initials of the four types of resources that government can draw on: Nodality, Authority, Treasure, and Organization. *Nodality* as a resource refers to the property of being in the middle of an information or social network. Government draws on nodality when it leverages its central position in a network to detect or put out information. For example, in the process of tax collection, government draws on nodality when sending out tax reminders, or scrutinizing the internet to detect tax evasion. *Authority* refers to the ability to command, permit, and prohibit through recognized procedures and symbols. Government can use authority to detect and obtain information by requisition, or as an effecting tool; for instance, it can command tax inspections and raids. *Treasure* refers to freely exchangeable resources (usually monies or money-like substances) that can be used by government as incentives or inducements to secure information or change someone's behaviour. An example of drawing on treasure as a resource would be government paying tax informers. *Organization* refers to resources directly owned by government – "a stock of land, building, and equipment, and a collection of individuals with whatever skills and contacts they may have, in government's direct possession or otherwise available to it" [19, p. 102]. An example of organization as a resource would be government officials scrutinizing traffic at ports or airports to collect tax-relevant information [19].

2) Stakeholders involved

When reviewing the papers, we also paid specific attention to which actors of the circular economy ecosystem each empirical study focuses on. Based on a number of iterations that considered the need to balance the granularity of the analysis with its practical use and heuristic, we identified the following categories: businesses (including all private business organizations not taking the role of providing IT); consumers (as individuals); IT providers; NGOs (including consumer groups), and research institutions (including both academic and non-academic organizations, such as private think tanks).

3) Product Life Cycle (PLC) stages

In line with the literature review on circular economy and IS carried out in Zeiss et al. [3], we classified papers based on the stage of the Product Life Cycle [20] they focused on (whenever they focus on any of them). The following stages were used as classification categories: *pre-use*, including studies focusing on activities from product idea to delivery; *in-use*, including studies focusing on activities from product delivery to end-of-life; and *post-use*, including studies focusing on activities from product end-of-life to product next-life.

4) Digital technologies

In our study we were also interested in the type of digital technologies used in each of the empirical cases investigated in each paper. In the analysis we also tried to trace whether the papers that we reviewed addressed digital technologies only on a general level or whether they mention some specific digital technologies. For the cases where specific digital technologies were listed, we made notes about the technologies that were mentioned. As a result, we obtained a list of technologies that were mentioned in the paper that we subsequently further analyzed.

The categories of each of the four dimensions used for the classification were considered non-exclusive so that, whenever applicable, a paper was classified in more than one category in the same dimension.

Two authors independently analyzed all the articles and characterized them using the categories as discussed above. Whenever possible, the analysis was done based on abstracts. When the abstract did not contain sufficient information to perform the characterization, full versions of the papers were reviewed to obtain the information. The characterization was carried out independently and the results were compared. Differences were discussed and resolved to arrive at the final classification.

4 FINDINGS

The 54 papers analyzed all included empirical research on one or more cases of circular economy in which digital government plays a role. While not all the papers were country-specific, the majority of the papers identified one or more country in which the empirical study has been carried out. The total number of countries focused on in the papers is 17.

As illustrated in Figure 1, it is interesting to observe that the country which is by far most focused on is China, followed by India, and then a long tail of countries in Europe, Asia, and the Americas, that are focused on only a handful of times. The focus on China reflects the early initiatives that the country has taken in the area of circular economy for a number of years now. China passed the Circular Economy Promotion Law in 2009, and has acknowledged the circular economy as a national development goal for already more than a decade [21]. This has triggered developments that were promptly followed by research. With the European Green Deal that is now setting ambitious agenda in Europe, we can expect the rise of interest also in the digital government research in Europe on issues such as circular economy.

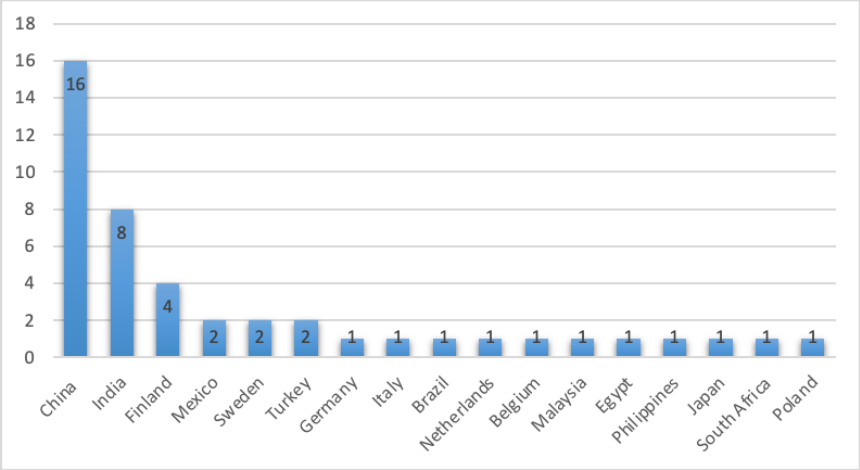


Figure 1: Number of papers by countries focused on in their analysis

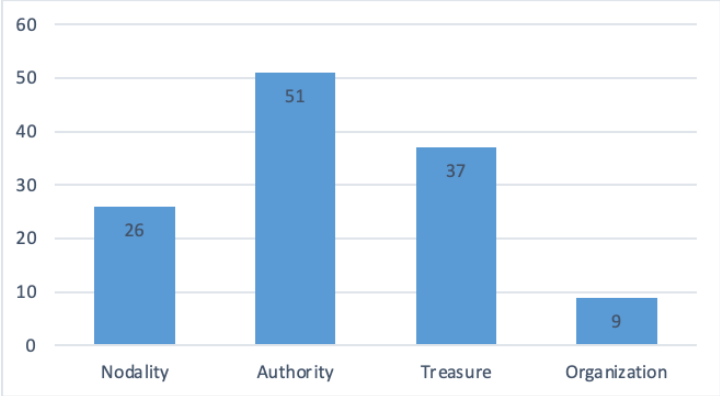


Figure 2: Number of papers by type of role taken by government in their analysis

4.1 Role of government

Figure 2 presents the results from our analysis with respect to the role of government. *Authority* is the role that was mostly encountered, followed by *treasure*. This is not surprising, as shift towards circular economy is often driven from the government side with policies and regulations and stricter requirements for monitoring and control. It is also not surprising that *treasure* appears as a second most encountered role, as it reflects the role of government to use financial incentives and subsidies to enable transitions. These two categories reflect the traditional roles of government of using regulatory pressure and using financial measures for steering a transition.

Our analysis also shows that the roles of nodality and organization are much less focused on. These roles relate to the positioning of the government in the wider ecosystem, building and brokering relationships between actors. These are roles that are very important for the circular economy transition, which requires actions from many actors, including businesses, NGOs, technology providers, and consumers, to identify new business models and models of engagement that will lead towards a future driven by circularity. Yet, in current research these roles have received limited attention and further research can focus on understanding what government can do to better fulfil these roles and to act as an enabler in the circular economy transition.

4.2 Stakeholders involved

Figure 3 provides an overview of the results when we look at the stakeholders involved in the circular economy ecosystems.

The vast majority of the studies focus on business actors in the supply chain, as can be expected in the context of circular economy. Other categories of stakeholders that are less focused on include individual consumers and research institutions. Only three studies include IT providers in their focus – a surprising fact, given the key role that IT plays in the development of circular economy, with its consequences for digital government initiatives.

4.3 Product Life Cycle (PLC) stages

Figure 4 summarizes the findings when looking at the aspect of Product Life Cycle (PLC) stages that are focused on in the reviewed papers. The focus is put largely on post-use stage, as many papers

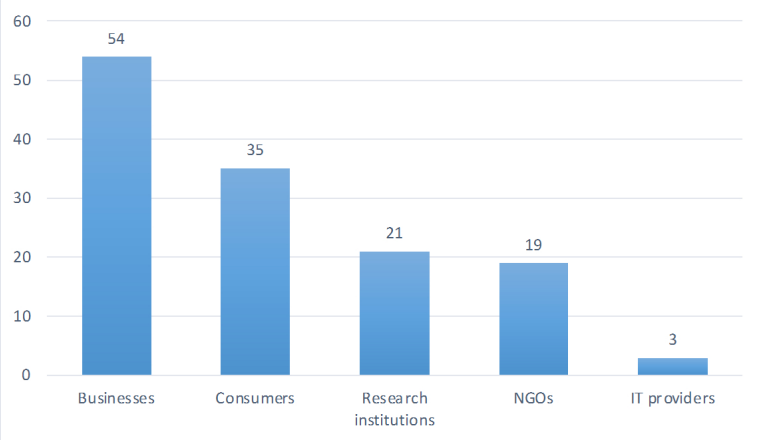


Figure 3: Number of papers by type of stakeholder included in their analysis

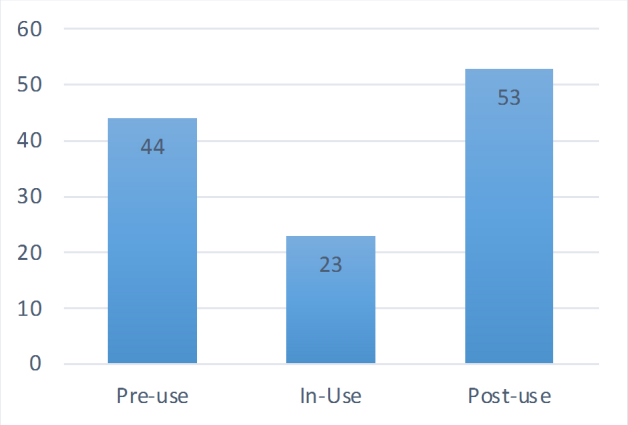


Figure 4: Number of papers by stage of the Product Life Cycle (PLC) focused on in their analysis

were focused on recycling, as well as on the pre-use stage. On the other hand, the in-use stage has received limited attention.

Looking at the pre-use and the post-use stages, businesses usually play a key role as they are involved in the production and logistics processes, as well as the recycling processes at the end of life. For the in-use stage, on the other hand, the role of the consumer can be considered paramount.

4.4 Digital technologies

While all 54 papers analyzed deal with the role digital technologies at least in a general way, 23 have an explicit focus on one or more specific technologies. Figure 5 presents a word cloud to illustrate the technologies that were mentioned in most papers.

The distribution of foci on specific technologies is rather scattered, with no one digital technology attracting most of the attention. The use of sensors in product supply chains, referred to as the Internet of Things (IoT), is the most focused on technology, but it is mentioned in only 5 papers. Other technology keywords include blockchain, Industry 4.0, and information platforms (focused on in 3 papers), followed by a long tail of technologies that have only very few papers dedicated to them – these include Artificial Intelligence, 3D printing, Geographic Information Systems, and robotics.

5 DISCUSSION

Findings from the literature review highlight a number of gaps in existing empirical research, with some of the categories in each of the four dimensions of the phenomenon of digital government and the circular economy (role of government, stakeholders involved, PLC stage, and digital technologies) that are still underinvestigated, despite arguably playing important roles.

In relation to the role of government, the traditional resources of *treasure* and *authority* are mostly focused on, with government stimulating the development of a circular economy either by economic incentives, or by establishing regulation and guidelines. Other potential roles that government can take in the development of an ecosystem for circular economy are relatively overlooked – namely the possibility for government to draw on its central position in important networks (i.e., *nodality*) to educate stakeholders and establish partnerships; and the possibility for government to draw on its own organizational resources, skills, and human resources (i.e., *organization*) to advance circular economy initiatives. In fact, among the key characteristics of the circular economy phenomenon is to draw on complex networks of actors of different nature (public and private organizations, diverse supply chains, etc.), and to require diverse skills (technical, legal, managerial, etc.). Policy interventions in other emerging areas of digitalization, such as Artificial Intelligence (AI), have focused on roles other than *treasure* and *authority*. In fact, a recent analysis of AI in government shows that the other nodality- and organization-related initiatives, such as awareness campaigns, training programmes, and data management actions, are dominant in comparison to regulatory "sticks" punishing certain behaviours, or "carrots" in the form of economic incentives [22]. Future research on digital government and the circular economy should pursue a more holistic view on the phenomenon of circular economy by providing more attention to the *nodality* and *organization* aspects of government role. Examples of key research questions in this dimension would be: what are



Figure 5: Word cloud of technologies mentioned in the papers

the characteristics of effective government information campaigns on circular economy? How can skills possessed by governmental agencies be drawn in the implementation of circular economy initiatives? What criteria should government regulation adopt to monitor circular economy targets achievement?

Existing research also features another imbalance concerning the focus on different stakeholders involved in circular economy ecosystems. The dominant focus on businesses and individual consumers means that other key stakeholders are relatively overlooked, namely research institutions, NGOs, and IT providers. However, understanding the role of IT providers, for example, is crucial when investigating digital government initiatives. Procurement interactions between government and IT providers are, in fact, a complex phenomenon with extensive impacts in terms of power relationships [23], or requirement specifications [24], [25], especially concerning emerging technologies. Future research on digital government and the circular economy will need to zoom out from an exclusive focus on businesses, to encompass a wider ecosystem of stakeholders, including IT providers, NGOs, and research institutions. Examples of key research questions in this dimension would be: what are power relationship between IT providers, government, and other stakeholders involved in circular economy initiatives? To what extent does research conducted by research institutions influence circular economy models? What are partnership models between government, research institutions, and NGOs?

Findings also show that existing research tends to focus mostly on issues related to the pre- and post-use stage of product lifecycles and, to some extent, overlook what happens in the *in-use* stage of a product. This stage comprises the period of the product's use by the consumer, and it is the stage where the goal is to intensify and extend the use of products and their components, in a circular economy approach. Future research should thus not only investigate circular economy initiatives in relation to pre- and post-use (e.g., product design, product recycling), but also in relation to the in-use stage. Examples of research questions in this dimension include: how does government regulation influence product repairing practices? How can digital government platforms improve product sharing and optimize consumption processes?

Last, the review of the literature highlights that specific digital technologies are seldom focused on in research on digital government and the circular economy. Blockchain and the Internet of Things (IoT) are key technologies that have potential to support the achievement of sustainable goals by enabling transparency and traceability in product supply chains and in post-use stages [26]. While this potential is partly acknowledged in existing research, future studies in digital government and the circular economy should give a much closer look at the role of specific digital technologies that carry potential for sustainability such as, for example, Artificial Intelligence [27]. Possible research questions stemming from the need to focus on digital technologies include: what are models of governance of blockchain technology in support of the circular economy? How can government balance regulation with stimulating innovation in the use of AI for circular economy? What skills are required for public servants dealing with Industry 4.0 initiatives for circular economy?

5.1 Towards an analytical framework

Figure 6 below presents a framework for understanding the role of government in the circular economy. The framework builds on the conceptual categories that we used during the exploratory literature review and allows to reason about the role of government in the circular economy from a holistic perspective. At the heart of the framework are the key roles of government i.e., nodality, authority, treasure, and organization. As we have seen in our analysis, the roles of authority and treasure are well recognized in existing literature, while the roles of nodality and organization have received more limited attention, and further research is needed.

The lines in the framework indicate key relationships between different aspects of the circular economy phenomenon. For understanding the role of government we consider that it is important to look at (1) the relationship between government and the Product Life Cycle (PLC) stages; (2) the relationship between government and other actors in the ecosystem, and (3) the relationship between

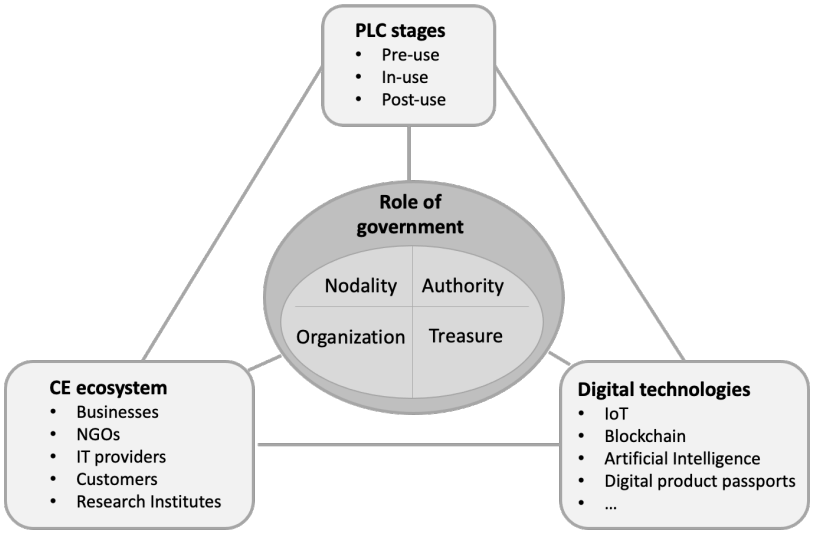


Figure 6: A framework for analysing the role of government in circular economy

government and the different types of information technologies supporting CE.

Our framework also captures that there can be direct relationships between other actors from the CE ecosystem and different PLC stages. The wider CE ecosystem can also use digital technologies to support their CE activities, and these technologies can be deployed at different PLC stages. This allows to capture the broader context of PLC stages, ecosystem actors, and technologies. By putting government with its roles in the center, the framework allows to take a government-centric view, while still taking the broader context of CE into account.

The framework is not meant to be a prescriptive model, but it is rather an analytical lens to structure our understanding of the role that digital government can play in facilitating the circular economy transition. Such understanding may help government organizations to more effectively play their role in the wider CE ecosystem.

In the next section, we provide some empirical examples to illustrate how the framework can be used in analysing the role of government in CE initiatives.

5.2 Applying the framework: examples from the automotive domain

To illustrate the potential usefulness of the framework, we draw on an analysis of an example of circular economy initiatives in the automotive industry. We first discuss some typical roles that government takes in the pre-use, in-use, and post-use stages (see sections A, B, and C in Table 1). We then discuss a scenario where government can take a more holistic view across the stages, taking different roles and engaging with the wider stakeholder community (see section D in Table 1).

5.2.1 Pre-use. Looking at the automotive domain, and looking at the pre-use stage of the CE processes (see also A in Table 1), car manufacturing can be seen as the *pre-use* stage. In this stage, government has a strong role of authority in terms of drafting legislations and the legal framework to put requirements on the manufacturing process. For example, for batteries and vehicles, the European Commission's Circular Economy Action Plan foresees to have rules on mandatory recycled content for certain materials of components [10]. From the point of view of the ecosystem, the primary affected actors are businesses involved in manufacturing of cars, be it the car manufacturing companies, or parts/ materials suppliers.

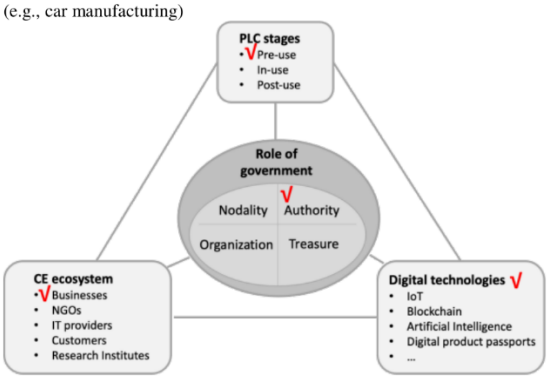
Information Technology plays an increasingly important part in providing visibility on CE and compliance. For example, businesses are required to monitor and report the use of dangerous substances in their products. With targets that the EU is putting on the use of secondary raw materials in new products by 2030 and 2050, it is likely that IT will play an important role in tracing the origin of materials used in new cars, and ensuring that the right percentage of secondary raw materials are indeed used in the production of new vehicles.

5.2.2 In-use. Looking at the in-use stage (see section B in Table 1), a role that government takes actively in some European countries, for example in the Netherlands, is the *treasure* role. Namely, in order to stimulate the transition from fossil fuel cars towards electric cars, governments are providing subsidies to make buying electric cars more attractive [13]. The primary actors from the wider ecosystems are the businesses that would like to make use of these subsidies for buying cars for business use, as well as individual citizens as consumers. One way Information Technology plays a role in this process is to monitor the eligibility for granting the subsidies and to register the ownership of electric cars. In particular, the latter is useful later in the process to monitor the lifecycle of the electric vehicle and, most importantly, to ensure that it is properly disposed.

5.2.3 Post-use. An important role that government has in relation to the post-use stage (see section C in Table 1) is the one of *authority*.

Table 1: Examples of government role in the CE in the automotive industry.

A. Pre-use
(e.g., car manufacturing)

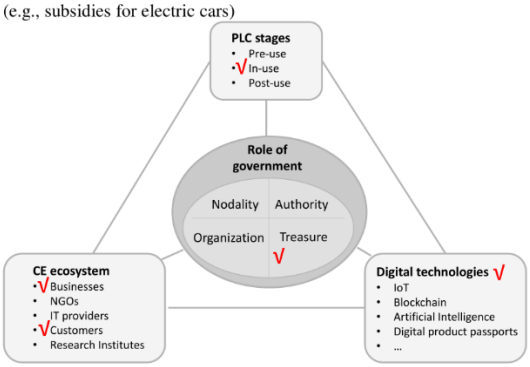


Government role
- Authority (batteries regulation; requirements for use of secondary raw materials)

CE ecosystem
- Primary affected actors: businesses

Digital technology
- IT for proving CE visibility and compliance (e.g., battery passports)

B. In-use
(e.g., subsidies for electric cars)

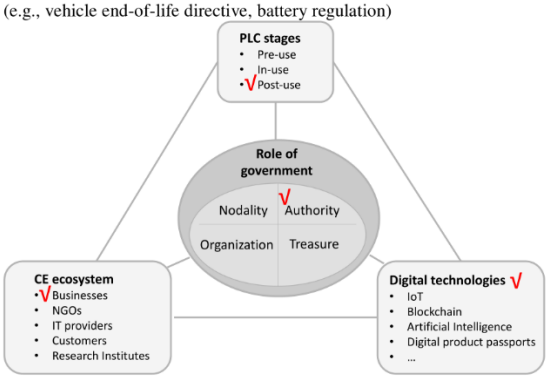


Government role
- Treasure (subsidies)

Ecosystem
- Primary affected actors: consumers, businesses (in case of company cars)

Digital technology
- IT for registration of ownership of cars and monitoring eligibility for subsidies.

C. Post-use
(e.g., vehicle end-of-life directive, battery regulation)



Government role
- Authority (end-of-life vehicle directive, battery regulation, extended producer responsibility)

Ecosystem
- Primary affected actors: businesses

Digital technology
IT for end-of-life registration and for monitoring proper recycling steps

D. A more holistic view on the role of government in all CE stages

Government role
- Government can take more roles while drafting legislation about the *pre-use* stage to use results from the *in-use* and *post-use* stages to prepare the grounds for the CE transition.
- Authority role for drafting legislation can be supplemented by the *organization, treasure* and *nodality* roles for piloting and providing feedback to the legislative process.
  - Organization: working together with NGOs, IT providers and other organizations in piloting and ensuring that the legislation is implementable; aligning internationally on policy and standards;
  - Treasure: providing public funding for piloting and experimentation;
  - Nodality: working with research and education institutions to create training materials and awareness to show best cases and to help governments/ companies/ citizens to make the CE transition.

By establishing regulatory frameworks, such as the end-of life vehicle directive [28], or the battery directive [29], European authorities aim to set requirements on what will happen with vehicles and their parts at the end-of-life stage and how they would be processed in an environmentally-friendly way. Due to the scarcity of certain raw materials, governments are also starting to monitor the flow of Critical Raw Materials (CRM) [30] to be secured for future use. All these can be seen as examples where government bodies are acting in their authority role. The primary actors affected by these regulations are businesses, be it businesses involved in the production who have to take roles also for the post-use stage, or parties like recycling companies involved in the end-of-life stage. Digital technologies play a role in monitoring the processes when the car is unregistered for use, as well as the movement of the vehicle and its components to the appropriate recycling destination and monitoring that the proper recycling processes have taken place. With the upcoming changes to the batteries directive, more information about the battery would need to be shared via battery passports to allow for better extraction of the valuable raw materials so that they can be streamlined as secondary raw materials in the production process of new products (cars or other).

5.2.4 A holistic view on the role of government through all CE stages. While in sections A, B, and C we discussed examples of the typical roles that government plays in terms of authority and treasure, there is also a wide variety of other roles that government plays

and can play more prominently in the future when we look across stages, and taking the broader actor ecosystem into account. For example, authorities at EU level will continue also in the future to revise existing legislations to stimulate the transition towards circular economy and sustainability, for example regarding the batteries used in electric vehicles and the introduction of battery passports. While these changes affect first and foremost the businesses, IT providers will play a key role in enabling the implementation of such passports, NGOs will play a key role in defining standards or echoing requirements from different communities, and research institutes will play a key role in working with these different stakeholders and enabling innovation. Government can play an active role in these piloting and experimentation stages, where valuable lessons learned about what is feasible to achieve in practice can be provided as feedback to the parties drafting legislation.

Taking this iterative perspective, governments can also take a more active role in this piloting and experimentation process, besides the role of authority. For example, governments can take the role of *treasure* and provide public funding for early stages of piloting and experimentation, stages that may be difficult to finance otherwise, as business cases for companies may not yet be clear. What is interesting to notice is that while legislation is drafted at EU level, governments of Member States may be responsible for its implementation. In these cases, national governments can be more active in the *organization* role, collaborating closely with the other actors in pilots as active participants, and helping to make the requirements from the point of view of government more explicit. From this position, government can also take an active role of *nodality*, sharing for example best practices with governments from other Member States, with businesses, as well as with policy makers at EU level.

All these illustrate that it is possible to explore the role of government in a much more holistic and dynamic way, where next to roles of authority, government at different levels can also play an active role in the innovation process by having the roles of *treasure*, *nodality*, and *organization*.

We do see governments acting in such roles as well. In Europe, EU funding programmes[1] have worked as an engine of innovation for decades. In the area of international trade and customs, a series of EU-funded projects[2] with involvement of businesses, IT providers and the active participation of customs and other government agencies, have been developing and piloting innovations in the area of safety and security, revenue collection and trade facilitation [31], [32]. In these projects, governments formed part of the innovation process, acting in their *organization* role and engaging actively with other stakeholders. For example in the CORE[3] EU project, customs authorities worked closely with supply chain partners and technology providers to pilot with data sharing infrastructures for voluntary sharing of business data with government for trade facilitation benefits. Piloting was done also with global blockchain infrastructures, such as TradeLens, to examine the potential offered by such global platforms for customs risk management. Similarly, in the PROFILE[4] EU project, several EU customs administrations collaborated with data analytics providers, external data providers, and academia to examine the possibilities offered by data analytics for customs. This rich knowledge and experience on how government can collaborate with supply chain partners, IT providers, and academia for developing innovative solutions, can serve as a fertile ground for further innovations in the area of circular economy where, next to customs agencies, also other government agencies interested in controlling the circular economy flows can take an active role.

In the area of international trade and customs we also see examples where, taking the innovation perspective, government can also play an active role of *nodality*. One such example is the EU-funded practitioners innovations network of customs professionals (PEN-CP[5], where results from other EU research projects can be further disseminated to other Member States' governments and business communities, allowing government agencies involved in research projects to share results with other administrations. While these examples are from the area of international trade and customs, they show how governments can take a multiplicity of roles, and such experiences may be useful for governments in shaping the circular economy transition. These earlier experiences from other domains can be also instrumental for shaping further research on understanding the role of government in circular economy.

6 CONCLUSION

In this paper we have tried to advance questions on the role of digital government in the circular economy. Based on a review of empirical literature, we highlighted foci and gaps in the existing knowledge base, and suggested directions for future research. The analytical framework we presented, and whose use we exemplified by drawing on the example of circular economy initiatives in the automotive industry, can be a first step towards supporting systematic research on digital government and the circular economy.

Limitations of this study are related to the exploratory nature of the literature review. Future insights into the state of the art of empirical research on digital government and the circular economy should expand the number of research outlets included in the review. Moreover, the proposed framework will need further validation through rigorous case analyses.

The idea of the circular economy is among the most powerful ones available to tackle the epochal challenges of sustainable development, and digital government initiatives have to be geared to enable and shape it. In the close future, the role of digital government needs to be better conceptualized, in order to facilitate the needed growth of a knowledge base for both research and practice.

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[1] E.g. FP6 (https://cordis.europa.eu/programme/id/FP6), FP7 (https://cordis.europa.eu/programme/id/FP7), Horizon 2020 (https://ec.europa.eu/programmes/horizon2020/en/home) , Horizon Europe (https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en)

[2] ITAIDE, CASSANDRA, CORE (http://www.coreproject.eu/), PROFILE (https://www.profile-project.eu/)

[3] http://www.coreproject.eu/

[4] https://www.profile-project.eu/)

[5] PEN-CP- https://www.pen-cp.net/)

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Exposing the Phish: The Effect of Persuasion Techniques in Phishing E-Mails

Michael Koddebusch
koddebusch@ercis.de
University of Münster, European Research Center for Information Systems
Münster, Germany

ABSTRACT

With ever-increasing amounts of data collected from citizens and businesses in Smart City environments, public administration agencies manifest their position as central data holders. However, this great ownership of data makes them a target of cybercriminals on the hunt for illicit enrichment. The predominantly used type of cybercrime is phishing and increasingly spear phishing, a more personal, target-oriented kind of phishing. Such attacks make use of so-called persuasion techniques to lure their victims. In this study, four persuasion techniques, namely Authority, Urgency, Danger and Benefit, were tested for effectiveness in a two-phased field experiment cooperating with four German municipalities. In total, 3452 fake phishing e-mails were sent to 1276 public officials. Results show that the persuasion technique of Authority has worked best and therefore presumably poses the biggest threat to the information integrity of public sector agencies, followed by Urgency, Benefit and Danger. Additionally, the study provides insight on the potential impact of the effects of constant exposure to phishing and shows that the degree of domain-specificity of attacks impacts the susceptibility of victims.

CCS CONCEPTS

• **Security and privacy → Social aspects of security and privacy**; • **Human-centered computing**; • **Applied computing →** *Sociology*;

KEYWORDS

smart city, phishing, spear phishing, persuasion techniques, human error, cybersecurity, experiment

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1 INTRODUCTION AND MOTIVATION

The concept of the "Smart City", a city in which "high technologies [...] create benefits for citizens in terms of well-being, inclusion and participation[...]" [20] is already implemented in many places [32]. Both practitioners and scholars are on the rise to conceptually grasp and communicate the benefits of such places. The core and foundation of the smart city to work is the upscaled collection, integration, processing, and utilization of large amounts of data captured by different kinds of sensors in our surroundings[18]. Local public administrations stand at the core of these developments. They can be considered the most prominent creators and collectors of data from citizens and businesses [30]. One of the most crucial foundations for the Smart City implementation is collecting and processing large amounts of user data [40]. According to [13], the Smart City requires a variety of sources to obtain data from, classified into traditional tools and innovative tools that allow for data sensing and mining of both physical and social infrastructure[6]. At best, this collection is being done in real-time, so that data can be processed immediately to ensure actual "smartness" and not only the simple analysis of historical data [37]. The cumulative collection of data, however, also implies the cumulative storage of data. With the public administration being at the core of each city, connecting individuals, politics, and businesses, the data inventories of these entities are likely to grow extraordinarily as well. Owning such large amounts of data assets, public administration entities will be an even more attractive target for cybercriminals than they are today. This means that the public administration must be awarded special attention for information security measurements when conceptualizing its role in the Smart City. This becomes especially important considering that cyberattacks are not only a potential future problem for public administrations but a severe threat already today[24]. Realizing the damages cybercriminals are causing current local public administrations, the need to increase information security in the future Smart City becomes obvious.

Regarding only the past year, there have been multiple reports in which cybercriminals attacked such administration agencies, compromising large amounts of sensitive data. Witten's (Germany) systems were down or considerably impaired for days in the aftermath of an attack[57]. The *Irish Health Service* lost thousands of data records to criminals, who published them partly online afterward[9, 26]. Rolle (Switzerland) got hacked, with the criminals then blackmailing the individuals and businesses they gathered data from for ransom money[52].

These examples demonstrate the inherent threats of the severe increase in data collection and processing in Smart Cities. To mitigate these threats, it needs more than technological advances, but

especially a human-centered approach to cybersecurity, as the "human error" is still the primary security concern for not only local public administrations [46].

Therefore, this paper puts the human at the center of attention. With phishing attacks being among the most common cybercrime incidents, we want to reveal which persuasion techniques trick the employees of local public administrations into succumbing to phishing attacks. This study aims to describe the effects of four different persuasion techniques of (spear) phishing e-mails. For this purpose, these techniques are being tested in a field experiment to establish an order with respect to their effectiveness among employees of local public administrations. Furthermore, the results will be analyzed against their domain-specificity, the effect of the recipients' gender, and the effect of experiment repetition. The insights gained shall enable IT security leads and responsible staff to initiate appropriate countermeasures to shield sensitive data from unauthorized access and thus help become ready to become a Smart City. The contribution of this work is of importance to implement Smart Cities not only in a way that is technologically possible but in a way that is safe and beneficial in terms of well-being [20] for its citizens, as it helps to protect the necessarily gathered personal citizen-data from criminals by preventing the *human error* [46] before it occurs.

The remainder of this paper is structured as follows: in the next chapter, related research to this article will be presented. After that, the experiment's method is presented, which includes justifying design decisions made during this process. Afterward, the experiment results are introduced and discussed before concluding with remarks on the implications of this work and opening up possibilities for future research.

2 RELATED WORKS

As outlined before, there is a strong link between the progress of implementing smart cities, generating and storing large amounts of data, and the information security level of the public administration. The more data is generated, the more robust its protection must be. That includes the phishing susceptibility of employees of local public administrations. Hence, the following paragraphs lay the basis of this article by giving an overview of related research.

2.1 Smart Cities, Security, and Privacy

A significant literature review of security and privacy risks that Smart City initiatives face has been offered by [32]. According to their findings, the literature streams related to these risks can be categorized into nine segments: (1) privacy and security of mobile devices, (2) Smart City infrastructure, (3) smart power systems, (4) smart healthcare, (5) frameworks, algorithms, and protocols to improve security and privacy, (6) operational threats for Smart Cities, (7) the use and adoption of smart services by citizens, (8) the use of blockchain systems within smart cities and (9) social media-related issues. They also suggest a framework to visualize the interdependencies of all these segments.

A closer look at risks related to actual criminal activity has been taken by [6], who discovered 29 security threats across the six segments of the smart city landscape: Smart Grids, Building Automation Systems, Unmanned Aerial Vehicles, Smart Vehicles, IoT Sensors, and Cloud applications. After analyzing related data sources and challenges, they conclude that smart city data is generated in vulnerable environments, and therefore security controls of different kinds must be in place. In line with that, [3] and [2] have investigated the severe problems cyberattacks can have on Smart Cities due to their dependency on IoT applications and conclude the need to investigate how to improve security.

However, security and privacy are no mere technological topics. As pointed out by [51], people in Smart Cities are concerned about the effects intensive data collection can have on their lives (e.g., data collection for service delivery vs. surveillance) and their role as individuals in Smart Cities.

While security and privacy do get attention in the Smart City discourse, the human factor in this regard has not gained much attention. This is surprising, as the importance of regarding how human behavior can undermine technological efforts in cybersecurity has long been recognized, for example by [46], [44] or [58].

2.2 The Role of Public Administration in Smart Cities

In general, public administration (PA) and its entities have an exposed position in the Smart City context. As [29] point out, the initially by [36] suggested decision-making process of PA is expanding in light of the Smart City as administrative agencies and their interaction with multiple stakeholders and between each other are becoming increasingly complex, which results in public administration agencies being among the largest data creators and gatherers in many countries [30]. Scholars like [21] saw this new position of PA and developed an integrated model to align technological, informational, and communication aspects of PA and its stakeholders better. A central discourse related to this development is the potential of big data, its analysis, and its application for PA [30]. Scholars in this field, for example, consider the application of big data in PA from a conceptual point of view ([38]), from a use case perspective ([14]), or a cost-vs-benefit evaluation ([22]).

However, the data ownership makes public administration agencies a top target for cyberattacks as PA typically stores the most valuable personal data such as birth records, social security information, and financial information on individuals and businesses. This, combined with the reputation of not being able to ensure data security [48] poses a significant threat to public administration and the individuals and organizations indirectly being affected by attacks.

2.3 Cybersecurity and the Public Administration

According to the Federal Office for Information Security (BSI), the German federal administration is subject to cyberattacks on a daily basis [11]. As several studies show, however, cybersecurity is not only a matter of concern in the German PA domain but is internationally a widely recognized issue as well [8, 17, 23, 45]. Scholars agree that cybersecurity is one of the main challenges for PA in the digitized world, and therefore in the Smart City in particular, with dangers such as attacks on electronic systems, cyberterrorism,

or cyber warfare [16, 34, 49]. Cybercrime can be divided into several streams, predominantly the installation of malware, identity theft, botnets, social engineering and spam, and fishing [12]. The Anti-Phishing Working Group, an international consortium organizing the global response to cybercrime, has registered a severe incline of phishing activity over the past years, culminating in an all-time high of 260,642 phishing attacks in July 2021 [4]. Moreover, the FBI counts phishing among the top three types of cybercrime [25]. Unfortunately, there is a lack of statistical recordings regarding the amount of phishing targeting public bodies. Some studies, however, indicate that PA is a commonly used target for phishing scams [19, 43, 50], which mirrors media coverage of public sector organizations increasingly serving as targets for cybercrime [24].

2.4 Phishing, Spear Phishing, Persuasion Techniques and Phishing Experiments

There is a multitude of different definitions of what phishing is exactly. Scholars worked to synthesize these definitions and elicit their main concepts [33, 35]. A resulting, often cited definition is: *Phishing is a scalable act of deception whereby impersonation is used to obtain information from a target.*[35] *Scalability*, here within, stands for the ability to mass-distribute messages, *deception* is the concept of intentionally misleading activity, and *impersonation* is the criminal pretending to be an individual or organization he/she is not. Despite this definition's comprehensiveness, it leaves out the central aspect that phishing e-mails not only trick users into giving away their credentials but can also include malicious links, leading to, when clicked, the installation of ransomware [27, 53], which is a central aspect of this study. A particular form of phishing is spear phishing, which adds the specialization with which a potential victim is being addressed [39]. This specialization is reached by putting more effort into investigating the victim's background and so being able to target it more precisely by using their names or the domains of organizations they work for. The rationale behind that is increasing trust through specialization and, therefore, a higher success rate [10].

Trust in these e-mails, however, is generated not only by the degree of specialization but also through special social engineering techniques, so-called influence- or persuasion techniques. Many scholars have investigated several persuasion techniques[5, 15, 41, 42, 47, 53–55]. Four of these techniques have been named predominantly when reviewing the literature: *Authority* (the e-mail conveys an authoritative tone, e.g., by giving orders to take action), *Urgency* (the e-mail conveys a sense of urgent deadlines that action needs to be taken by), personal *Benefit/Gain* (the e-mail content promises some reward being given to the victim when action is taken) and *Danger* (the e-mail content announces the victim to fear consequences if no action is taken).

Several researchers have pursued experiments to measure how many individuals of a pre-defined population would fall for phishing e-mails. These experiments were established in different environments, e.g., the healthcare sector [28] or a university setting [1]. However, the public sector was also regarded before, on a ministerial level though [7]. The results of these experiments differ quite heavily from each other, between 14% to 30% click rates. None of these examples, however, focused on persuasion techniques of phishing e-mails in their experiments. While we will set these results in context to the results of this study in the further course of this article, it becomes evident that, depending on experiment set-up and experiment context, scholars regularly reach varying results from their research.

3 RESEARCH METHOD

To achieve meaningful results, a field experiment based on [31] was conducted. This entailed preparing and implementing a phishing simulation in cooperation with four small-to-medium-sized municipalities in Germany [25,000-55,000 inhabitants]. The selection process of partners took different factors into account. First, we selected potential partner municipalities based on their physical proximity to our research institution, as we deemed their likelihood to partake higher if they were acquainted with our institution or had previous experience in cooperation. Next, we wanted to ensure comparability between the municipalities in terms of inhabitants, so we excluded all potential partners with more than 80,000 inhabitants simply because there were not enough cities of this size in reach of our physical search radius (which is a physically distinct region in Germany). Afterward, we excluded all potential partners with fewer than 20,000, as these entities are often not independent. Finally, we reached out to ten potential partner municipalities. After some follow-up activities (e-mail, phone), four of them signed up for an information meeting, in which we informed them about the objectives, timelines and benefits for them. All four of them agreed to partake in the experiment. During this simulation, 3452 harmless phishing e-mails were sent to a total of 1726 unique individuals. *Harmless* in this context means that our phishing simulation did not aim to install malware on the recipients' computers. Instead, we only tracked the number of clicked links. When clicking a link, the individual was directed to a created web page, providing information about the experiment and helpful tips against phishing and cybercrime. The experiment was carried out in December 2021/January 2022.

In line with [31], the experiment consisted of (1) input to the experiment, (2) activities during the experiment, and (3) conclusion to the experiment.

Input: In preparation for the experiment, we closely worked together with the IT-Security leads of the respective cities, who organized approvals of all relevant actors within the cities' administrations. Additionally, each city provided four comprehensive lists of e-mail-addresses listing all available addresses for the respective administration. We initially received 1874 e-mail-addresses, 148 of which were removed as they did not represent individual employees but were functional addresses (such as support@... or admin@...). The remaining 1726 addresses belonged to public officials and employees of all hierarchical levels of the administration.

Parallel to the organizational preparations, the technical infrastructure was set up. An open-source software [56] to exercise phishing simulations was installed and tested on a commercial Virtual Private Server located in Germany to ensure GDPR compliance. Moreover, the preparation phase included conceptually and visually designing the phishing emails based on the insights gained from analyzing the literature on phishing persuasion techniques. The

preparations concluded in four e-mail-templates embodying one influencing technique each:

(1) Authority (municipal data center communicating an obligation)
(2) Urgency (urgent citizen request)
(3) Danger (mail order receipt with the announcement to collect the invoice amount from the recipient's bank account)
(4) Benefit (opportunity to partake in a partner program granting discounts to cultural offers)

To implement degrees of specificity to the e-mail templates, two of them, *Authority* and *Urgency*, were designed as spear phishing e-mails by embedding them into a specific public sector context. The remaining two templates, representing *Benefit* and *Danger*, were more general and could have as well been targeting organizations from other domains. The simulation was configured to target all recipients by addressing them personally (depending on the case by first- or last name).

Each e-mail-template contained several links for the recipients to click on to. The decision to design exactly **four** e-mails representing one persuasion technique each was based on the desire to conduct an experiment with a sufficient number of recipients for each e-mail template. The total number of recipients was determined by the four municipalities willing to partake in this experiment. If we had included more persuasion techniques, the number of recipients would have shrunk by 86 individuals (one more) per technique and 144 individuals per technique (two more), which would have drastically decreased the reliability of the results. We chose the four persuasion techniques *Authority*, *Urgency*, *Danger* and *Benefit* as they were the most common ones discussed in the relevant literature. Some less often discussed concepts were, for example, *Social Proof*, *Trust*, *Empathy* or *Curiosity*. However, due to the limited number of subjects explained before, we had to limit the to-be-tested persuasion techniques to the most relevant ones.

The design phase went through three iterations so that the partners on the side of the local administrations could give their feedback to increase the credibility and authenticity of our e-mails. After finalizing the designs, e-mail-accounts and -domains were acquired to provide each e-mail-template with a realistic sender profile. The templates were written in HTML to incorporate them into the phishing simulator. All e-mail-addresses were split into four groups, with an equal share of each city per group. As the last step, a landing page was designed and implemented that recipients clicking on links were directed to. This landing page explained the experiment and ensured the reader not to fear any consequences. Additionally, we provided information on phishing and IT security in general. The installation of the landing page was a requirement given by the partners, as resentment among the workforce was expected to occur when they would eventually find out there was an experiment with which they were being tricked.

Main activities: After completing all preparations, the actual experiment started. Each e-mail-template was sent to between 429-434 public officials and employees across all four municipalities in the first phase. The e-mails were sent successively over eight hours. It was impossible to send all e-mails at once as automated security measures of the e-mail provider would have been triggered, blocking all further e-mail dispatch. The runtime of the simulation was precisely one week from sending the first e-mail. During this time, we tracked recipients clicking the links in the e-mails. The described process was repeated four weeks later, sending the same e-mails to a different set of recipients of the same population. Pursuing a second phase of the experiment was deemed necessary by both the researchers and the partners. The second phase was required to validate the results obtained in the first phase of the experiment. However, we consciously decided not to have a third or fourth phase. This was mainly because we wanted to prevent distortion of our results from the recipients within one municipality's administration "gossiping" to each other. According to our partners, the risk of colleagues talking to each other about the e-mails (and therefore easier recognizing them as phishing) was too high.

Conclusion: Following the data collection, all results were extracted from the phishing simulation tool, anonymized, pseudonymized, and cleansed by all information allowing inferences to the identity of the individual experiment subjects. Before that, however, we manually annotated the subjects' gender (male, female) to the individual results based on their first names to allow for analysis concerning gender. Manual annotation was necessary as the gender of the individuals was not included in the dataset delivered by the partners. After this, the data were statistically analyzed by means of non-parametric tests: There are several possible ways of comparing mean values. In this experiment, the samples were completely independent of each other. All e-mails were sent across all public administrations without the employees knowing to be a part of an experiment. This excludes comparison methods for dependent methods (e.g., t-test for dep. samples, simple ANOVA). Furthermore, the tested variable is non-metrical, which requires us to perform a non-parametric test (parametric tests would be f.e. sign-test, Friedman-test). We thus chose the non-parametric Wilcoxon-test for the comparison of two groups and the Kruskal-Wallis-test for comparisons of more than two groups (comparison of the persuasion techniques).

The data was analyzed in an RStudio environment using *wilcox.test()* and *kruskal.test()* packages included in there.

Figure 1 depicts the phases and activities of the experiment as outlined above.

4 RESULTS

Before presenting the results in a detailed manner, their main insights shall be pointed out: The overall experiment resulted in a click rate of 7.39%, which means 255 clicks across both phases. The domain-specific e-mails were more effective than the rather general e-mails, with *Authority* being the most effective persuasion technique, followed by *Urgency*, *Benefit* and *Danger*. The results also show click rates to decreased in the second phase of the experiment, with lower click rates for all persuasion techniques. There seems to be no difference in susceptibility between male and female subjects. Except for male vs. female subjects, all results showed statistical significance.

4.1 General Insights

As Table 1 depicts, the overall click rate of the experiment was 7.39%, so 255 clicks, which summarizes all e-mails sent across both

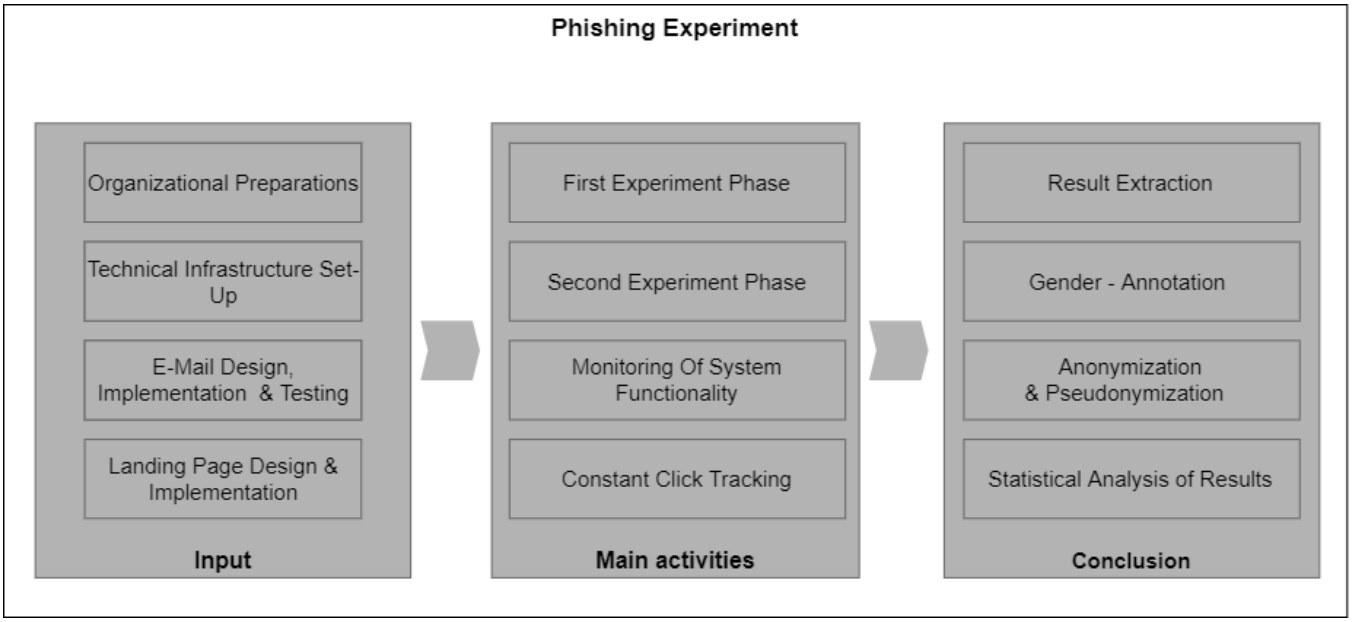


Figure 1: Research Design of the Phishing Experiment.

phases and all four persuasion techniques. While it has to be acknowledged that other experiments brought to light higher rates, it cannot and must not be misjudged that every single click on a link has the potential to infect the systems of public administration agencies with mal- and ransomware, as the examples given in the introduction showed, risking the integrity of sensitive data of citizens and businesses.

Table 1: Click rates by Total Experiment

Total		
Sent	Clicked	Click rate
3452	255	7.39%

Tables 2 and 3 give an overview of the distribution of clicks for each persuasion technique for both phases. The order of which persuasion technique has had the most impact is slightly different across both phases: Authority is ranked first in both phases, and Danger is ranked last in both phases. Urgency, however, has worked better in the first phase than Benefit, and Benefit was more successful than Urgency in the second phase.

It quickly becomes clear that the second phase exhibits an overall lower click rate than the first phase (Table 4). The decrease between the experiment's first and second phase of -2.05% can be considered significant with a Wilcoxon-test's p-value of < 2.2e-16.

4.2 Persuasion Techniques

Table 5 shows the click rates evaluated by the used persuasion technique. Overall, Authority has had the most impact, followed by Urgency, Benefit, and Danger. While the highest rate (Authority) is just slightly over two percentage points higher than the lowest (Danger), a difference in effectivity rates must be recognized. The test for significance between the mean comparison of all persuasion techniques has been successful, which indicates the meaningfulness of the results, even if the differences between the different samples are not too high. The list below depicts the Kruskal-Wallis-Test results:

- Authority vs. Urgency: chi-squared = 136.47, df = 1, p-value < 2.2e-16
- Authority vs. Benefit: chi-squared = 215.71, df = 1, p-value < 2.2e-16
- Authority vs. Danger: chi-squared = 118.52, df = 1, p-value < 2.2e-16
- Benefit vs. Danger: chi-squared = 131.25, df = 1, p-value < 2.2e-16
- Benefit vs. Urgency: chi-squared = 166.22, df = 1, p-value < 2.2e-16
- Danger vs. Urgency: chi-squared = 196.96, df = 1, p-value < 2.2e-16

4.3 Gender Differences

There was no big difference between the click rates of male and female subjects, as Table 6 points out. Neither is this difference considered significant, as the Wilcoxon-test has shown. The sample size of female recipients has been larger by 134 individuals, resulting in 268 more emails being sent to females across both phases.

However, as Table 7 indicates, the difference between the results for male and female click rates compared between both phases has proven to be significant, which resembles the trend of click rates of the second phase also, in general, being lower, as above pointed out in 4.1:

Table 2: Click rates by Phase and Persuasion Technique [Phase 1]

Phase 1											
Authority			Urgency			Benefit			Danger		
Sent	Clicked	Click rate	Sent	Clicked	Click rate	Sent	Clicked	Click rate	Sent	Clicked	Click rate
433	43	9.93%	434	41	9.45%	430	32	7.44%	429	31	7.23%

Table 3: Click rates by Phase and Persuasion Technique [Phase 2]

Phase 2											
Authority			Urgency			Benefit			Danger		
Sent	Clicked	Click rate	Sent	Clicked	Click rate	Sent	Clicked	Click rate	Sent	Clicked	Click rate
434	29	6.68%	429	26	6.06%	433	30	6.93%	430	23	5.35%

Table 4: Click rates by Phase

Phase 1			Phase 2		
Sent	Clicked	Click rate	Sent	Clicked	Click rate
1726	147	8.52%	1726	107	6.20%

- Click rates male vs. female total: p-value = 0.2597
- Click rates female [phase 1] vs. female [phase 2]: p-value < 2.2e-16
- Click rates male [phase 1] vs. male [phase 2]: p-value = 3.834e-12

4.4 Domain Specificity

Across both phases, the domain-specific persuasion techniques, Authority and Urgency in the case of this experiment, had a more considerable impact than the non-domain-specific techniques, Benefit and Danger, as shown in Table 9. The results, admittedly, do not indicate a large difference between the effects of both. However, they hint that subjects are more likely to fall for (spear) phishing e-mail contextualizing their domain than domain-independent phishing.

Comparing domain specificity and non-domain specificity between both phases reveals that both categories lowered their effectiveness in the second phase, with a decrease of -3.59% for specificity and -1.30% for non-domain specificity (Table 8). The developments pointed out here can be regarded as significant as the Wilcoxon-test results show:

- Click rates domain specific vs. non-domain specific: p-value < 2.2e-16
- Click rates domain specific [phase 1] vs. domain specific [phase 2]: p-value = 1.441e-10
- Click rates non-domain specific [phase 1] vs. non-domain specific [phase 2]: p-value < 2.2e-16

5 DISCUSSION

To draw assumptions of the results above, they must be set in context to similar works. A major phishing campaign had been executed by [28] in 2018 in the healthcare sector of the United States, in which 2,971,945 e-mails were sent over a more extended period across several institutions, resulting in 422,062 clicks, a click rate of 14.2%.

In another study, [1] performed a phishing simulation with a target group of 135 individuals, 22 of whom clicked on the embedded link, making the click rate 16.2%. The setting in this study was a university in Iran, so the e-mail was sent to university employees and students and embodied the persuasion technique of Benefit as it promised for the recipient to partake in a lottery.

The most similar research to this one has been carried out by [7], who conducted a phishing experiment in a Dutch ministry, targeting more than 10,000 employees. Out of the total number of recipients, 2,723 were part of a control group who had not experienced any interventions (such as other groups of the same experiment had). Around a third (>30%) of the control group clicked the link in the e-mail.

The examples above show that scholars conducting such research select very different research designs and scopes. Hence, the results they obtain differ very much from each other. Even though these examples can only conditionally be used compared to this study, as this one is the first phishing simulation in a local public administration context focusing on persuasion technique, it is pretty noticeable that all other studies retrieved higher click rates. This opens up room for assumptions and interpretation: the most obvious factor to be considered is the degree of authenticity of the e-mails designed for the simulation campaign. It might be possible that most of the recipients immediately revealed the e-mails as potentially harmful. This, however, is unlikely to be the reason for the low click rates, as our partners from the municipalities were heavily involved in the design process and confirmed that they had had several security issues due to a lot less authentic scam.

The next factor to be considered is that employees of local administrations might have an above-average IT security awareness level, which would be a desirable insight of the experiment for the municipalities. It must be mentioned that, obviously, it is favorable for as few individuals as possible to fall for phishing and other kinds of scams. However, as every wrong click can potentially infect the whole IT landscape of public administrations, the overall low click rate may not be seen as an invitation to relax on IT

Table 5: Click rates by Persuasion Technique

Authority			Urgency			Benefit			Danger		
Sent	Clicked	Click rate	Sent	Clicked	Click rate	Sent	Clicked	Click rate	Sent	Clicked	Click rate
867	72	8.30%	863	67	7.76%	863	62	7.18%	859	54	6.29%

Table 6: Click rates by Gender

m			f		
Sent	Clicked	Click rate	Sent	Clicked	Click rate
1592	116	7.29%	1860	139	7.47%

Security hardening activities.

Leaving aside the overall click rates, there are some exciting results to consider. The probably most significant insight of the experiment is that spear phishing, meaning an enforced domain specificity of phishing in this context, is a lot more likely for recipients to succumb. While social engineering research has found evidence for this in several studies, it is an essential point for local public administration agencies, like spear phishing, with the increasing use of automation technology, is becoming less complex to execute for cybercriminals. Moreover, it appears that especially the imitation of authority or at least an authoritative tone affects whether recipients fall for the scam or not. This is not fully clear yet; a potential direction might be that public administrations are often organized traditionally and hierarchically, with employees being very servile to their superiors. In contrast, the often proclaimed schemes of Benefit and Danger seem to be somewhat outdated. Hence, employee training efforts must focus not only on common signs of phishing detection, such as link directions or spelling mistakes but must work to expand the employees' horizons as to how precise they can be targeted. Additionally, employees should probably be trained to not rely on their own (perceived) knowledge and give potentially harmful messages the benefit of the doubt but rather be overcritical and always scrutinize e-mails, that delegate instructions.

The second point worth elaborating on is the difference in the effectiveness of the experiment's first and second phases. There are several reasons to consider why the click rate of the second phase was lower than the first one: potentially, employees remembered there had been a phishing campaign four weeks earlier and therefore were more aware of potential threats. Or, as the experiment has been carried out in rather small cities (25,000-55,000 inhabitants), a certain degree of gossiping between the employees could have played a role: if employee A told employee B about the experiment (that they were made aware of through the landing page when clicking the link), employee B could have remembered this conversation, when he/she was targeted with the same template four weeks later. Independent of the reason, however, the downwards trend of the click rate is a desirable development. Assuming that there is a correlation between the decrease of the click rate after being exposed to the first phase of the experiment, one could theoretically assume that constant exposure of employees to phishing could minimize its effect. This, however, is put up for further research and can not be confirmed at this point.

There has not been a major nor significant difference between the susceptibility to (spear) phishing between male and female employees of the local public administration agencies, which clears out potential assumptions of one gender being more perceptive to such scams than the others. It is essential to acknowledge that efforts to enhance IT security awareness should focus on personality-(e.g., gullibility) and skill-based(e.g., IT-affinity) aspects rather than gender aspects.

In summary, this study has shown that spear phishing is a serious threat to the data integrity of the Smart City. With the local public administration being a central actor in the Smart City context, collecting and creating large amounts of data, the human factor in cybersecurity must be the focus of attention. No cryptographical technologies can fully secure data assets if cybercriminals use social engineering and persuasion techniques to trick organization insiders into providing them with access to the most vulnerable systems. To prevent their employees from accidentally falling for (spear) phishing and strengthen IT Security awareness, public administration leaders should focus on effective countermeasures, including technical and human aspects.

6 CONCLUSION

This study presents a phishing simulation in the context of local public administrations to investigate the effectiveness of persuasion techniques in (spear) phishing e-mails. During the experiment, 3452 phishing e-mails were sent to the employees of four small-to-medium-sized municipalities in Germany. Four e-mails were designed, two of which were domain-specific, the other two were not. The results show (compared to similar studies, pursuing similar research designs) an overall rather low click rate, 7.39%, which is a favorable outcome of the experiment for the involved partners. Judging from the clicks obtained, the domain-specific e-mails were more effective than the non-domain-specific ones. The e-mail conveying Authority was the most successful simulation, followed by Urgency, Benefit, and Danger.

As pointed out above, the continuous shift from contemporary cities to Smart Cities is already a reality in many places. This development reshapes the role of the public sector in general and local public administrations in particular, with administration agencies becoming major data holders of citizens' and businesses' sensitive data. This ownership makes them a target for cybercriminals, who use technology and social engineering to break into the systems and unlawfully benefit from all this data. Therefore, efforts on information security hardening must place the human (and the inherent

Table 7: Click rates by Phase and Gender

Phase 1						Phase 2					
m			f			m			f		
Sent	Clicked	Click rate	Sent	Clicked	Click rate	Sent	Clicked	Click rate	Sent	Clicked	Click rate
796	70	8.79%	930	77	8.28%	796	46	5.78%	930	62	6.67%

Table 8: Click rates by Phase and Domain Specificity

Phase 1						Phase 2					
Domain Specific			Non-Domain Specific			Domain Specific			Non-Domain Specific		
Sent	Clicked	Click rate	Sent	Clicked	Click rate	Sent	Clicked	Click rate	Sent	Clicked	Click rate
867	84	9.69%	859	63	7.33%	863	55	6.37%	863	52	6.03%

Table 9: Click rates by Domain Specificity

Domain Specific			Non-Domain Specific		
Sent	Clicked	Click rate	Sent	Clicked	Click rate
1730	139	8.03%	1722	115	6.68%

human error) at the core of all activities. While security technologies are becoming more efficient and protective, the "human backdoor" remains a vulnerable point in shielding the precious data treasure.

6.1 Implications for Research and Practice

This research has been a first step to identifying which persuasion techniques are a special threat to public administration employees and, therefore, the agencies' data and information integrity. The study sheds light on the specification of the "human error" in local public administrations as it reveals the danger of different persuasion techniques, which allows for the development of appropriate countermeasures. Moreover, the lower click rate of the second phase of the experiment suggests the assumption that constant exposure to phishing simulations could drastically reduce susceptibility to actual phishing attacks. Gender as a factor for phishing susceptibility has been eliminated.

So far, practitioners in the public sector and responsible IT-security staff had to rely on domain-foreign or -independent insight on the phishing susceptibility of their employees. Founding on this study, they can now tailor their IT-security training more specific to the needs identified here. For example, as it is still common to talk about persuasion techniques of Benefit and Danger in phishing training, such training should emphasize other techniques, such as Urgency and Authority. Moreover, employees should be trained to be especially suspicious when receiving content that fits the public sector domain. As a third point, administration leaders should consider implementing continuous phishing simulations not to surveil their staff but to keep awareness high.

6.2 Limitations and Future Research

The results presented in this study can only be regarded as generally applicable to a limited extent. Despite being tested and proven for their statistical significance, the differences between the samples (persuasion techniques, experiment phases, gender, domain-specificity) are only relatively minor. Hence, their validity can merely be assumed and should be challenged by scholars pursuing similar endeavors. Moreover, four persuasion techniques were tested. The reason for this is outlined in chapter three. In the literature, there are more persuasion techniques that could have been considered; unfortunately, the total sample size of recipients and other restrictions imposed by the partners did not allow for testing more techniques. Furthermore, the demographic information on the recipients is relatively thin, with manually annotated gender and no age information given. With more information, a more precise evaluation would probably have been possible. Also, it is debatable whether the months of December / January are the most convenient ones to carry out such an experiment, with many people leaving for the holidays early or coming back to the office late. However, the general conditions of the study did not allow for postponing or bringing it forward. As the study was carried out with public sector partners in Germany, its representativeness in the international context cannot be granted.

The study provides information on the susceptibility of employees of local public administrations to different phishing persuasion techniques. However, it also raises several questions: first, researchers should confirm or refute the validity of this study regarding the overall click rates of the simulation. Second, the order of effectivity of persuasion techniques should be tested with larger population size. Third, a follow-up experiment should be conducted to understand whether constant exposure to phishing decreases the overall susceptibility. Fourth, as these persuasion techniques are only one shade of social engineering, researchers must investigate what else tricks recipients of phishing to fall for it.

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Please stop trying to predict elections only with Twitter

Kellyton Brito
Departamento de Computação, Universidade Federal Rural de Pernambuco
kellyton.brito@ufrpe.br

Rogério Silva Filho
Centro de Informática, Universidade Federal de Pernambuco
rlcsf@cin.ufpe.br

Paulo Adeodato
Centro de Informática, Universidade Federal de Pernambuco
pjla@cin.ufpe.br

ABSTRACT

This study began from a genuine desire to discover how using Social Media (SM) data could predict presidential elections worldwide. However, instead of defining a new prediction model or improving one already in existence, we began by studying the fundamentals and evolution of election polling and predictions since before the poll crisis of 1936. We also built on our experience of collecting and analyzing data from many different SM platforms. Lastly, we performed a deep analysis of nine reviews on predicting elections with SM data from 2013 to 2021. We observed that as from 2010, the volume and sentiment analysis based solely on Twitter posts tweeted by ordinary people mentioning candidates and parties was by far the most commonly used approach. However, currently, and contrary to initial expectations, most of the research that uses this approach has been unable to solve many of the challenges encountered since it began in 2010, and also shares many of the characteristics of unsuccessful straw polls performed before 1936. As examples, we highlight the impracticability of polling over Twitter, due to several biases and technical barriers, the need for external data, and the high dependency on the arbitrary decisions of researchers. Lastly, we indicate some of the possible future directions, such as a focus on creating repeatable processes; the use of SM data as part of statistical models, instead of polling; diversifying the input data sources, including multiple SM platforms and non-SM data such as polls and economic indicators; and using machine learning for regression of the vote share, rather than for sentiment analysis.

CCS CONCEPTS

• **Information systems** → World Wide Web; Web applications; Social networks; • **Applied computing** → Operations research; Forecasting.

KEYWORDS

Social Media, Twitter, Elections, Machine Learning, Sentiment Analysis

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1 INTRODUCTION

This work is based on nine surveys regarding predicting elections with Social Media (SM) data, published from 2013 to 2021 [1]–[9]. They are all unanimous in indicating that the most commonly used approach is based on [10] and uses volume and sentiment analysis of posts on Twitter. However, as discussed by [9], the success of this approach is no better than chance.

Electoral polling and prediction form an old discipline. The first poll similar to modern surveys dates back to 1824 [11]. Later, a new form of "straw poll" began, and academics consider that the advent of modern scientific polling appeared in 1936 [12]. Despite its long history, traditional polls have often been criticized, like during the crises of 1936 [12], 1948 [13], and 1996 [14]. Indeed, there is evidence of contemporaneous biased polls (Fry & Brint, 2017; Kimball, 2019), which have been commonly attributed to unrepresentative sampling, a decline in response rates at the polls, and the effects of social desirability (Kennedy et al., 2018; Sturgis et al., 2018; W. Wang et al., 2015), to cite but a few.

On the other hand, over the last decade, we have experienced the advent and popularization of SM platforms, which has denoted a new communication paradigm and has fundamentally changed both how people communicate and how politicians campaign. Social Media platforms present a new way for politicians to communicate with the electorate, and provide a place where politicians and social researchers may gather, quickly and cheaply, a massive volume of data regarding the behavior and beliefs that people hold. Thus, SM platforms have appeared as a new location for gathering data regarding public opinion, and are possibly able to compensate for some of the disadvantages of traditional polling.

Within this scenario, Twitter, launched in 2006, is indicated as the first platform to be used as the basis for predicting presidential elections, and was used by [10], [15] related to elections held in 2008 and 2009. This approach is based on counting the volume of mentions regarding the respective candidates on Twitter and correlating the percentages with the vote share [10], and may be improved with the sentiment analysis of the mentions [15]. In a seminal study, Tumasjan stated that "the mere number of tweets mentioning a political party can be considered a plausible reflection of the vote share, and its predictive power even comes close to traditional election polls." [10] More than ten years later, this approach is still the most commonly used, having undergone certain improvements in the sentiment analysis, as presented in recent surveys.

Despite being the most commonly used approach, the use of volume/sentiment analysis on Twitter has also been the most criticized, and began to be challenged just after its launch [16]–[18]. Furthermore, Tumasjan's study was directly contested by [19], who argued that "the results are contingent on arbitrary choices of the

authors" and indicated that simply by including just one more party or collection day the results could be greatly changed. Surprisingly, despite some of the improvements on sentiment analysis, derived from improvements in machine learning research, most of the drawbacks contained in the initial criticisms are still present in the current research, as indicated by [7]–[9].

In this context, the objective of this study has been to investigate the feasibility of predicting electoral results based only on Twitter, particularly presidential elections. For this, we analyzed nine surveys related to predicting elections, ranging from 2013 to 2021 [1]–[9], and summarized the results. We also performed a brief review of the evolution of election polling and predictions of the time, highlighting some of the problems that have been faced since the beginning of the last century, including the "polling crises" of 1936 and 1948. We have also analyzed the current state, characteristics, and constraints of Twitter and other SM platforms, including the technical constraints on data collection, in order to build a rationale by comparing past and current approaches. The analyses have led us to make a call to researchers into predicting elections with SM data, to avoid predicting elections only with Twitter and to present some alternatives.

The remainder of this paper is organized as follows: Section 2 presents the fundamentals related to election polling and predictions, and the current state of social media. Section 3 presents the problems encountered in 12 years of research, starting from a summary of review results, and focusing on what we consider to be the four main points. In Section 4, we present and discuss possible new directions, followed by Section 5, which presents concluding remarks and future work.

2 THE FUNDAMENTALS

2.1 The evolution of election polling and predictions

According to [11], the earliest counterpart of modern opinion surveys occurred in 1824. At that time, the polls were most commonly counts made in many forms: at regular public meetings being held for other purposes, such as Fourth of July celebrations; at meetings specially called to assess the public's presidential leanings, often sponsored by one candidate and as such were really only campaign rallies or informal endorsement meetings; and in "poll books", left out at public places such as taverns over a period of time, for people to write down their preferences.

A new form of straw polls is attributed to the Literary Digest starting in 1916. It was based on sending a huge amount of ballots to citizens by mail and counting the results of respondents. This method was popular until the advent of modern scientific polling in 1936, when prestigious pollsters conducted straw polls of millions of people to indicate a victory for Landon in the U.S. presidential elections, and others, who then started conducting quota-controlled surveys, correctly signposted a victory for Roosevelt [12][20].

Motivated by the level of criticism directed toward the polling errors of that particular election, Crossley [12] classified the polling methods of the time and studied the reliability of each. At that time, polls were either conducted by mail, by personal interview, or a combination of both. Most were performed on huge randomly selected samples, although some were performed on small scientifically distributed samples. Some used the cumulative method, adding its results together into a single report, and others used sampling at several points during a campaign. The analysis discovered that polls with better results were conducted wholly or in part by personal interviews, with small samples, and were repeated at frequent intervals. The polls with the worst results, and that used by the Literary Digest, were conducted through the postal service, with a huge sample, and only provided one complete report accumulated over a period of several months.

The study highlighted what was considered at the time to be the ideal poll: (i) it needed to be flexible, not based on dated mailing lists, and designed so that it could be readily adjusted if new information became available during its course; (ii) a fairly small sample would work appropriately in all but close states; (iii) the distribution of the sample was of paramount importance; and (iv) it should not be cumulative, but repeated in similar cross-sections at intervals to show trends. Many years later, [20] demonstrated that the non-response bias was one of the biggest issues. These principles are still valid today.

Just 12 years later, in 1948, another unexpected result in the U.S. challenged the polling industry yet again. After a strong adverse reaction, a distinguished group of social scientists and statisticians mounted an intensive review of the election polling procedures and results. Their report [13], and the chapter "Measuring the Error" established the measures that have been used ever since to evaluate the accuracy of election polls, but have been barely used by SM researchers.

Since then, election predictions have evolved into three approaches, as presented below.

2.1.1 Approaches to Election Predictions. Three main approaches may be observed for predicting elections: polling, statistical forecasting models, and political stock markets [21] [22].

In polling, researchers directly ask a sample of people for which candidate they intend to vote. Following this, the vote share percentages from the responses are taken to forecast the final vote shares. This approach began with the work of Gallup [12], and is the most well-known and most commonly-used approach worldwide. It is firmly based on selecting a representative sample of citizens and other design decisions— regarding the mode, timing, sampling method, question formulation, weighting, etc.— so as to enable extrapolation from a few answers to the entire population. Thus, each of these methodological decisions may potentially bias the results, thereby leading to different results from different pollsters. In order to deal with this, the aggregation of many different polls has become popular, and is referred to as polling aggregation or polling the polls [21], [23].

Statistical forecasting, also called macroeconomic models, began to appear around 1980 [24], [25]. At the core of these models is the assumption that the vote share is a function of other indicators, such as government performance, economic performance, or economic growth. These statistical models may also take into account polling results, such as incumbent popularity. A general theory is that voters reelect incumbents during good (economic) times and do the opposite during bad times [26]. Thus, the debate largely regards

which economic indicator to be used and also regards the inclusion of other variables in the model, such as polling numbers [22], [27].

The third approach, the political stock market, considers how traders invest money in candidates running for office. In this market, people buy and sell candidate futures based on whom they judge as being more likely to win, and the investment share of any one candidate provides a vote forecast for the candidate [28]. This approach may be considered a specialized polling approach since it polls the opinion of traders. Although traders are not a representative sample, they are just assumed to be making informed judgments and have the confidence to wager their money on it.

2.1.2 Measuring Prediction Accuracy. After the 1948 polling crisis, the report produced by Mosteller et al. [13] established eight different metrics for assessing polling accuracy. Two of these measures, the "Mosteller Measure 3" and the "Mosteller Measure 5", have been widely used ever since in order to evaluate the accuracy of elections polls [21], [29].

The "Mosteller Measure 3" is the average, without considering the sign, of the percentage point deviation for each candidate between his/her estimate and the actual vote. In statistics, it is widely known as the mean absolute error (MAE). The "Mosteller Measure 5", which we call the absolute error on the margin (AEOM), is the absolute value of the difference between the margin separating the two leading candidates in the poll and the actual vote.

Other metrics may also be used, such as the "Mosteller Measure 4", which measures the percentage error and is known in statistics as the mean absolute percentage error (MAPE), and the root mean squared error (RMSE), which penalizes outliers.

With emphasis on the MAE, these metrics were used by [29] to assess prediction errors in pre-election polls. The analysis drew on more than 30,000 national polls from 351 general elections in 45 countries between 1942 and 2017. The study observed that, contrary to conventional wisdom, the recent performance of polls has not been out of the ordinary. By calculating the estimated average poll during the week prior to elections, they discovered that the MAE had almost no change, from 2.1% during the 1940s and 1950s, to 2.0% since 2000. They also reported that errors were higher in presidential elections (an average of 2.7 percentage points) than in legislative elections (1.8 percentage points). Lastly, as expected, they reported that errors decreased as the elections approached.

These metrics should be used in future studies regarding predicting elections with SM data, instead of just indicating the winner or claiming that the predictions were close to the official vote share, as so often occurs in many studies [9].

2.2 The current state of social media

Contemporary SM platforms are new: Twitter debuted in 2006, Facebook was launched for public access also in 2006, and Instagram emerged in 2010. This scenario is also constantly changing: Kuaishou, also known as Kwai, was launched in 2011, and TikTok in 2016 and has already become very popular [30]. Currently, more than half (51%) of the global population actively uses SM platforms [31]. Figure 1 presents a projection of the world's most-used SM platforms, demonstrating that Facebook, Whatsapp, Youtube, Facebook Messenger, Weixin/WeChat, and Instagram are the most used.

These platforms may be classified into two groups. In conversation platforms, the main feature consists of allowing direct conversation between two (or a group of) people. Examples are Whatsapp and Facebook Messenger. In newsfeed platforms, the main features consist of a pair of posts/newsfeed. People are encouraged to post contents, which may contain text, photos, audio, video, and links. The contents are shown to their connections in a newsfeed format, and viewers may interact with them, usually either by clicking "like" (signaling that he/she liked the content), by commenting on the post, or by sharing it with his/her own connections, thereby amplifying the reach of the message.

2.2.1 Newsfeed algorithms and the bubble effect. As a matter of privacy, direct conversation platforms do not usually allow data collection by third parties. Thus, the newsfeed platforms are most suited for studies on predictions. On these platforms, people may connect to, or just follow, either a few or thousands of other accounts. Thus, since it is impracticable to show users all the posts of all their connections at once, platforms use optimization algorithms to choose which content to show on their news feed, in order to maximize showing them what is probably of most interest to them.

Since 2017, the Twitter algorithm has used deep learning to build user timelines. They explain that "Right after gathering all Tweets, each is scored by a relevance model. The model's score predicts how interesting and engaging a Tweet would be specifically to you. A set of highest-scoring Tweets is then shown at the top of your timeline, with the remainder shown directly below."[32] They also detail that the algorithm takes into account the following measures: (i) The Tweet itself: its recency, presence of image or video, total interactions (e.g. number of Retweets or likes); (ii) The Tweet's author: the user's past interactions with this author, the strength of the user's connection to him/her, the origin of the relationship; and (iii) You: Tweets that the user found engaging in the past, and how often and how heavily the user uses Twitter.

The algorithm of other platforms is similar. Facebook [33] prioritizes showing popular content to users and content that corresponds to what they have previously liked. Similarly, Youtube explains that the home screen is based on two items: performance, or how well a video has engaged and satisfied similar viewers, and personalization, based on a viewer's watch and search history [34].

These algorithms help users by showing them what they probably want to see. However, this approach has received much criticism because it leads to filter bubbles. As users are only presented with content that they and their connections already like and are familiar with, possible new viewpoints and opposite ideas are filtered out, leading to a false sense of unanimity. Extensive research into the downside of this scenario is currently being performed by social scientists [35], [36].

Newsfeed SM platforms may be viewed as places where it is possible to gather public opinion, especially if we consider that half the world's population is currently using them. Thus, SM allows researchers to gather a huge amount of data from an unpredictable number of people at a low cost [37]. However, collecting this data may also be a challenge. Next, we overview the official data collection methods from Twitter.

2.2.2 Social Media Data Gathering. The publishing of data by SM platforms is an important part of the entire ecosystem of SM. This

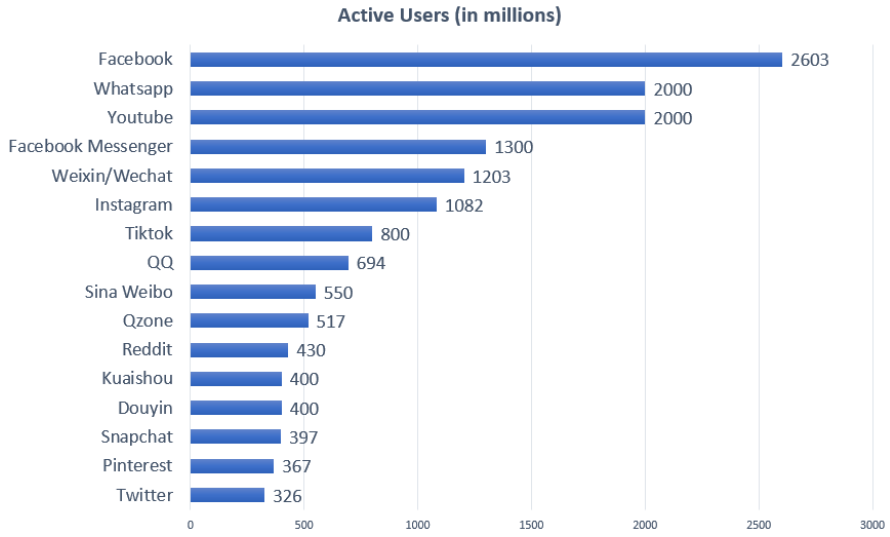


Figure 1: – Projection of the most commonly used SM platforms worldwide, according to [31]

publishing allows the development of third-party applications, from social games to entire marketing platforms. It also allows social studies. However, publishing this data has become a sensitive topic, and several mechanisms are under discussion in order to protect user rights, especially after the Cambridge Analytica scandal [38]. In this particular episode, Cambridge Analytica used data analytics to sway the electorate, relying on the participation of SM platform users through their own psychological manipulations.

Twitter and other newsfeed platforms have well-defined methods for publishing data that has been collected from them through the use of application programming interfaces (API's). The prime API version of Twitter, until November 2021, was v1.1 [39], when they officially brought in the v2 API as their primary API[1]. Due to the recency of this new version (v2) at the time of writing this paper, we have focused on explaining v1.1, the version used by previously published work.

Twitter API allows the search for users and gathering their metadata, such as name, picture and biography, and all his/her posts. It also allows an open search on the platform based on keywords. This may be served in two ways: as a traditional query request with an (almost) immediate response and streaming connections to serve APPs with real-time tweets.

However, due to the huge number of tweets performed every second and the amount of information that may be retrieved in this manner, the platform presents some limits. First, for basic, free access, the Twitter platform does not guarantee that all tweets will be retrieved. In fact, it simply returns a sample of tweets, as the official documentation states, "The Twitter Search API searches against a sampling of recent Tweets published in the past 7 days."[2] There are also rate limits. For the search API, there is a limit of 100 tweets per request and 180 requests per user in a window of 15 minutes. Hence, a maximum of 18.000 tweets per user may be collected in the time window, which could be sufficient for searches with few results, but not for presidential elections in populous countries. Even if this were sufficient, Twitter does not guarantee the completeness, and the researcher would never be aware of how many Tweets had not been included. One alternative for achieving completeness is to use Twitter premium API v1.1. This version is a paid API, which allows searches on the full archive of Twitter. However, in addition to prohibitive costs, the rate limits also prevent collecting the huge amount of Tweets posted during electoral periods in populous countries.

Despite these drawbacks, we nonetheless believe that Twitter is the most commonly used platform for predicting elections due to a particular feature on this API: the open search capabilities. With this, researchers are able to search just for "Biden", "Merkel" or "Putin" and receive Tweets in which they are mentioned. This functionality is not present in this form on the APIs of other platforms, such as Facebook and Instagram [40], which are more focused on the timelines or, at most, open search on hashtags.

It should be noted that the new version of the Twitter API launched in November 2021 promises a new level of access for qualified researchers. However, due to its recency, it has not yet been possible to obtain access and analyze it.

3 PROBLEMS ENCOUNTERED DURING 12 YEARS OF RESEARCH ON PREDICTING ELECTIONS WITH TWITTER

3.1 A summary of 12 years of research

In order to identify the main problems of predicting elections with Twitter, we have analyzed the context of polls and the SM scenario presented in Section 2, along with 9 surveys on predicting elections with SM data, performed between 2013 and 2021, and which are summarized below.

[1]The announcement was made through their official blog: https://blog.twitter.com/developer/en_us/topics/tools/2021/build-whats-next-with-the-new-twitter-developer-platform

[2]https://developer.twitter.com/en/docs/twitter-api/v1/tweets/search/overview

In 2013, Kalampokis et al. [1] presented a systematic review that aimed to understand the predictive power of SM, not only within the electoral context. By analyzing 52 studies, 11 regarding election predictions, they identified that the main approaches were based on volume, sentiment, and user profiling. Moreover, the use of predictive analysis using linear regression was also identified, although not in studies related to the political context. They also verified that 40% of the studies that had used sentiment-related variables were unsuccessful and that this percentage increased to 65% with lexicon-based approaches. Lastly, they emphasized a lack of assessment for predictive analytics and controversial results of electoral predicting studies.

In the same year, Gayo-Avello [2] presented a study that we consider to be the first review that specifically centered on predicting elections with SM, and focused on Twitter. By analyzing 10 previous studies from 2010 to 2013, he concluded that "the presumed predictive power regarding electoral prediction has been somewhat exaggerated." Moreover, as in [1], he identified volume and sentiment analysis as the main approach as well as the need to use more up-to-date methods for sentiment analysis. He also expanded the list of challenges, such as the dependency of arbitrary decisions made by researchers regarding keywords, parties, candidates and selecting the data collection period, and problems related to Twitter, such as demographic and self-selection bias, including bias related to spam, misleading propaganda and astroturfing. He ended the study by mentioning that regression models would be a future direction.

In 2015, the study performed by O'Leary [3] presented a general overview of the main approaches for prediction using Twitter in many different domains, and briefly described a few studies related to election predictions. His analysis highlighted the controversy over the issue related to the number of tweets that may be used to predict elections. In 2018, Kwak [4] presented the results of a survey, including 69 papers, which supported the argument that SM can be used for understanding political agendas, rather than election forecasting. More recent studies, [5] and [6], have presented limited nonsystematic surveys, both analyzing 13 papers, and have added some arguments to the original review by Gayo-Avello [2]. Koli [5] argued that prediction using Twitter may have better results in developed countries than in developing countries, due to a higher literacy rate and wider internet access. In addition, Bilal [6] considered the challenges of sentiment analysis in languages other than English.

In 2021, three surveys summarized these initiatives. Chauhan et al. [7], surveyed 38 papers, Brito et al. [9] performed a systematic review of 83 relevant studies, and Santos et al. [8] analyzed 53 studies. Chauhan et al. [7] began from the premise that forecasting election results is an application of sentiment analysis or opinion mining by gauging the mood of the public through SM. Their major findings were in line with previous studies: most used Twitter as a corpus for prediction, researchers focused on sentiment-oriented content analysis and the most commonly used sentiment analysis was the traditional lexicon-based approach.

In a broader study, while Brito et al. [9] agreed that the volume/sentiment analysis on Twitter is the most commonly used approach, they also added that this approach presents a low success rate (just 55% of the 64 studies that used this approach achieved success). They also summarized the main challenges into four categories: process, sampling, modeling and performance evaluation. From these, we are able to highlight the challenges in defining a repeatable processes, the no representativity of sampling over Twitter, the choices of arbitrary data collection, such as keywords and the period of data collection, the high susceptibility to volume manipulation and the presence of a natural bias in the differences in supporter behaviour on SM platforms, the difficulties in using data from multiple networks besides Twitter, and the need to use ML models, not only for sentiment analysis but also for predictions.

Lastly, the most recent survey [8] agreed with [9] on most points, emphasizing the need for processes that were not dependent on arbitrary choices, and for models unaffected by volume manipulation. They also indicated new challenges involved in using ML models for sentiment analysis on Twitter, especially those related to data labeling for training the models during the short period of electoral campaigns, and the non-availability of domain (labeled) datasets.

3.2 Main Identified Problems

We believe that the points presented in Section 3.1 should be sufficient to clarify that predicting elections with Twitter is a very challenging, if not impractical, task. In this section, we move a step further, by considering the viewpoint of historical knowledge on the poll industry and the current state of SM platforms in order to emphasize four points. First, we believe that it is not feasible to poll over Twitter posts, and that statistical forecasting should be used. Second, for statistical forecasting, other sources are needed in addition to Twitter, particularly offline sources. Third, in practice, methods for filtering Twitter posts efficiently may only be clearly defined after the elections, since they depend on several arbitrary decisions. Lastly, we have identified that contemporaneous research is repeating the same errors of straw polls performed before 1936.

3.2.1 It is not feasible to poll over Twitter posts. The main assumption of studies based on volume on Twitter is to use this platform to poll the opinion of citizens. Thus, if X% of posts is related to a candidate, he/she will probably obtain X% of the vote share. The approach is enhanced by the use of sentiment analysis to identify whether the opinion of the user is in favor or against the candidate, and some minor improvements (such as avoiding duplications) are usually performed.

Three main reasons lead us to believe that we can not (or at least, should not) poll over Twitter posts.

The main premise of polling has been forgotten: Polling methods are firmly based on selecting a representative sample of respondents to enable extrapolation from a few answers to the entire population. However, it is clear that Twitter is not a representative sample of the entire population. In fact, it is a strongly biased sample. For example, a report published in 2019 observed that Twitter users in the U.S. were younger, likelier to be identified as Democrats, more highly educated, and had higher incomes than U.S. adults overall [41]. These data do not reflect world or U.S. demographics. Moreover, this scenario has probably changed since the report, as the popularization of TikTok has attracted a large audience of young people [30].

Some may argue that the large amount of data collected off the platform from a huge quantity of people may compensate this bias.

However, even though 51% of the population use SM, Twitter is not even among the top 10 of the most commonly used platforms, as previously presented in Figure 1. Thus, because of this, other SM platforms should also be considered.

A direct correlation can not be guaranteed: Although recent research has reported a correlation between SM performance and electoral performance in a specific context [48], it should not be assumed that this occurs in all elections worldwide. For example, in the famous response to the Tumasjan's seminal study, Jungherr [19] found that the party which obtained the most mentions on Twitter obtained only 2% of the vote. This may occur on Twitter and SM platforms in general, because of many reasons, such as the use of automated software, known as BOTs [42] spammers, paid propaganda, astroturfing, coordinated organization of supporters on SM, or even the natural differences between the behavior of users [43].

Twitter technical reasons: As presented in Section 2.2.2, the Twitter API clearly states that "The Twitter Search API searches against a sampling of recent Tweets published in the past 7 days", and that "This means that some Tweets and users may be missing from search results. If you want to match for completeness you should consider the premium or enterprise search APIs". Even considering the use of premium or enterprise APIs, the costs and rate limits are highly prohibitive for using in populous countries with millions of posts related to elections every hour. This reason may have been softened by the launch of the new Twitter API in November 2021, allowing researchers to gather data with lower limitations. However, it will be limited to researchers authorized by Twitter, and still needs to be validated by the research community.

3.2.2 To use statistical forecasting, other sources and historical data are needed. Due to the fundamental challenges of using Twitter as a polling strategy, we argue that the data collected on this platform, and at SM platforms in general, should be used in a statistical forecasting approach. As presented in Section 2.1.1, at the core of these models is the assumption that vote share is a function of different indicators, such as government performance, economic performance and growth, and also polling results. An example from the U.S. presidential elections was offered by [22] and is presented below:

$$V = 37.31 + 0.28P + 1.32E + e$$

where V = presidential party share in the election; P = presidential popularity, in the July Gallup Poll of the election year; E = percentage growth in the real GNP over the first two quarters of the election year; and e = error.

The statistical forecasting is also strongly based on historical data, used for the adjustment of the function's parameters. Thus, in a possible setup, Twitter or other SM data may be used as part of a broader equation. However, since Twitter is a new phenomenon and presidential elections are usually held at 4 or 5 year intervals, the lack of historical data regarding its use may be prohibitive for making accurate predictions even in this setup.

3.2.3 Methods for data gathering mentions may only be clearly defined after the elections. Starting from initial papers challenging the use of Twitter for predicting elections [17]–[19], and including all reviews presented in Section 3.1, they all agree on one point: predictions are based on arbitrary choices for data collection. These choices include, but are not limited to, two main choices: the time and duration of data collection and the keywords for filtering the posts.

The literature states that the time of data collection varies from the last day or week before elections to some months before. The duration of data collection also varies from one day to more than 90 days of collection. These decisions are barely justified, and a baseline data collection period has not yet been found.

The selection of keywords for filtering is also challenging. For example, some candidates have "common" names, and a search for their names may include many results unrelated to elections. Also, candidates sometimes adopt nicknames that people may prefer to mention, or new nicknames may just naturally appear and become adopted by people during the campaign. Lastly, misspelling or abbreviations are also very common. Thus, the correct selection and pruning of these keywords may be not practical for performing in real time during the campaigns.

3.2.4 We are repeating the same errors of straw polls performed before 1936. Current research on predicting elections with Twitter is, in many ways, similar to straw polls that started in 1824, which led to the polls crisis of 1936 [12].

Collecting posts on Twitter may be seen as a combination of the three main modes of data collection which began in 1824: (i) it is a "poll book", which people may voluntarily just "sign", by publishing his/her opinion regarding a candidate; (ii) it is a public meeting, where a massive quantity of people gather together for purposes other than elections and eventually talk about elections; and (iii) it usually contains informal endorsement meetings, especially called for this purpose, when candidates or parties post and prompt their supporters to like, share or act in an organized manner.

Moreover, it is also similar to the Literary Digest of 1936, based on sampling a huge number of people in certain ways. The biased sample used for the poll has been blamed as the source of the flawed result, and a similar bias occurs when using Twitter, as previously presented. In addition, the non-response bias is also indicated as an important component of errors [20]. This non-response bias is strongly present on Twitter, due to a minority of people being responsible for the majority of posts [43], and it is reasonable to suppose that most citizens prefer not to show their political leaning in a Twitter post.

In addition, most current research uses the cumulative method, adding its results together into a single report. This approach is the opposite of the 1936 advice [12]. At that time, it was found that polls with better results were conducted and repeated at frequent intervals, discarding previous results. On the other hand, polls with the worst results, and the one used by the Literary Digest, only provided one complete report accumulated over the collection period, such as in contemporaneous Twitter-based approaches.

4 POSSIBLE DIRECTIONS

This section presents some of the possible directions for research on predicting elections with SM data. Since there are many possible directions, the intention is not to provide an exhaustive list, but rather to contribute with some guidance.

4.1 Create a repeatable process for the future rather than a model of the past

Most studies are only applied in one electoral context and are performed after the elections. Also, as previously discussed, most of them are subject to arbitrary decisions made by researchers that may, involuntarily, bias the results. Thus, the first advice is that researchers should focus on defining general and repeatable processes, which are capable of predicting elections in multiple scenarios, and assessing the processes with several case studies. The assessment should also use the consolidated metrics of the polls domain, as presented in Section 2.1.2.

4.2 Use SM as a part of a statistical model, not polling

As discussed in Section 3.2, for a number of different reasons, while it is practically impossible to use Twitter for polling, it may be used as a part of statistical forecasting. Thus, the use of statistical models may be promising. For example, statistical time series models [44] such as exponential smoothing, auto-regressive moving average (ARMA), auto-regressive integrated moving average (ARIMA), and Kalman filter, as well as nonlinear models, may be used. One possible use is the daily estimations of the tendencies of candidates, as to whether one candidate is more likely to increase or decrease the vote share based on the perceptions gathered from SM data. Lastly, these models may be combined with other data sources, as presented below.

4.3 Diversify the input data sources, including multiple SM platforms and non-SM data

Considering that Twitter is far from being the most commonly used SM platform, other platforms, such as Facebook, Instagram, or TikTok, should also be considered for use in the models. Mixing the platforms, each with a specific bias regarding its users, may be used in a similar manner to traditional polling aggregation [23], inheriting some of its benefits. Similarly, by using statistical methods, it is expected that additional data, other than SM data, should be included, e.g., the use of historical data from past elections, if available, economic indicators, or traditional polls, as already used in other statistical models, may be promising.

We highlight the potential benefits of using traditional poll data, which may be considered the best available approximation to actual public opinion. Their main disadvantage is that they demand long periods of time and high costs in order to perform. Thus, in many countries, they are performed at considerable intervals. However, by combining SM data with poll data, the model can benefit from eventually receiving "imprecise ground truth" from the polls and collecting daily data from SM platforms. Thus, daily predictions may be performed.

4.4 If Machine Learning is used, use it for regression rather than sentiment analysis

As the current use of Twitter is mostly for polling, the focus of using ML models is more on improving sentiment analysis than on improving the prediction model. However, the vote share prediction may clearly be considered a regression task, when methods are designed to predict a continuous numeric output where an order relation is defined. There are several different approaches for regression [45], most of them suitable for this domain, but not as yet studied within this context. One possible direct application of ML regression as the basic model for predictions is to use sources from multiple SM platforms as features and poll data as labeled data. Thus, the model may be trained with poll data and used for performing daily predictions.

5 CONCLUDING REMARKS

Strategies based on volume and on sentiment analysis of Twitter posts are, by far, the most commonly found in the literature when the objective is predicting elections based on SM data. However, this approach also receives the most criticism, its results are constantly challenged, and the success rate may be considered no better than chance.

This study has aimed to investigate the feasibility of predicting electoral results based only on Twitter, especially in presidential elections. For this, we have analyzed the evolution of polling since its early roots in 1824, the contemporaneous scenario of Twitter and SM platforms, and several surveys on predicting elections with SM data performed between 2013 and 2019. Thus, we have highlighted the major identified problems and indicated some possible directions.

As the main problem, we are convinced that it is not feasible to poll over Twitter posts. This is due to several reasons: it is not compliant with the fundamental premise of polling, which is based on selecting a representative sample of citizens, and there is strong evidence that Twitter polled data can not be extrapolated to the entire population, plus there are also technical barriers on Twitter API. One possible alternative, statistical forecasting, requires other sources and historical data. Moreover, most methods may only be clearly defined after the elections.

Surprisingly, researchers are repeating the same errors of straw polls performed before 1936. Despite digitalization, current approaches may be considered a mix of "poll books" and massive data gathering. Moreover, they do not consider the critical non-response bias, and are based on a cumulative method, among other similarities.

Lastly, the study has presented the viewpoint of authors regarding the future directions of predicting elections using SM data. The main recommendations derived from this study are:

- To create repeatable processes for the future, rather than a model of the past;
- To use SM as a part of a statistical model, not polling;
- To diversify input data sources, including multiple SM platforms and non-SM data, specially polls; and
- If Machine Learning is used, use it for regression rather than sentiment analysis.

The results of this study contribute to the research field by providing the academic community, as well as practitioners, with a better understanding of the challenges in the area that open up opportunities for future research. Possible future studies include defining and validating new models by considering the discussion and results presented throughout this work. In addition, a temporal

update may also be performed in order to compare the evolution of this topic over time.

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Social media institutionalization in European local governments: a comparison of administrative traditions

J. Ignacio Criado
Department of Political Science and International Relations, Universidad Autónoma de Madrid
ignacio.criado@uam.es

Julián Villodre
Department of Political Science and International Relations, Universidad Autónoma de Madrid
julian.villodrede@uam.es

J. Ramon Gil-Garcia
Center for Technology in Government and Rockefeller College of Public Affairs and Policy, University at Albany, State University of New York, Business School, Universidad de las Americas Puebla, Mexico
jgil-garcia@albany.edu

ABSTRACT

Social media institutionalization entails the formalization of these digital platforms within the routines, rules and procedures of public organizations. The institutionalization of social media in government is an important process, as it may help to seize the disruptive affordances of these platforms and generate important benefits. However, there is a lack of knowledge about the actual results agencies obtain from social media institutionalization. In addition, the few existing studies on social media institutionalization have focused on a single case or a unique context, so a comparative perspective is also necessary. Therefore, in this article we analyze how social media institutionalization is taking place in city councils of European countries of four different administrative traditions: The Netherlands (Continental), Spain (Napoleonic), Sweden (Scandinavian), and the United Kingdom (Anglo-Saxon). This study is based on the results obtained from an original cross-national survey on social media adoption, use, and institutionalization. Main differences are found between the Spanish city councils and the three other countries, mostly regarding to the presence of social media policy guidelines. Other social media institutionalization features show very similar characteristics across administrative contexts, with limited differences in relation to leadership or the presence of evaluation mechanisms.

CCS CONCEPTS

• **Information systems** → World Wide Web; Web applications; Social networks.

KEYWORDS

social media, institutionalization, local governments, administrative traditions

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1 INTRODUCTION

Over the last decade, public administrations have adopted social media as a promising management and communication tool. From this perspective, social media can become a basic government resource to increase nodality [Hood and Margetts, 2007], boosting transparency, participation, and collaboration [Bonsón et al., 2015; Ellison and Hardey, 2014; Bertot et al., 2012], and, ultimately, creating public value [Calhan et al., 2021; Criado and Gil-Garcia, 2019]. However, social media offers highly disruptive and unstable environments that may collide with public interests, and where public organizations may have few possibilities for control [Feeney and Porumbescu, 2020; Van Dijck, 2013]. At the same time, different internal visions on how public administrations should achieve social media benefits may arise [Villodre et al., 2021; Mergel and Bretschneider, 2013]. To overcome some of these issues and maintain stability, public administrations may decide to institutionalize social media. In this article, we explore how is social media institutionalization arising within different European local governments, representing different administrative traditions, and if differences can be reported from our comparative study.

Social media institutionalization can be defined as a process that entails the formalization of these digital platforms within the routines and rules of the organization with the aim to seize their disruptive nature and take advantage of its potentials. Thus, regaining organizational stability [Abbott, 1992; DiMaggio and Powell, 1991], of what otherwise generates highly unstable and conflictive socio-political digital spheres. Social media institutionalization is important as it may reduce the uncertainty that public administrations face when using these platforms to interact with citizens [Chen et al., 2016]. Institutionalization also helps to avoid communication crisis, and to start a socialization process inside the organization, encouraging the diffusion among units and departments that may have not yet adopted social media [Bretschneider and Parker, 2016].

Previous literature on social media and government have considered institutionalization as the final stage of the adoption process. This has been inspired by previous e-government staged models [Andersen and Henriksen, 2006; Layne and Lee, 2001], often criticized by their linearity [Sandoval-Almazan and Gil-Garcia, 2008; Bannister, 2007]. However, there is a lack of knowledge on how public employees' perspectives and certain organizational features affect social media adoption and use. Thus, there is a need to address the distinctive paths and results of social media institutionalization in different governmental contexts. Although these social media platforms might be the same, their use and specific tactics have been different across public organizations [Wukich, 2022; DePaula et al., 2018; Sandoval-Almazan et al., 2018; Meijer and Thaens, 2013; Mergel, 2013]. Moreover, social media institutionalization has usually been studied regarding to specific national contexts or single cases [Medaglia and Zheng, 2017]. Whereas some notable exceptions exist [Criado and Villodre, 2021; Bonsón and Bednárová, 2018; Bonsón et al., 2015; Ellison and Hardey, 2014], the rule seems to be the lack of comparative research across different administrative contexts in the literature on social media and government.

To fill this gap, we explore the results of social media institutionalization by focusing on local governments as one of the layers that has been extensively adopting and using these technologies during the last decade. We conducted an original cross-national survey on social media adoption and institutionalization to investigate the results of the social media institutionalization process in city councils of four European countries: The Netherlands, Spain, Sweden and the United Kingdom. These four countries depict four different administrative traditions [Painter and Peters, 2010]: Napoleonic; Continental; Scandinavian; and Anglo-Saxon, respectively. Results are analyzed in an exploratory way using five social media institutionalization features derived from the existing literature: a) coordination; b) guidance and protocols; c) evaluation mechanisms; d) training; and e) leadership. We try to answer the following research questions: *How is social media institutionalization happening in city councils? Are there differences in social media institutionalization related to different administrative traditions?* The main contribution of this article is the consideration of social media institutionalization as a process that could have different results depending on some characteristics of distinctive administrative contexts.

This article is structured as follows. First, we draw into social media literature and previous e-government research on the interplay between technology and institutions to identify different social media institutionalization features. We also explore differences in social media use across administrative traditions. Second, we describe the research methods used in this study, focusing on the characteristics and analytical approach for our cross-national survey on social media. Third, we present the results, comparing social media institutionalization features within the four cases. Fourth, and derived from the results, we discuss the main findings and make some proposals regarding the differences in institutionalization between administrative contexts. Finally, we provide some conclusions, identify research limitations of this study, and suggest avenues for future research.

2 LITERATURE REVIEW

This section presents our literature review, including two different parts. On the one hand, we present the notion "social media institutionalization" and the different features that we use to gauge it. Our starting point is the work of previous authors who characterized the idea of institutionalization of social media in government, mostly as the final stage of deployment of this type of technologies. Therefore, refreshing this approach with more recent viewpoints and approaches looking at the recent developments of this idea is the purpose of this initial part of the literature review. On the other hand, the study reviews the other building block of the study, oriented to argue the existence and implications of administrative traditions in the study of public administration. Particularly, this part of the literature review appraises the features of each administrative tradition, including here Anglo-American, Continental, Scandinavian, and Napoleonic, based on their particularities regarding cultural or institutional aspects. Hence, the next paragraphs reflect our intention to connect both social media institutionalization and different administrative traditions as the foundation of the theoretical and analytical approach of this paper.

2.1 Social media institutionalization features

Social media and government literature has considered social media institutionalization as part of the social media adoption process. One of the most important studies in this regard has been the staged model proposed by [Mergel and Bretschneider, 2013], which has three phases, the final one being social media institutionalization. The first stage is known as "entrepreneurship and experimentation". During this stage, public employees, who already use social media in their personal environments, begin to introduce social media in the organization. Each of these employees has its own vision on how social media should be used. In large organizations, it could be the case that several of these different visions start to compete. Derived from this informal use, the degree of experimentation in this stage is very high.

The second stage is known as "ordering chaos". The most extreme case that could arise during this stage is that different departments inside the public organization have developed completely different views on how to use social media, and they start to conflict with each other. Middle and top management starts to develop a global strategy that mitigates the possible risks of disorder, reducing competing visions under one that will represent the organization.

The third stage is known as "institutionalization" and refers to a point at which social media has been "institutionalized" within the public organization. Social media institutionalization has been defined as a "*continuum of practices that moves from convergence of routines and standards, the alignment of the innovative practices with the organizational mission to the integration of social media into the existing technology paradigm and the standard operating procedures in public affairs communication*" [Mergel, 2016: 144]. As a result of this process a series of guidelines and protocols are introduced, serving as a general framework to avoid the undesired effects of the previous adoption phases [Chen et al., 2016].

The effects of this institutionalization process are manifold. They represent a framework of reference, which facilitates the socialization of the units of the organization that have not yet adopted social

media [Bretschneider and Parker, 2016]. Thus, other units that have not participated in the early experimentation processes can quickly catch up without the risks associated with the experimentation and early adopting stages [Rogers, 2003]. Institutionalization reduces the level of informal experimentation and regulates it. Moreover, institutionalization provides security to the communication process, both for the citizen (by making public administration's action through these networks more predictable), and for the public administration itself (by providing protection against unwanted effects derived from certain affordances) [Chen et al., 2016]. Finally, although this is not always the case, it usually entails the creation of new roles inside public organizations, including social media strategists, content curators, or community managers [Criado and Villodre, 2021; Mergel and Bretschneider, 2013].

Our study addresses some of the main limitations in the current literature about social media institutionalization in the public sector. First, it is necessary to generate more empirical knowledge about the specific features encompassing the institutionalization processes. This is so, because literature has paid little attention on how to operationalize social media institutionalization and measure it accordingly. Second, the staged model for social media adoption proposed by Mergel and Bretschneider, as it is the case with other e-government-related staged models [Andersen and Henriksen, 2006; Layne and Lee, 2001], takes for granted a linear progression [Bannister, 2007]. It is assumed that organizations advance through phases at different impetus, but they will have the same results at the final stage. This assumption is counterintuitive with the different ways of using social media [Wukich, 2022; DePaula et al., 2018; Sandoval-Almazan et al., 2018; Meijer and Thaens, 2013; Mergel, 2013]. From this perspective, we will identify in the literature organization features that may affect the process of social media institutionalization. Accordingly, we have defined five organizational dimensions based on previous literature assumptions [Villodre et al., 2021], that are summarized in Figure 1. We describe each of them below.

Coordination. Social media institutionalization culminates a process in which the organization's social media strategy has been fully established. To guide this process, governance and control must be exercised by the organization. Coordination refers to how this control occurs, something that it is very tied to which departments or units are leading the institutionalization process [Villodre et al., 2021; Mergel, 2016; Zheng, 2013]. Possible formulas for this control to happen are related to the centralization of management (usually in communication departments) or its distribution (by creating cross-departmental social media management groups) [Villodre et al., 2021; Mergel, 2016]. Coordination is an essential feature of institutionalization, ensuring optimal information flows in decision making between departments and units [Zheng, 2013]. Good coordination is also important to integrate more sophisticated uses of social media [Lee and Kwak, 2012].

Guidance and protocols. Social media institutionalization entails the adoption of standards, rules and procedures that guide how social media will be used. As previous literature has shown [Bretschneider and Parker, 2016; Mergel, 2016; Mergel and Bretschneider, 2013] institutionalization will stablish protocols and rules within the organization that will usually come in the form of social media policy guides [Chen et al., 2016; Yi et al., 2013]. Social media policy guides are formal documents (public or internal) that contain principles and procedures to guide public employees on how to use social media platforms as tools for government [Chen et al., 2016; Yi et al., 2013]. Social media policy guides can be developed based on simple principles that usually refer to common sense, or they can detail each step that public employees must take when interacting on social media using institutional accounts.

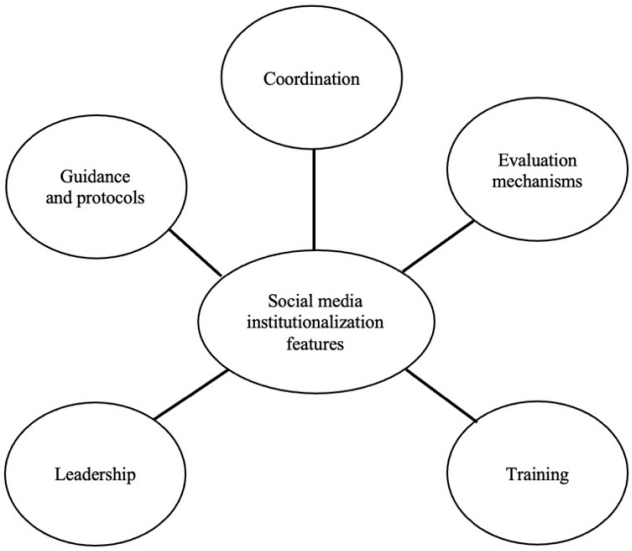


Figure 1: Different social media institutionalization features.

Evaluation mechanisms. When social media is institutionalized, public administrations need to check if their proposed objectives have been achieved or not. The utilization of social media inside public organizations usually comes along with monitoring tools supporting public employees in the evaluation of results and the improvement of public communication and service delivery [Bekkers et al., 2013]. There are several types of evaluation mechanisms. On the one hand, the performance evaluation, refers to the use of quantitative and qualitative metrics to measure social media results [Chen et al., 2016]. Another interesting evaluation mechanism are social media monitoring techniques [Loukis et al., 2017; Bekkers et al., 2013]. These types of techniques allow visualizing the activity of a community, so that feedback can be extracted from citizens' interactions, even enabling government agencies to anticipate to citizen needs. Broadly, social media evaluation mechanisms are key institutionalization features since they allow public administrations to check if their digital strategy fulfill their needs.

Training. Social media institutionalization occurs in organizations when some public employees achieve an expertise as "community managers" or "content curators". These public employees may have become community managers as a part of a formal training plan inside the organization [Zheng, 2013; Meijer and Thaens, 2013; Kavanaugh et al., 2012]. Nonetheless, they also could achieve knowledge on how to manage social media on their own, including the case of learn-by-doing informal learning processes [Galanis et al.,

2016]. In any case, specific training for social media managers is important as a means of helping them to overcome new challenges and appropriately manage interactions with citizens [Gálvez-Rodríguez et al., 2018].

Leadership. Social media institutionalization usually entails several middle-top managers with different visions about social media. These leaders are usually political actors or middle managers with trust on street-level bureaucrats in charge of social media operations [Nath and Kanjilal, 2018]. For social media to be institutionalized, they need to foster, accept, or at least tolerate, this process of internal appropriation. Specifically, political leaders and policymakers are sometimes willing to take a leadership role with the implementation of social media strategies in mind [Rodríguez-Bolívar and Alcaide-Muñoz, 2018]. To ensure institutionalization, public employees in charge of social media try to ensure the support of these leaders reinforcing the digital strategy of the organization.

2.2 Social media across administrative traditions

In this article we study each of the abovementioned social media institutionalization features in city councils of four European countries. The selection of countries was made regarding administrative traditions, as a way of having a representative mixture of different administrative contexts. Literature has indicated the presence of at least four administrative traditions [Painter and Peters, 2010]. First, the Napoleonic tradition (here represented by Spain) comprises an organizational system where public administrations are heavily constrained by formal rules and strict procedures, with a highly interventionist approach. Second, the Continental tradition (represented in our study by the Netherlands) reflects strong legal basis with an organicist, integrative, federalist and interlocking cooperative approach. In third place, the Scandinavian tradition (represented by Sweden) entails a de-centralized and welfare-state oriented administrative perspective. Finally, the Anglo-Saxon tradition (represented in this study by the United Kingdom), is usually linked to a stateless model (the State is not the core part of the discourse of law/politics). It is also an administrative tradition that heavily relies on pluralism.

More recently, some authors have updated this perspective including a set of nuances from the comparative perspective of public administration. Here, Peters, 2021 states that whereas comparison of public bureaucracies is difficult, it is also something of value. In fact, "*even while there is a significant increase in using experimental methodologies for studying political phenomena, the best way to study political institutions, and perhaps especially the public bureaucracy, is through comparative analysis*". He supports that the general model of four administrative traditions in Western countries is still applicable, but they have not been equally transmitted to their former colonies, and giving room to a colonialist perspective of bureaucracies in developing countries. Also, other Confucian and Islamic traditions have gained recent momentum in some Asian and Middle East countries, respectively. Therefore, the comparative approach to our four administrative traditions is still of value to reflect about different administrative phenomena and promote comparison across public administrations in different national contexts. This is the perspective that we take in this study.

However, there is a lack of knowledge on how administrative traditions impact the adoption and institutionalization of social media in public administrations. Previous literature has highlighted that some administrative traditions are more prone to the diffusion of innovations than others. There are two main findings in relation to this topic. On the one hand, literature has stated that administrative contexts could be of importance to study participation through social media, because certain traditions such as the Scandinavian, Anglo-Saxon and Continental tend to favor public administration reforms and public innovation [Pina et al., 2007]. However, literature has also stated that certain Napoleonic tradition countries could have a great tendency towards fostering citizen participation and other innovative social media practices, although it is also assumed that they have cultural and structural constraints that prevent innovation [Bonsón and Bednárová, 2018; Bonsón et al., 2015].

3 RESEARCH DESIGN AND METHODS

As mentioned before, this article explores the results of social media institutionalization in different European city councils using a comparative perspective. Each case is representative of one administrative tradition [Painter and Peters, 2010], being Spanish city councils a reflection of the Napoleonic tradition, Dutch city council's representative of the Continental tradition, Swedish city councils an example of the Scandinavian tradition, and United Kingdom city councils a case of Anglo-Saxon tradition. Our work poses the following research questions: *How is social media institutionalization happening in city councils? Are there differences in social media institutionalization related to different administrative traditions?* To answer these questions, we conduct an original cross-national survey on social media adoption, institutionalization, and use. We analyze and compare each case in relation to our five social media institutionalization features (coordination, guidance and protocols, evaluation mechanisms, training, and leadership) using descriptive statistics. In this section, we describe our sample selection and data collection through a questionnaire. We also specify the operationalization of the five social media institutionalization features, and we explain our analytical approach.

3.1 Sample and data collection

This article focuses on the study of social media institutionalization in local governments. This is so because it is one of the layers of government that has been widely adopting social media [Bonsón and Bednárová, 2018; Medaglia and Zheng, 2017; Ellison and Hardey, 2014]. This fact may be due to the proximity of this level of government to the citizens, as well as because of the challenges faced by city councils in relation to the integration of citizen participation [Ellison and Hardey, 2014]. Therefore, we expect to find a high level of social media institutionalization within this group of public organizations.

For this study we have selected municipalities with more than 50.000 inhabitants. The decision to apply this threshold was twofold. On the one hand, it is important to avoid sampling problems associated with the "infra-municipalism" phenomenon which is especially true for the Spanish case [Olmeda, 2017], with many municipalities

(from a total of 8131 city councils) having less than 1000 inhabitants (5002 city councils). On the other hand, by increasing the municipality size, we ensure that we find in all cases city councils with greater resources and, therefore, where the level of social media institutionalization could be higher [Rodríguez-Bolívar and Alcaide-Muñoz, 2018; Reddick and Norris, 2013].

Data in this study comes from an original questionnaire. This survey is part of a cross-national study conducted by the researchers and comprises a total of 22 questions related to social media adoption, social media institutionalization, and social media use in European city councils from four countries (Spain, the Netherlands, Sweden and United Kingdom). The questionnaire was developed with an identical format in all four countries to ensure comparability between questions. For each case, the questionnaire was presented in the specific language of the country. The survey was built based on previous research with questionnaires on social media and government [Criado and Rojas-Martín, 2015; Bailey and Singleton, 2010].

Data collection happened in different time periods depending on the country but following the same process and using the same questions. First, for Spanish city councils (called *ayuntamientos*), the survey was conducted between June 2016 and December 2016, having a response rate of 84% (122 cases out of 145 municipalities with more than 50.000 inhabitants). For the cases of the Netherlands, Sweden and United Kingdom, the questionnaire was conducted between January 2017 and December 2017. In total, 31 out of 77 Dutch municipalities (called *gemeente*) with more than 50.000 inhabitants responded to our questionnaire (40% response rate). For Sweden, a total of 28 out of 47 municipalities (called *kommun/stad*) with more than 50.000 inhabitants filled our survey (60% response rate). Finally, for United Kingdom, a total of 20 out of 152 councils with more than 50.000 inhabitants responded to the survey (showing a response rate of 13%). The very low response rate in the case of the United Kingdom should be considered as a research limitation with possible impacts on the comparability of our results.

The survey targeted the person in charge of the social media strategy in each city council. It was hosted by the Google Forms platform (which was also used to store responses before the analysis stage) and distributed via e-mail to each city council. Because of the intentional design of the questionnaire, in some cases, municipalities did not answer all the questions, generating missing values. This was also in part because we did not enforce mandatory answers, so city councils were free to answer or not if they did not have the information for a specific question or find it problematic. Despite this, the number of missing values was very low.

3.2 Operationalization and analysis of social media institutionalization features

To explore social media institutionalization in our sample of city councils, we have referred to its features as we describe them in the literature review. We used the data coming from our questionnaire to operationalize each feature. Although the survey has 22 questions, only 5 were used for the operationalization of each social media institutionalization feature. First, coordination refers to the unit or department in charge of social media management and was operationalized by measuring unit involvement (being a centralized coordination, if only one department is involved, or a distributed coordination if more than one department is involved). For guidance and protocols, we explored the presence of social media policy guides. With respect to evaluation, we referred to the existence of evaluation for social media results. In relation to training, the indicator used was the existence of specific training on social media for public employees. Finally, leadership was built upon the perception of a sense of leadership supporting social media inside the organization. Table 1 summarizes the operationalization of the five social media institutionalization features in relation to our survey questions, indicating also their measurement.

We analyzed social media institutionalization features using descriptive statistics. Descriptive results are compared across cases (representing four administrative traditions) for each of the social media institutionalization features. Following the analytical boundaries and limitations of this study, no empirical inferences have been made. When performing the analyses, we found no outliers. We used the STATA 16.0 software to carry out the descriptive statistical analysis.

4 ANALYSIS AND RESULTS

In this section, we present the main results of this study. The results are discussed in a comparative manner for each social media institutionalization feature in relation to the city councils of the four countries we have analyzed (which represent different administrative traditions). Table 2 summarizes the descriptive results showing how different social media institutionalization features behave for each administrative tradition (city councils from each of the four countries). We describe the results with more detail below.

4.1 Coordination

The first social media institutionalization feature is coordination. As a feature, coordination refers to the way the city council manages the social media strategy. Coordination could be centralized if, for example, all social media management decisions are made by a single unit, and the rest of the departments are devoted to applying what it is designated. Coordination could also happen in a distributed manner, if the management decisions are not located in a single unit, but in several departments that develop the social media strategy. As we can see from Table 2, there is a tendency in all cases towards a more distributed social media coordination, with 80 cases in Spanish city councils (Napoleonic tradition) (66.67%), 21 cases in Dutch city councils (Continental tradition) (67.74%), and 13 cases in United Kingdom councils (Anglo-Saxon tradition) (68.42%). The only case where this inclination is not so evident is among the Swedish city councils (Scandinavian tradition), where there seems to be an equality in numbers for both identified coordination strategies.

4.2 Guidance and protocols

The second social media institutionalization feature that we explore in this study is the presence of guidance and protocols. When institutionalization occurs, technologies are formalized as a part of the rules and procedures of the organization. For social media, rules are usually contained in social media policy guidelines, formal documents that detail how the public organization should use social

Table 1: Operationalization of social media institutionalization features.

Feature	Indicator	Question (from survey)	Measurement
Coordination	Unit involvement for social media management	Q7. Please could you indicate which unit/s or department/s are involved in the management of social media in your organization?	Multiple choice. Recoded following this rule: 0-Centralized (if only one department is involved); 1-Distributed (if more than one department is involved)
Guidance and protocols	Presence of social media policy guides	Q3. Please indicate whether a guide has been developed for using digital social media in your organization.	Dichotomic (0-No, 1-Yes)
Evaluation mechanisms	Existence of evaluation for social media results	Q4. Is there a system in place for assessing or measuring the results of using social media?	Dichotomic (0-No, 1-Yes)
Training	Existence of specific training on social media management for public employees	Q11. Do they receive training on how to manage social media?	Dichotomic (0-No, 1-Yes)
Leadership	Perceived sense of leadership supporting social media	Q12. Do you think there is a sense of leadership in your organization supporting the presence on social media?	Likert scale (1-Minimum sense, 5-Maximum sense)

Source: Authors' own elaboration.

Table 2: Results of social media institutionalization for different administrative traditions.

Social media institutionalization	Administrative traditions and countries (for city councils)			
Features	**Napoleonic (Spain)**	**Continental (Netherlands)**	**Scandinavian (Sweden)**	**Anglo-Saxon (United Kingdom)**
Coordination	Centralized (40, 33.33%), Distributed (80, 66.67%). N = 120	Centralized (10, 32.26%), Distributed (21, 67.74%). N = 31	Centralized (14, 50%), Distributed (14, 50%). N = 28	Centralized (6, 31.58%), Distributed (13, 68.42%). N = 19
Guidance and Protocols	No (83, 69.17%), Yes (37, 30.83%). N = 120	No (14, 45.16%), Yes (17, 54.84%). N = 31	No (3, 10.71%), Yes (25, 89.29%). N = 28	No (0), Yes (20, 100%). N = 20
Evaluation mechanisms	No (40, 33.33%), Yes (80, 66.67%). N = 120	No (3, 9.6%), Yes (28, 90.3%). N = 31	No (9, 32.14%), Yes (19, 67.86%). N = 28	No (3, 15%), Yes (17, 85%). N = 20
Training	No (55, 45.83%), Yes (65, 54.17%). N = 120	No (2, 6.4%), Yes (29, 93.5%). N = 31	No (7, 25%), Yes (21, 75%). N = 28	No (3, 15%), Yes (17, 85%). N = 20
Leadership	Mean (3.51), Std. Dev. (1.00). N = 120	Mean (3.32), Std. Dev. (1.04). N = 31	Mean (3.32), Std. Dev. (1.02). N = 28	Mean (3.6), Std. Dev. (1.27). N = 20
Total N (obs.)	122	31	28	20

Source: Authors' own elaboration. For each country, we analyze the local level of government (city councils).

media [Chen et al., 2016; Yi et al., 2013]. As we show in Table 2, there seems to be two different trends for the adoption of social media policy guides. On the one hand, we can see city councils that have adopted to a great extent these documents, especially for the case of Sweden (Scandinavian tradition) (25 city councils, 89.29%), and the United Kingdom (Anglo-Saxon tradition) (for all the 20 councils analyzed). And, to a lesser extent, in Dutch city councils (Continental tradition) (17 cases, 54.84%). In contrast, we have the opposite trend in Spanish city councils (Napoleonic tradition), reflecting a lack of adoption of these documents: only 30.83% of the city councils that responded to our survey (37 cases out of 120 observed) have adopted social media policy guides.

4.3 Evaluation mechanisms

The third social media institutionalization feature is the presence of evaluation mechanisms. With this feature we coin the fact that the formalization of social media usually comes with a need to evaluate how the digital strategy is progressing, and if it is appropriately serving organizational interests. As we show in Table 2, evaluation mechanisms are widely used in all cases. However, their use is especially relevant in Dutch city councils (Continental tradition)

(28 cases, 90.3%) and in United Kingdom councils (Anglo-Saxon tradition) (17 cases, 85%). Although quite used, municipalities in Spain (Napoleonic tradition) and Sweden (Scandinavian tradition) seem to be adopting the evaluation of social media results to a lesser extent. In any case, considering the results, it does not appear that the administrative context makes any substantive difference in relation to evaluation. The general trend seems to indicate that the evaluation of social media results is perceived as important when it comes to institutionalizing these digital platforms.

4.4 Training

The fourth social media institutionalization feature that we explore in this article is the presence of training in social media. Here we refer to the fact that public employees that oversee social media profiles receive (or not) specific training on these digital platforms in order to be able to manage them according to the organization's strategy and needs. As shown in Table 2, the main course of action here seems to be towards offering training to public employees in all administrative contexts. However, there is something to note about this trend. Particularly, in the Spanish case (Napoleonic tradition), unlike the rest of the cases, there is also a very considerable number of municipalities in which public employees do not seem to be receiving training in social media management (55 cases, 45.83%). This number is much higher than in the other cases, where the lack of training on social media remains below 25%. This fact may be linked to how social media training is conceptualized in different context. For instance, although it is possible to refer to it through the classic concept of formal learning, it is also likely that it does not reflect the fact that informal learning also takes place inside public organizations.

4.5 Leadership

Finally, the last institutionalization feature that we study in this work is the perceived support of leadership for social media in the organization. Under this category, we refer to the fact that for social media to be formalized in the organization, high rank civil servants, and particularly, senior political appointees, must support this formalization process in some way. As shown in Table 2, the perception of the importance of support from these leaders is relatively high for all cases, with Likert means ranging from 3.3 to 3.6 points, with no differences between cases. Hence, it seems that public employees responsible for social media understand that for institutionalization to take place, it is necessary that senior officials and political leaders of the organization provide resources, support, or at least do not interfere with the institutionalization process developed by other actors, including social media strategists and managers.

5 DISCUSSION AND IMPLICATIONS

The above results have allowed us to understand how social media institutionalization is occurring across different administrative contexts. In general terms, social media institutionalization processes are advancing at a similar pace in European local governments. However, it is possible to find certain differences in this path since it is not occurring the same way for all the institutionalization features. The extent to which these differences can be attributed to certain characteristics of administrative traditions will require a more sophisticated analysis. In this section, we discuss our main findings and carefully compare them with previous research. Therefore, our goal is to establish new theoretical assumptions about the relationship between administrative traditions (at the local level of government) and the institutionalization of social media. These assumptions need to be empirically considered and tested in future studies.

First, regarding social media coordination, we found a generalized trend towards distributed strategies, except for the case of Sweden (Scandinavian tradition), where it has not been possible to observe this approach. Although according to theory on administrative traditions [Peters, 2021; Painter and Peters, 2010] the Swedish case should be highly conducive to decentralization of management decisions, it is also likely that they are aware of the problems of distributed management, especially when we talk about coordinating emerging and highly disruptive technologies [Mergel, 2016].

Second, in relation to social media policy guides, we have found a clear difference between the Spanish municipalities (Napoleonic tradition) and the rest of the cases. In general, it seems that Spanish municipalities are not adopting this type of documents that formalize social media management in organizations. Even though Spain belongs to the Napoleonic tradition, where the administrative context fosters the adoption of procedures and constrains for administrative actions [Peters, 2021; Painter and Peters, 2010], this context does not seem to have an impact when it comes to social media management. This fact could be linked to a slower process of social media institutionalization in comparison with the other cases, considering that the Spanish case is where we also found the greatest absence of evaluation mechanisms and of specific training in social media management. All this could connect with the idea that the Napoleonic tradition is often less inclined to introduce innovations as part of the formal structures of organizations [Pina et al., 2007], because of its more inflexible organizational culture. Because of this, it could be likely that Spanish municipalities are less oriented to formalize and standardize social media, although this does not imply that they cannot develop practices that take advantage of the participatory potential of these platforms [Bonsón and Bednárová, 2018; Bonsón et al., 2015].

Third, although there is a clear perspective for the analyzed European local governments towards offering training to the public employees in charge of social media, it is also possible to find differences for the Spanish case (Napoleonic tradition). It seems that in the Spanish case there are many city councils that do not seem to provide training for social media management. However, it is not clear if what really happens is that a different kind of learning is taking place in this case, namely informal learning [Galanis et al., 2016]. Despite not having access to formal and structured learning, in this group of city councils, the existence of informal learning would imply that public employees rely on their own personal training resources, or they learn by doing, encouraging experimentation within the organization [Galanis et al., 2016]. Although this idea somehow gainsays the philosophy of the Napoleonic tradition (not very prone to the promotion of administrative innovation), it should be seen as a kind of internal push coming from public employees oriented to provide better service delivery using the potential of web 2.0 technologies. These public employees could be seen as

entrepreneurs and enthusiasts motivated to face the inflexibilities of the administrative context in innovative ways.

Finally, it seems that the evaluation of social media results, and the perception of leadership for the promotion of social media, are equally important regardless of the administrative context. Leadership seems to be particularly critical, since it implies that, ultimately, and regardless of the administrative context, the support of formal political elites and public leaders is key for social media to be properly institutionalized. This fits well with previous research that has indicated the importance of the political level for the use of digital platforms and the development of smart governance, among other innovations in local governments [Rodríguez-Bolívar and Alcaide-Muñoz, 2018; Rodríguez-Bolívar, 2017].

Bearing all this in mind, the most important theoretical implication that can be drawn from this work is the fact that social media institutionalization could have different paths and results depending on the context. This should be the case for certain institutionalization features such as the presence of policy guides, evaluation mechanisms and training, being the most important differences between the Spanish city councils and the rest of the cases. Moreover, for social media coordination we have detected the presence of cases where social media management is centralized (a single unit carries out the strategy) or distributed (several units are responsible for the digital strategy), which is in line with previous work with institutionalization models [Villodre et al., 2021]. However, these differences seem to be not related to the context, as a tendency towards distributed coordination is generally observed. All these results underline that there is no single way to carry out institutionalization. And that, even if it is considered as a stage of the adoption process [Mergel and Bretschneider, 2013], it should not be addressed as a linear course of action as it could lead to a certain variety of formulas [Bannister, 2007]. The only exception to this may be the presence of leadership to support social media, as it seems to result the same way with minimal differences between and within administrative contexts.

All these findings can also have important practical implications. Knowledge on social media institutionalization features can help public managers to better integrate these platforms into management routines according to the administrative context and the organizational needs. This is so because social media institutionalization features offer guidance elements that can help public employees in charge of social media to assess the state of institutionalization in their organizations, allowing them to see if it is on a satisfactory path. In the same way, public employees can put these features in relation to the risks associated with the use of social media, both internal (e.g., a culture that is not conducive to cross-departmental communication) and external (e.g., inappropriate use of social media by external agents when sharing information or interacting with communities). So that they can adopt different strategies according to their administrative reality and resources.

6 CONCLUSIONS

This paper has explored the results of social media institutionalization in different European city councils using a comparative perspective across administrative traditions, digging into five social media institutionalization features: coordination, guidance and protocols, evaluation mechanisms, training, and perceived leadership. Broadly, our findings show that social media institutionalization processes seem to be similar across the studied administrative contexts. The most notable differences are found between the Spanish case (Napoleonic tradition) and the rest of the administrative traditions. These differences are largely related to the lack of adoption of social media policy guidelines and regulations. Here, our conclusion is that such differences could be a result of a lower level of institutionalization in Spanish city councils, derived from the nature of an administrative context not very prone to administrative innovation. However, this perspective is just based on preliminary evidence and further research is needed.

Our work is not without some limitations, and results should be carefully interpreted. On the one hand, United Kingdom councils had a very low response rate. This can cause bias in the analysis, since there is a probability that the municipalities that responded to our survey were the ones most committed to the use of social media (in the other three countries we received answers to the survey from representative samples of city councils over 50.000 inhabitants). On the other hand, differences between cases should be understood as a descriptive exploration, since no specific statistics have been used to establish inferences or significant relationships among our variables. Therefore, this study is the first stage of a long journey to understand the interplay between institutionalization of social media and how different administrative traditions understand, shape, and achieve it.

Overall, this work opens new avenues for future research on social media institutionalization. Future work should continue studying possible differences in social media institutionalization between administrative contexts. For this purpose, it will be particularly important to explore qualitative designs allowing us to delve more in-depth into organizational processes and clarify the features linked to different potential models, depending on the orientation for each social media institutionalization feature. Similarly, it will be of importance to carry out regression and other correlational models where institutional and environmental features of the administrative and political context are considered, including the prospect of broaden the number of countries or changing the size of the city councils included in the sample. Finally, future attention to institutionalization processes, models, or implications should help public managers to develop better informed social media policies and strategies.

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Tips, Tidings, and Tech: Governmental Communication on Facebook During the COVID-19 Pandemic

Ehsan-Ul Haq
euhaq@connect.ust.hk
The Hong Kong University of Science and Technology
Hong Kong SAR

Tristan Braud
braudt@ust.hk
The Hong Kong University of Science and Technology
Hong Kong SAR

Lik-Hang Lee
likhang.lee@kaist.ac.kr
Korea Advanced Institute of Science and Technology
South Korea

Reza Hadi Mogavi
rhmogavi@connect.ust.hk
The Hong Kong University of Science and Technology
Hong Kong SAR

He Zhang
hezhang@mail.tsinghua.edu.cn
Tsinghua University
China

Pan Hui*
panhui@ust.hk
The Hong Kong University of Science and Technology
Hong Kong SAR

ABSTRACT

The COVID-19 pandemic led governments to rely on the versatility of social media to communicate with their citizens. This paper analyzes the Facebook communication of political leaders and health departments from 17 countries during the COVID-19 pandemic. We evaluate the citizen's response under the frameworks of *media richness* and *user engagement*. We note that governments and leaders communicate primarily through richer media (photos and videos), despite a negative correlation between media richness and user engagement. Plain-text messages posted by country leaders attract the most engagement, while their COVID-19 communication tends to generate lower engagement. On the other hand, health departments' pages experienced a sharp increase in engagement around COVID-19 communication as citizens sought information during the pandemic. Finally, topical analysis shows that *Discussions* and *Co-Use* of COVID-19 with other topics can boost citizens' engagement. Our comparative analysis shows practical implications for social media users and social media designers. Our findings can help governments and organizations design effective social media communication during crises.

CCS CONCEPTS

• **Applied computing** → **E-government**; • **Human-centered computing** → *Empirical studies in collaborative and social computing*.

KEYWORDS

Risk Communication, Citizen Engagement, Media Richness, COVID-19, Social Media

*Pan Hui has second affiliation with University of Helsinki, Finland

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1 INTRODUCTION

In crisis times, governments and citizens alike leverage social media to disseminate information and interact with each other. Understanding the phenomena behind such interaction and the resulting user engagement with content is an important research area for social and computer science researchers, i.e., devising more efficient methods to disperse comprehensible and relevant information [6, 16, 25]. The scale of the COVID-19 pandemic has never been seen before in the social media age. The resulting social isolation led citizens to turn to social media for accessing information and preserving social contact [11]. This situation revealed new challenges and limitations in government and citizens' social media communication. Lessons learned from such experience will help understand the implications of social media during large-scale crises.

This paper sheds light on governments' Facebook communication content characteristics that lead to higher citizen engagement during the COVID-19 pandemic. Strategies like the use of hashtags and attitudinal language can increase the engagement of citizen [20, 67]. This work, in particular, focuses on a detailed message niche and social media modalities in terms of content type (videos, photos, and text) as a confounding factor in engagement. Our observations can help governments understand the impact of using a particular communication modality and a choice of topic to increase engagement. We measure the engagement based on the typical engagement markers on Facebook, i.e., likes, shares and comments. We correlate such engagement with the content type and topic through a multicountry (17 countries and regions) and multilingual (10 languages) study of the use of Facebook by heads of state and official health departments across the globe (e.g., America, Asia, Europe, and Oceania). For these regions, we collect year-long data from the head of government and the local health department's Facebook pages, from the early signs of the pandemic

in January 2020 to December 2020 and consisting of over 50,000 posts.

We consider the clarity of a message that can be embedded in three media types (photo, video, and text) as a confounding factor for the engagement. To better formalize this quality into the media types, we leverage the Media Richness Framework [22] that describes the degree of informativeness by media types. Social media provides opportunities to engage with the audiences directly; users can respond through a multiplicity of engagement cues. Content-type (e.g., photo or video) and the content itself (e.g., technical or general information) on social media play a significant role in communicating timely and relevant information during a crisis [6]. In contrast, *Uncertainty* (lack of information) and *Equivocality* (ambiguity) are significant factors impacting governmental communication [23]. We provide a fine-grained analysis of the citizens' response to the government campaign and evaluate which types of posts are the most efficient at conveying information. In particular, this paper aims to answer the following research questions:

- **RQ 1: What type of content (ranked on media richness framework – Text, Photo, Video) in governmental communications generates the most response from the public?**
- **RQ 2: What COVID-19-related topics yield higher user engagement, and which engagement marker is more prominent?**
- **RQ 3: Is there any difference between health-related and leaders pages on COVID-19 communication and engagement? And how does it vary across the countries?**

This study with year-long data provides insights into how governments can leverage Facebook as an efficient crisis management channel. We primarily categorize the posts based on their content type and topic and further analyze the engagement received by the leaders and government pages. Such analysis can help the leaders and governments understand their citizens' content preferences and design efficient communication plans on a large scale. We show that although many governments primarily communicate through videos, this media type may not be the most appropriate to keep citizens engaged, even compared to purely text-based messages. Citizens are more likely to respond to topics related to live discussions, policies, and situation awareness posts with a higher number of comments. In contrast, the posts about technological tools such as tracking apps only result in very mild engagement.

2 RELATED WORK

The use of Information and Communication Technologies (ICT) such as social media to control and prevent a crisis developed into an interdisciplinary field as *Crisis Informatics* [20, 47, 58, 65]. Informating (i.e., narrowing the gap between information producers and consumers) the relevant stakeholders through social media in various crisis scenarios impacts the crisis control [58]. Also, through informating, social media can decentralise crisis response management compared to centralised and concentrated source [52]. Cyberspaces enables Citizen's collaboration with the governments in several ways [10, 27, 41]. For instance government and citizens' co-produce the content to increase the outreach of the message [45].

In this paper, we aim to understand the most efficient content and message for informing and rallying the citizens for crisis control. In the following paragraphs, we briefly discuss the relevant literature related to governmental communication and social media usage related to COVID-19.

2.1 COVID-19 and Social Media

COVID-19 emerged as one of the prominent research motivations to study social media communication for public health [15, 24, 56, 66]. OSNs are the biggest data source to analyse the societal behavior during this pandemic. A large number of studies focused on sentiment analysis [7] and topical discourse on in the societies [21, 24, 46]. An earlier research emphasizes the similarity of COVID-19 content sharing patterns across different OSNs and other online platforms [17]. However, a more recent study shows that social media discourse on COVID-19 varies among social media platforms and physical locations [24]. Our work further highlights that even on the same platform, the nature of the pages (leader vs health department) also show significant difference in the page growth.

2.2 Governmental COVID-19 Communication

The use of social media to support governance is common [5, 25, 28, 35, 35]. OSNs are used to disseminate information to the citizens [29] and listen back to their opinions [25, 57]. A diverse choice of OSNs and respective multi-modalities offer a room for researchers to evaluate the effective communication [14, 37, 45, 66]. In terms of crisis related communication, one of the main objective of the governments is to update the citizens about the control and prevention measures [50], in line with the 'informating' objectives [58]. Accordingly, the role of country leaders is also critical in crisis communication [31]. Verified accounts such as governments or official accounts can be a source of accurate information [3, 40, 48].

Several studies evaluate the role of governmental social media communication in context of COVID-19 [36, 49, 54, 61, 68]. Governmental organizations used OSNs to disseminate information related to COVID-19 [61]. and increased the tendency of their followers to evaluate the quality of COVID-19 related information and avoid misinformation [32, 60]. In contrast, our work compares governmental communication, not only among several countries, but also within the same countries, among different representatives. We focus on the government leaders and the health departments' pages. As political figures, the government leaders can exhibit a partisan bias, and health department pages may become more relevant by dispensing health advice and updates, as suggested by increase in their followers.

2.3 COVID-19 and Citizen Engagement

Several studies analyse confounding factors for higher engagement in COVID-19 communication [14, 66]. The amount of information in the message and its format (e.g., a photo or a video) have a significant effect on engagement. To better formalize the impact of the format of the message on engagement, Chen et al. [14] use the *Media Richness Framework* [22] to categorize different media types according to their media richness. Depending on the social media capabilities to share the information in the form of videos, photos,

text or external links, the level of information can be categorized according to media richness [14]. Yang et al. used similar comparisons for Wuhan's local government social media accounts [66]. Both studies found that, despite carrying higher media richness, videos get less engagement from the audience. However, both of these works only consider one type of accounts (usually the local government accounts) in their analysis. Finally, [20] uses the retweets measures to highlight the impact of using collective communication strategies to engage the citizens. Our study builds upon such theories of media richness and user engagement. We attempt to study the richness of content posted by country leaders and health departments against user engagement. This study aims to figure out whether the inverse relationship between media richness (e.g., text, images, and videos) and engagement (e.g., likes, shares, and comments) is universal, or the local culture and the types of pages contribute to more nuanced findings.

3 METHODOLOGY

This study follows a standard content analysis technique; starting with data sampling, coding, and analysis [8]. We adopt a comparative approach between COVID-19 and non-COVID-19 related posts. We then use statistical analysis on interaction parameters (i.e., like, share, and comment) to quantify social media engagement. We first define the basic terminologies, annotations, and respective descriptive statistics that we are going to use in the rest of the work.

3.1 Dataset

We aim to present a selection of countries representative of the COVID-19 situation at the time of data collection in the late 2020. Thus, we select the countries with the highest COVID-19 cases across the major geographical regions. We limit our selection criteria to regions where the government leader and the health department use Facebook. And finally, we only consider the regions whose language corresponds to the researchers' linguistic capabilities. Our dataset includes the USA, Canada, Brasil, Columbia, Peru, Hong Kong, South Korea, Taiwan, Turkey, India, Pakistan, Australia, New Zealand, Spain, France, Italy, and the UK. Accordingly, we collect data from the verified Facebook page of the state leader (elected leader serving as either Prime Minister/President or executive of the country based on her democratic system). We also collect data from the verified and official page of the health department/ministry in a country. We manually search for governmental websites and political party/individual websites to find the Facebook accounts. In case of the absence of links to social media, we search on the internet to find the relevant Facebook page and manually verify each page. We use the CrowdTangle API [1] to collect the data from our seed accounts. We collect every post shared by these accounts from the 1st of January 2020 to the 1st of December 2020. We retrieve all fields provided by API; for instance text and number of interactions (comments, shares, likes, and emotion reactions) for a post. We accumulate 37 accounts belonging to 17 political leaders and 20 health departments, resulting in 51,361 posts in which heads of state share 21,763 posts.

[1] https://www.crowdtangle.com

3.1.1 Ratio of posts related to COVID-19. We use a comprehensive list of keywords based on our dataset's different languages to filter COVID-19 related posts. Five researchers curated the keywords who are either native speakers or have multilingual proficiency in each country's primary languages. We start our sampling with the words representing COVID-19 at various pandemic stages. These words consisted of the words likes *'COVID', 'virus', 'coronavirus', 'ncov', 'novel', 'pandemic', 'COVID-19', 'wuhan', '2019-nCoV', 'isolation', and 'SARS-CoV-2'*. We then use the combination of the words that represent the precautions and control measures and some more generic words related to pandemic. *'mask', 'pandemic', 'stay home', 'stayhome', 'save live', 'lockdown', 'wuhan', '2019-nCoV', 'isolation', 'quarantine', 'social distance', and 'wash hands'*. After finalizing the keyword list in all languages, we perform iterative filtering of the content to remove any false positives for COVID-19 related messages. In total, our dataset has around 24,000 COVID-19 related posts. Table **??** (Appendix) shows the frequency of overall posts. Table 5 (Appendix) shows the numbers in each category and a ratio of COVID-19 related posts to the total posts in our observation period. The results show that the ratio of combined COVID-19 related posts varies from 20% to 80%.

Many factors may affect this difference: the severity of the pandemic in the country and the intensity of the response; with the government introducing more measures to slow down the spread. Similarly, organizational differences between countries and regions can significantly impact the type of communication. For instance, France's highest governmental authority is not only in charge of healthcare but also of other social services. Different regions have a dedicated organization for disease prevention, with a more specific focus on COVID-19.

3.2 Citizen Engagement

In this paper, we focus on quantitative measures of engagement; using the number of comments, shares, and likes, as often used in communication research [8, 9]. We use the engagement measure, normalised based on the number of followers for a page, as proposed by [9]. The engagement measure is calculated as the sum of the popularity (number of likes), the commitment (number of comments) and the virality (number of shares).

We report the average number of engagement markers depending on the media type (photo, video, or status) in Table 6 (Appendix). We observe that non-COVID-19 posts often elicit more responses from Facebook users than COVID-19 posts for all media types. However, the engagement is often more uniform for COVID-19 posts, with a lower standard deviation. This difference may be explained by the vastly diversified topics among the non-COVID-19 posts.

3.3 Media Richness

A communication medium's ability to deliver a message with clarity is referred to as the medium's richness [22]. This ability is evaluated through several factors, including the multiplicity of cues, grammar commonalities, and personal focus. Face-to-face interaction is considered a highly rich interaction as it features most of the available cues to help share a message between people. Contrariwise, a text-based message embeds fewer cues and is considered a less rich medium. Facebook allows users to share videos, photos, and

text-based messages. Such content can either be native to Facebook (content uploaded directly to Facebook) or links to third-party websites. Crowdtangle API classifies the content (videos, photos, and text-based messages) depending on whether it is uploaded directly to Facebook or shared from some other websites. The media type classification are as follow: *video, native video, YouTube, live video complete, photo, link,* and *status* (see Table **??**). Videos are classified as *Videos* if they were uploaded directly to the platform, while *live videos complete* are the videos that are premiered live using the Facebook Live feature. *YouTube* and *video link* is a further classification of a video link depending on whether it is a YouTube video or a link to a video on any other platform. All the above video types are regarded as higher media-rich content. *Photos* are considered at a medium scale of media richness. *Link* and *status* (text) are low media-richness content.

The dataset's most frequently shared content types are photos, videos, and text statuses in decreasing order. Although prominent in the non-COVID-19 related category, status messages are not as common in COVID-19 related messages compared to photos. Facebook allows the video to be streamed live or to be uploaded from the operating device, along with an option to schedule it later. The count of the posts in each data type is shown in Table **??** (Appendix).

3.4 Message Content Topic

To categorise the message content, we take inspiration from a codebook with four main categories: *latest news, appreciation for front-line staff, guidance for stakeholders, and information about government crisis handling* [14]. Our preliminary data analysis showed that not all content in our dataset can be organized in the original four categories. For instance, many messages provide updates on government policies or invite citizens to live discussions and press conferences. There is also significant communication around the promotion of technology tools. To develop a modified codebook, we randomly select 15% of the COVID-19 related data sample [8] from each countries' data to label according to our topical categories, with the Integrated Deductive and Inductive approach [39]. Two postgraduate students were then given the data, and their agreement on the categorization was measured. A substantial agreement with Kappa-cohen k=0.74 was achieved [43]. Finally, eight categories are finalised as follows:

- **Situational Awareness (S)**: Information on the current situation of COVID-19, such as report on the number of cases, daily increases, or mortality rates.
- **Prevention Tips (T)**: Messages share practices to prevent the COVID-19 spread. These tips can include reminders to wash hands or wear a mask or explanation on how to wear a mask.
- **Policy Updates (P)**: Announcements of government policies related to COVID-19. Messages contain updates about the number of medical personnel and equipment, guidelines for individuals, businesses, public spaces sanitation, and travel restrictions. Occasionally, messages contain global government policies such as general economic reforms with reference to COVID-19.
- **Co-Use (C)**: COVID-19 is co-used with other topics. Messages belonging to this category are either global messages encompassing many independent topics, including COVID-19 (e.g., weekly government updates), or messages linking COVID-19 to other topics (e.g., COVID-19 and presidential elections in the USA).
- **Discussions and Press Conferences (D)**: Live audio or video streams for Q&A and press conferences. Many governments provide periodic live streams for informing their citizens in real-time.
- **Technology Tools (TT)**: Information about the websites and mobile apps by the government. Many governments set up at least two kinds of tools: websites and portals for tracking the pandemic and mobile apps for patients' contact tracing.
- **General Information (I)**: General information about the pandemic and the coronavirus. Often, parts of the message bring further details on the coronavirus without belonging to the above categories. Symptoms, medications, and information on transmission belong in this category.

Figure 1a shows the frequency of the manually labelled content topics. Messages primarily fall into the *General Information (I)* category, as most messages in our dataset present additional information that does not fit into other categories. *Health Tips (T)* also account for a large portion of the messages, followed by *Discussions (D)* and *Situation Awareness (S)* messages. Fewer posts fit into the *Co-Use (C)*, *Policy (P)*, and *Technology Tools (TT)*. Overall, government leaders and health authorities focus on live communication and prevention through health tips and situation reports.

4 ANALYSIS AND RESULTS FOR RQS

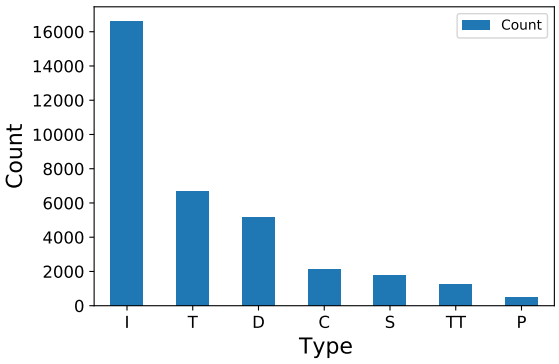
In the following sections, we analyse each research question individually.

4.1 RQ 1: Media Richness and Engagement

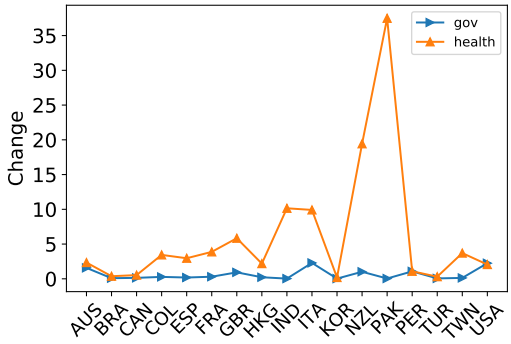
We look at the difference in engagement based on media richness. Our media richness categories are in line with [8], with the detailed granularity of the video types. One-way ANOVA evaluates the media type's significance on three engagement markers (Like, Comments, Shares). The media type has a statistically significant effect on all markers ($p<0.001$), followed by the Bonferroni adjustment. We extend this analysis by performing negative binomial regression on the data. As the standard deviation of our interaction parameters is higher than the mean (Table 6, Appendix), the data is not normally distributed. We thus perform negative binomial regression and use the Incident Rate Ratio (IRR) [12, 51] that allows comparing the change in the engagement parameters' values (likes, shares, and comments) for the content types (photo, videos, text). Additionally, the IRR represents the relative difference in the incidence rate of a given engagement parameter compared to the reference variable. For instance, in Table 1, the IRR of 'likes' for COVID-19-related photos is 2.66, with the media type 'link' used as a reference. Such IRR means that the incidence rate of 'likes' for a COVID-19 related post featuring a photo is 2.66 times higher than for a COVID-19 related post featuring a 'link'.

Table 1: Effect of media type on Likes, Shares, and Comments. All values are statistically significant with $* = p < 0.001$. IRR values and standard errors are reported with comma separation.

	Likes		Shares		Comments	
Type	COVID-19	non-COVID-19	COVID-19	non-COVID-19	COVID-19	non-COVID-19
Live Video	2.22*, 0.03	1.91, 0.03*	1.56*, 0.03	1.86*, 0.03	3.95*, 0.03	4.42*, 0.03
Native Video	3.21*, 0.02	1.11*, 0.023	3.19*, 0.02	1.56*, 0.023	1.43*, 0.02	0.85*, 0.023
Photo	2.66*, 0.02	1.17*, 0.023	1.07*, 0.02	0.71*, 0.023	0.76*, 0.02	0.69*, 0.023
Status	12.90*, 0.3	6.18*, 0.03	6.28*, 0.3	3.16*, 0.03	11.94*, 0.3	5.078, 0.03
Video Link	2.10*, 0.16	2.32*, 0.02	1.87*, 0.16	2.12*, 0.02	1.82*, 0.18	1.99*, 0.02
YouTube	0.18*, 0.42	0.67*, 0.09	0.10*, 0.42	0.36*, 0.09	0.19*, 0.42	0.39*, 0.09
Log-Liklihood	−2.6e5	−3.13e5	−2.0737e5	−2.5535e5	−1.9794e5	−2.8521e5



(a) Message count in each category. (I)nformational messages, (T)ips and (D)iscussions are shared most.



(b) Change in the number of people who like a Facebook page over the year, the change is higher for health related pages.

Figure 1: a) Collected Messages and User Numbers. b) Change is number of followers on health department and political figures Facebook pages.

Table 1 shows the effect of media type on the number of comments, likes, and shares as compared to the 'link' media type for our entire dataset. Both COVID-19 and non-COVID-19 data show a consistent effect of the media type on the engagement parameters. The incidence rate of 'comments' ($IRR > 11$), 'likes' ($IRR \geq 12$), and 'shares' ($IRR > 6$) for 'status' (text-based posts) in COVID-19 category is much higher than for 'link' posts. Media-rich content such as 'native video' and 'photo' shows a much lower incidence rate for all engagement parameters than the 'status' type. We notice that COVID-19 posts show a much higher engagement disparity across content types than non-COVID-19 posts for all three engagement parameters. Moreover, previous studies show a negative correlation between media richness and user engagement [14]. However, our results only partly confirm these studies. According to Table 1, plain-text statuses generate much more engagement than more media-rich content such as videos.

However, we show an essential distinction between live videos and other video uploads on Facebook. Live videos get significantly more comments than regular video uploads [59] that are not necessarily streamed in real-time. This observation potentially suggests an analogy of live video streaming to a face-to-face meeting [38].

4.2 RQ2: Content Topic and Engagement

We address the question of topic-related engagement at 2-level granularity. We compare the engagement related to COVID-19 posts with non-COVID-19 posts, before delving into the details of the COVID-19 posts.

4.2.1 COVID-19 and Engagement. We evaluate the engagement difference for COVID-19 post to the non-COVID-19 post on our three engagement markers. All our engagement markers have a lower incidence rate for COVID-19-related posts than its counterpart. COVID-19 related posts get 0.61 times the likes, 0.59 times the shares and 0.35 times the comments as compared to those of non-COVID-19 related posts, which can be explained by the number of periodic posts for situation updates, leading to a lower engagement of citizens. We notice that comments have a significantly lower incidence rate for COVID-19 posts, showing a lower level of direct citizen interaction.

Table 2: Effect of content type, using Tools and Technology (TT) as a reference, where statistically significant with $* = p < 0.001$. and IRR values and standard errors with comma separation.

Type	Likes	Comments	Shares
Policy Update (P)	5.45*, 0.1	4.17*, 0.1	5.6*, 0.1
Co-Use (C)	6.6*, 0.1	5.06*, 0.1	7.03*, 0.1
Situational Awareness (S)	1.90*, 0.04	0.76*, 0.04	0.82*, 0.04
Discussions (D)	8.68*, 0.05	5.46*, 0.05	5.13*, 0.05
Tips (T)	3.59*, 0.05	0.838, 0.05	3.05*, 0.05
Informational (I)	4.04*, 0.04	2.14*, 0.04	3.19*, 0.04
log-likelihood	$-2.6e5$	$-2.0e5$	$-2.1e5$

4.2.2 COVID-19 Topic and Engagement. Now, we look at engagement based on our COVID-19 content-topic as described in Section 3. We only use the COVID-19 related posts for this analysis as our categories are solely based on crisis-related topics. We use the labelled data to train a deep learning model and build a classifier to categorise the rest of the COVID-19 related data. We use the SOTA pre-trained HuggingFace transformers library to build a multi-lingual classifier [26], and hence classify our data. Next, as a similar approach in RQ1, negative binomial regression evaluates message content's effect on the engagement parameters. Table 2 shows the IRR for each content type using Technology and Tips (TT) as a reference.

Remarkably, situational awareness messages have a lower incidence rate for the number of likes and shares, while situational awareness and tips have a lower IRR for the number of comments. We notice a significant effect of the content topic on the engagement parameters. Citizens are more likely to comment, thus showing their opinions on posts that explicitly request citizen feedback (discussions), government policies, and broader topics encompassing COVID-19. Noticeably, citizens react more passively to health tips and daily updates. Most messages involving situation awareness are periodic (daily or weekly); they elicit fewer likes and shares than the other categories. Finally, technological tools result in a low number of comments, likes, and shares, consistently with the relative lack of success in tracking applications.

4.3 RQ3: Page Specific Analysis

Finally, we compare: 1) posts from country leaders and government health departments for media richness and 2) content-topic relative engagement between both types of accounts. Users who like or follow a page can do it for different reasons. For instance, a particular leader's Facebook page's following could be motivated by a partisan or political interest. However, the health-related page followers may have other motives than purely political. We expect citizens to respond differently to similar content posted on each page. We finally compare these pages for each country to derive country-specific communication patterns.

4.3.1 Media Richness and Engagement. We display the IRR of the engagement parameters depending on the content type in Tables 3 and 4 for leaders and health departments, respectively. Leader pages (Table 3) show consistent results with what we observed for the entire dataset. Likes, shares, and comments have a significantly higher incidence rate for statuses than links. Richer media displays lower engagement. The IRR shows that if other parameters are kept constant, text-based messages will average almost four times more comments, likes and shares than photo messages in COVID-19 related messages. Similar to the entire dataset, our engagement parameters' incidence rate is more homogeneous among content types for non-COVID-19 posts. In terms of the health department pages (Table 4), this trend does not hold. The status messages show a lower engagement than media-rich content such as photos and videos. Likes, comments, and shares have a much higher incidence rate for video and photo content as compared to link content. Native videos get a higher number of likes and shares in COVID-19 categories. However, live videos get more comments than the native videos in both COVID-19 and non-COVID-19 categories.

We notice that live videos generate three times more comments than photos and two times more than native videos, but fewer likes and shares. We then compare the incidence rate of likes, shares, and comments for the health departments' pages while using the leader's page as a reference. Our results are statistically significant and show that health-related pages are likely to get about 0.45 times the likes, 0.46 times the shares, and 0.13 times the comments on their COVID-19 posts compared to the leaders' pages. Comments have an incidence rate almost ten times lower for health departments' COVID-19 posts than leaders' COVID-19 posts. Regarding non-COVID-19 posts, health departments' pages display a significantly lower engagement than the leaders' pages, with about 0.05 times the likes, 0.11 times the shares, and 0.03 times the comments. Such an observation suggests that users primarily follow health departments' pages for COVID-19 related posts, while they are significantly more interested in other topics discussed by the country leaders. The key reasons for the above differences in engagement between leaders' posts and health departments' posts can be explained as follows:

(1) Live videos get higher comments for health department pages. We believe that this is embedded in the live video broadcast modality on Facebook. In general, live videos on Facebook are a broadcast medium where the broadcaster streams in real-time. However, the users on the viewing end are not part of the video broadcast, and the comments are the only real-time functionality available to the users to interact. This is also visible in the Facebook design; comments during the live video stream are tagged with the timestamp in the

Table 3: IRR for likes, shares, and comments with respect to the content type for country leaders' posts, using "link" content type as a reference: statistically significant with $* = p < 0.001$; IRR values and standard errors with comma separation. The engagement parameters have a higher incidence rate for text-based messages (status) than richer media such as videos and photos.

	Likes		Shares		Comments	
Type	COVID-19	non-COVID-19	COVID-19	non-COVID-19	COVID-19	non-COVID-19
Live Video	1.11, 0.07	1.56*, 0.04	0.91, 0.07	1.51*, 0.04	2.83*, 0.07	3.60*, 0.04
Native Video	1.38*, 0.05	1.28*, 0.03	1.49*, 0.05	1.78*, 0.03	1.06, 0.05	0.99, 0.03
Photo	2.26*, 0.05	1.94*, 0.03	0.85*, 0.05	1.11*, 0.03	1.22*, 0.05	1.17*, 0.03
Status	8.54*, 0.06	4.70*, 0.03	3.68*, 0.06	2.42*, 0.03	6.57*, 0.06	3.88*, 0.03
Video Link	3.60*, 0.4	1.94*, 0.23	2.88*, 0.4	1.79, 0.23	2.56*, 0.4	1.68, 0.23
YouTube	0.96, 0.3	1.85*, 0.2	0.18*, 0.3	1.13, 0.2	0.53*, 0.3	1.24, 0.2
Log-Liklihood	−.57e5	−2.0e5	−4.6e4	−1.7e5	−4.8e4	−1.7e5

Table 4: IRR for likes, shares, and comments with respect to the content type for health departments' posts, using "link" content-type as a reference: statistically significant with $* = p < 0.001$; IRR values and standard errors with comma separation. Higher media richness leads to higher engagement.

	Likes		Shares		Comments	
Type	COVID-19	non-COVID-19	COVID-19	non-COVID-19	COVID-19	non-COVID-19
Live Video	4.01*, 0.04	3.03*, 0.1	3.00*, 0.04	4.48*, 0.1	6.86*, 0.04	8.7*, 0.1
Native Video	5.99*, 0.03	1.22*, 0.04	6.98*, 0.03	2.08, 0.04*	2.82*, 0.03	0.5, 0.04*
Photo	4.16*, 0.03	1.57, 0.04*	2.06*, 0.03	1.72, 0.04*	1.12*, 0.03	0.5, 0.04*
Status	0.35*, 0.1	1.90*, 0.2	0.41*, 0.1	1.14, 0.2	0.26*, 0.1	0.7*, 0.2
Video Link	0.15*, 0.2	0.21, 0.6	0.13*, 0.2	0.32, 0.6	0.27*, 0.2	0.3, 0.6
YouTube	0.27*, 0.04	3.04*, 0.1	0.20*, 0.04	0.52*, 0.1	0.46*, 0.04	0.43*, 0.1
Log-Liklihood	−2.1e5	−1.0e5	−1.6e5	−8.5e4	−1.4e5	−2.0e5

video. Users use the comments to provide feedback or ask questions in real-time.

(2) Richer media gets higher engagement for health department posts, while text-based messages show a higher engagement for country leaders. Health departments worldwide tend to communicate primarily through photos and videos, while country leaders primarily use text-based posts. Such a disproportion may explain our results, as leaders and health departments may focus on content with a higher engagement. At the same time, citizens may also be more engaged with the type of content they expect to find on a given page.

(3) COVID-19 posts get more engagement than non-COVID-19 posts for health department pages compared to leaders pages. Overall, people tend to follow health department pages for health-related reasons, while they follow country leaders for a more general agenda. With COVID-19 being a significant health-related event, citizens are expected to interact more on the topic on health-related pages.

4.3.2 COVID-19 and Engagement. We then compare the engagement for COVID-19 related posts to non-COVID-19 posts for country leaders and health departments. We use IRR for 'likes', 'shares', and 'comments' based on the page type (leader and health department). The data is normalized based on the number of followers each page has. We use non-COVID-19 posts as a baseline for comparison. For COVID-19 posts by country leaders, we notice a sharp decrease in all three engagement markers' incidence rates compared to non-COVID-19 posts. Leader pages get 0.63, 0.65 and 0.66 times the likes, shares, and comments they would get on non-COVID-19 posts. On the other hand, the incidence rate of likes, shares and comments is significantly higher for COVID-19 posts posted by health departments than non-COVID-19 posts. Such an increase is especially noticeable for likes, which have an incidence rate more than six times (6.29) higher for COVID-19 posts. IRR for shares and comments is 2.67 and 2.66 times compared to non-COVID-19 posts for health-related pages. This result confirms our findings from the

previous subsection, where we noted a wider discrepancy in engagement between country leaders' pages and health departments' pages for non-COVID-19 posts than for COVID-19. All of these results are statistically significant, $p < 0.05$.

Next, we compare the engagement across the leader and health-related pages for COVID-19 related engagement. We use the leader page as the baselines and measure the likelihood of getting likes, shares, and comments on the interaction parameter to compare the reach of sharing COVID-19 content on a leader's page to posting a COVID-19 message on a health-related page. Our results are statistically significant with p< 0.05 and show that health-related pages are likely to get about 0.45 times the likes, 0.46 times the shares, and 0.13 times the comments on their COVID-19 posts compared to leader pages COVID-19 posts. There is less difference in IRR for the comments on COVID-19 related posts. In terms of non-COVID-19 posts, the difference in IRR is even more significant. Health-related pages are likely to get about 0.05 times the likes, 0.11 times the shares, and 0.03 times the comments on the posts compared to leader pages on non-COVID-19 related posts. It suggests that COVID-19 related posts have received more interest on the health pages than other posts

4.3.3 Region-Specific Analysis. Leaders and health departments across our dataset show distinct behaviour in social media sharing and focus. COVID-19 represents more than 70% of Hong Kong and Taiwan posts, between 60 and 70% in France and India, 50-60% for New Zealand, Spain, Canada, Columbia, South Korea, and Australia and 40-50% for Brazil, UK, Italy and Peru. Pakistan, the USA, and Turkey are the last three. However, the absolute number of posts in the US is higher than in other regions. Further analysis within each country shows that health-related pages are more active than leaders' pages on COVID-19. Thus, we compare social media usage and engagement within each region independently. We compare the leader's page and the health department's page to see the efficacy of niche-oriented pages and the content type within each country. 'Photo' and 'video' both combined make more than 50 percent of the content on health related pages across all countries, with 'photo' being the most used and 'video' as the 2^{nd} most used content type.

For leaders' pages, content type preference is not consistent across the countries. The top three content choices are 'video', 'photo', 'text'. However, the most used content type varies from country to country. For instance, Hong Kong's leader has more photos while India's leader has more text-based messages than other media types. The health-related pages display a higher engagement for 'photo' and 'video' media types. The lack of text-based status messages limits the confirmation of the overall pattern. In terms of videos, 'live video' gets more comments. However, the overall 'likes' and 'shares' are higher for 'native video' and 'video' types. It is also interesting that 'YouTube videos get lower engagement than other videos.

As displayed in the previous sections, the health departments' page is more active for COVID-19 communication than the leader's page. We show the number of COVID-19 related posts and the distribution of content topics per day for Australia in Figure 2. [2] We use the stacked distribution of topical content from each day for 11 months. The right y-axis shows the daily number of cases, with a black dotted line plot. the left y-axis shows the number of COVID-19 related messages per day on the mentioned page, represented by the stacked bars. The Turquoise line represents the user engagement based on per 1000 thousand followers of the page.

The results show that even though both health departments' and leader's pages posted about COVID-19 before the peak in each country, engagement only started to increase with the number of COVID-19 cases in all countries. The leader's pages are more focused on Policy updates; however, the health departments are more focused on COVID-19 tips and situational awareness. This also aligns with our Pearson's correlation test on the number of users who likes any particular page with the frequency of COVID-19 related posts. However, Pakistan and New Zealand have a lower correlation for health-related pages, which can result from a massive increase in the community for those pages. However, the correlation is inconsistent across countries affected by lesser communications from certain accounts. For instance, Peru's leader has very few posts on COVID-19, resulting in a lower correlation score. However, for most pages, the results show a positive correlation.

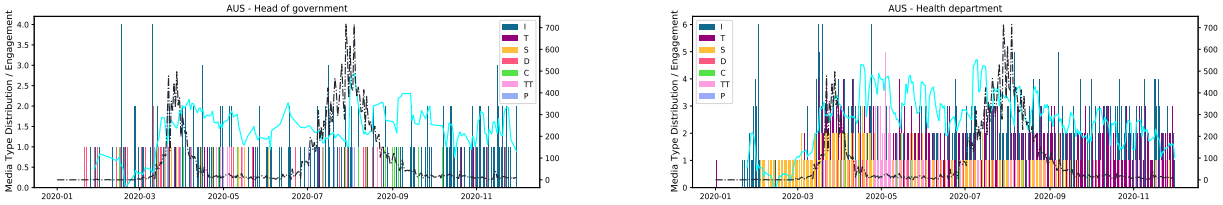
4.3.4 Role of the Health Department. Health-related departments were more proactive than the head of state. In our dataset, we have the number of users who like a given page at the time of a given post. We first look at the change in the number of users that like the page from the first post in the year 2020 until the last post in our dataset for that page. Figure 1b shows the number of changes for both leader and health page in a given country. Additionally, in all of the countries in our data sample, the health-related departments were the first ones to post anything regarding COVID-19, as shown in Figure 2 for Australia. [2] There is at least one week difference between the health department and leader's page COVID-19 related post. Our analysis also shows that most of the countries posted in January 2020 about COVID-19 (it was named COVID-19 later), in reference to Wuhan province in China and mentioned that they are monitoring the situation. This shows the countries used social media for COVID-19 communication even before the COVID-19 cases appeared.

Overall, we see significant differences in content type and topic in both kinds of pages within each country. The health-related pages use videos and photos more frequently than any other type in terms of media types. In some regions, live videos have been used widely by health-related pages. The proportion of status messages to the other media types is relatively low on health-related pages. Health-related pages got significantly larger responses to their COVID-19 posts than non-COVID-19 posts. However, this difference is not as large as in the case leader's pages. Health-related pages observed a larger change in the number of users who liked the page than country leaders; in addition, the health departments' page is more active for COVID-19 communication than the leader's page.

5 DISCUSSION AND CONCLUDING NOTES

This paper provides a comparative analysis of the use of social media by the governments in terms of content type and topic related to COVID-19. We look at the leader's and the health-related Facebook page communications and evaluate the posts' engagement on these pages. We analyze the citizen engagement against the content

[2]The figures for the 16 other countries and regions can be found at https://github.com/ehsanulhaq1/tips_tech_tidings/blob/main/supplementary.pdf



(a) Australia - Govt. **(b) Australia - Health Dept.**

Figure 2: Per day content distribution (number of posts (left axis)) along with the COVID-19 spread (Black dotted line, right y-axis) and normalised average engagements score for all per day (Turquoise left y-axis).

types (photo, video, text) according to their richness and content categories (the theme of the message).

The governmental and official communications on social media have been studied in terms of the government strategies to disperse information regarding COVID-19 [19, 20, 53, 67].Our results supplement such findings by highlighting the confounding factors for higher engagement on social media. We list the seven key highlights that are important for effective communication in terms of better engagement: **1)** Higher media richness does not necessarily attract more engagement. Plain text messages have a higher engagement than all other content types. **2)** Live videos maintain a high engagement and, more particularly, a high incidence rate of comments. **3)** COVID-19-related posts display a lower overall engagement than non-COVID-19 posts. **4)** Among COVID-19 posts, Discussions (D) and Co-Use of COVID-19 with other topics (C) get the most engagement. **5)** Plain text status messages lead to a high engagement for country leaders, while Health Departments' pages have higher engagement on live videos. **6)** Both Health department pages and country leaders share primarily content that gets little engagement (photos, videos). In contrast, live videos (high engagement for health department pages) and plain-text status (high engagement for country leaders) are underrepresented. **7)** Health Department pages display a much higher engagement for COVID-19 posts as compared to non-COVID-19 posts, as opposed to country leaders where non-COVID-19 posts have a slightly higher engagement.

5.1 Media Affordance

"The Medium is the message" is a term coined in 1964, long before the emergence of Web 2.0 and social networks [44]. Media carry the power to transform human actions. Web 2.0 not only gave rise to multiple media, for instance, social networking sites, online discussion forums, and messaging applications, but those media are also continuously evolving with ever-increasing affordances. In this work, we extend the efforts made to understand citizens' engagement in the government's (COVID-19) communications on Facebook. We take the content type as our primary variable to measure such response. Our results confirm previous studies' results about the negative correlation between higher media richness and citizen engagement. We suggest that live videos are effective tools for communication and discussion with citizens from a communication perspective. Our analysis of the data shows that different governments have used the live features to answer citizens' queries about COVID-19 or the policy updates (Figure 3, Appendix). Our results provide insight that in addition to the factors that may affect the social media adaptability within the institutions [63], the communication mode and characteristics should also be considered in the success of such platforms' adaptability.

5.2 Data-Driven Opportunities

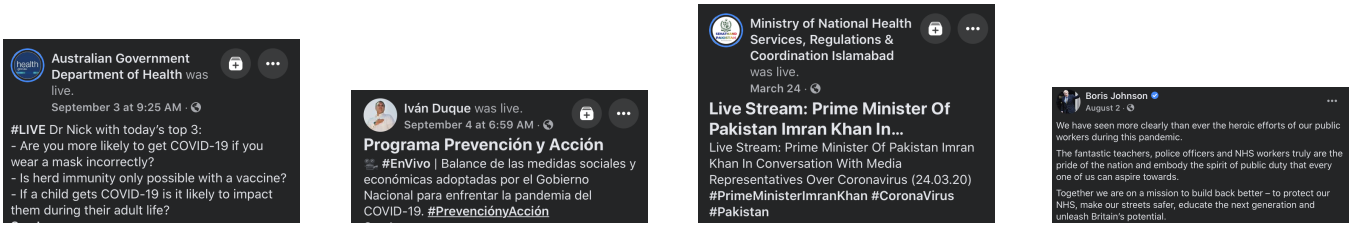
In our analysis, we look at the central entities in different countries and regions; however, the discussion around health-related topics can be more localized in nature and may vary depending on the demographics [34]. The text analysis in comments can provide a detailed analysis of users' opinions from diverse demographics. Our study shows that most of the discussions carried out by governmental accounts are general. However, these accounts tend to carry more dialogic components, such as '@' and 'URLs' in COVID-19 discussions. More sophisticated analysis, such as natural language processing (NLP) and network analysis tools applied against the use of certain hashtags, mentions, and websites, can provide deeper causal analysis [13, 30]. In parallel to opinion mining, our dataset shows that the video, which is one of the least effective types to get citizen engagement is also one of the most shared content types on these accounts. Governments need to understand user content consumption and engagement using historical data, to effectively communicate with citizens during a crisis.

5.3 Support for Inclusiveness

The Human-Computer Interaction (HCI) and Computer-Supported Co-operative Work (CSCW) research communities have focused on designing spaces that could incorporate factors such as inclusiveness, equality, and appreciation [18, 33, 55, 64]. In times of distress, leaders' social media presence and communication with the citizens can uplift people's well-being [4]. For instance, many leaders appreciated the front-line workers, particularly health staff, as shown in Figure 3d.

Alongside these appreciation posts, leaders shared news about economic relief and also rallied their communities for donations during the crisis. However, although these pages share information about donations funds, there are no proactive approaches to help those actions. For instance, Facebook has a feature for collecting donations and giving to charity[3]. We have not observed the governments using such functionalities in our data. We also note that

[3]https://www.facebook.com/business/learn/lessons/tools-to-connect-donations-on-facebook



(a) Australian health department using live stream to answer questions about COVID-19

(b) Colombian leader using the live stream to talk about the economic measures taken during COVID-19

(c) Pakistan's health ministry sharing a live stream of a press conference by the prime minister over COVID-19

(d) An appreciation message for different community groups

Figure 3: Use of Live Video Streams in Different Countries and Regions

such payment gateways have region-specific availability that might limit their usage. Leaders and departments should focus more on technological support to be more holistic in their approach. Overall, we note that social media is primarily used for its original goal: communication between the various stakeholders. Although social media platforms such as Facebook aim to become more pervasive by pushing other functionalities like fundraising, these functionalities are barely employed by governments.

5.4 Crisis, Communication Effectiveness, and Social Media Design

In recent years, many social media platforms included support for crisis control. Facebook has developed functionalities for crisis response[4], which allows users to mark themselves as safe in case of disasters. OSNs can control the propagation of factual information as compared to contradictory information [2] Another important consideration in social media design is the role of algorithmic rankings and content outreach. Political figures might not be able to reach certain groups of citizens who are possibly in a political echo-chamber. Such effect and mitigation during the crisis is an important future research direction.

Our study allows us to understand what type of official information is the most effective and, thus, what kind of information social media platforms may bring forward in a given cultural context. Direct communication, as it is in the case of live videos, may help overcome misinformation issues and can be explored by the research community. For instance, live video streaming has been effectively used to spread reliable information during the 2018 students' social movement in Bangladesh [1]. As such credible and relevant authorities can use social media to convey the correct information in a more direct way. Citizens increased interest and interactions with official social media during COVID-19 have been reported [54]. Our comparative approach shows that health department pages saw a significant increase in terms of their follower across the countries, suggesting the need for niche-oriented social media presence to be more trustworthy and goal-oriented.

[4]https://www.facebook.com/about/crisisresponse/

5.5 Limitation and Future Work

Our study presents several limitations that we aim to address in future works. This work only provides empirical evidence of engagement parameters such as likes, shares, and comments and does not evaluate the message's contents beyond the content categories. A future work based on comments analysis can help better understand citizens' responses [6]. Cautiously, engagement does not necessarily reflect effective communication. In some countries, the government channels may be able to manipulate the people's opinions [1], and citizens' understanding of online content might be biased due to local policies [42]. The underlying information in social media posts may contain content that can cause more harm than good, as was the case in India during COVID-19 [2]. A detailed analysis of such discourse can provide insight into the quality of information and its effects on society. Our sample of leaders also presents limitations. Most country leaders are political figures, and their following primarily relies on their partisan memberships, even though they represent the region at the time of analysis. As such, the content outreach from these leaders may be affected by the partisan preferences [62]. In future works, we will consider a larger sample of partisan leaders from more than one party to quantify better the effectiveness of political leaders' communication during the crisis.

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A DESCRIPTIVE STATISTICS

The Tables **??**– 6 show the collected data, statistics, and their classes, as described in Section 3.

Table 5: Number of COVID-19 related posts by each country

Account	COVID-19	non-COVID-19	Ratio
Turkey	269	1482	0.15
USA	2239	9210	0.20
Pakistan	988	2439	0.29
Brazil	1451	1709	0.46
UK	1444	1690	0.46
Italy	764	848	0.47
Peru	891	947	0.48
New Zealand	374	349	0.52
Spain	930	813	0.53

Account	COVID-19	non-COVID-19	Ratio
Canada	1285	1023	0.56
Colombia	1582	1240	0.56
South Korea	1038	808	0.56
Australia	1530	1043	0.59
India	3987	2563	0.61
France	1534	911	0.63
Taiwan	1592	664	0.71
Hong Kong	1220	308	**0.80**

Table 6: Descriptive statistics for Media type and Engagement Parameters

Media		Likes			Comments			Shares		
		Total	COVID-19	non-COVID-19	Total	COVID-19	non-COVID-19	Total	COVID-19	non-COVID-19
Nat. Video	Avg	20053.4	20322.3	19902.3	2351	1625	2758.9	4188.6	4070.1	4255.1
	STD.	63312.2	83158.3	48743	6171.2	4921.8	6738.7	14747	15485.7	14315.7
Photo	Mean	18736.6	16842.4	21074.1	1489	866.1	2257.7	1621.4	1368	1934.1
	STD.	72809.6	73798.9	71504	6322.5	3659.1	8468.6	7001.2	5937.2	8113.8
Status	Mean	103717	81694.7	110878	15782.3	13554.2	16506.9	8497.2	8022.7	8651.5
	STD.	139572.4	115131.3	145947.7	26786.4	24352.1	27496.6	17677.8	14681.4	18547.8
Live Video	Mean	26715.4	14049.7	34239.9	10682.7	4482.1	14366.2	3934.8	1994.5	5087.5
	STD.	47595.7	36706.3	51570.8	23729.6	10331.6	28247.9	9013.2	5404.7	10421.4
Video Link	Mean	25097.3	13266.2	41576.4	3910.9	2062.8	6485.1	3819.5	2395.7	5802.7
	STD.	49500.5	34376.9	61988.7	8103.2	4791.8	10788.1	9762.4	8192.5	11467.4
YouTube	Mean	2959.1	1155.8	11963.9	392.9	220.2	1255.4	267.6	125	979.7
	STD.	15839.9	5007.9	35890.6	1820.2	661.5	4107.2	1457.8	321.6	3416.9
Link	Mean	12573.8	6330.7	17946.3	2273.8	1135.2	3253.7	2060.6	1277.8	2734.2
	STD.	38227.8	28529.1	44234.4	5089.9	2621.3	6342.1	6807.2	4261.5	8344

Institutional Trust and Social Media Use in Citizen-State Relations: Results from an international cross country vignette study

Vincent Homburg
University of Tartu, Johan Skytte Institute of Political Studies, Lossi 36, 51003 Tartu, Estonia & Erasmus University Rotterdam, ESSB Department of Public Administration & Sociology, Burgemeester Oudlaan 50, 3062 PA Rotterdam, The Netherlands E:
vincent.homburg@ut.ee

ABSTRACT

The objective of this article is to identify whether trust affects citizens' use of social media to initiate conversations with government on social media platforms. Using a vignette survey, we gathered data from the Canada, Greece, the Netherlands and Paraguay. Multivariate analysis showed that controlling for demographics and individual-level adoption factors, trust in government does not impact citizens' use of social media to initiate conversations about public issues, but trust in social media business and organizational infrastructure is (both in democratic countries as well as in flawed democracies). These results highlight how trust in institutions affect citizens' engagement and digital participation, and identifies conditions under which social media platforms may contribute to a vibrant democracy.

KEYWORDS

social media, adoption, diffusion, citizen-state relations, trust, comparative study

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1 INTRODUCTION

Despite a growing conceptual and empirical body of knowledge on adoption of social media in citizen-state relations and on digital participation and citizen engagement, there are at least three gaps in the literature. The first one is that the majority of current literatures focus on why *government agencies* adopt social media for interaction with citizens [9, 12, 45], and, with few exceptions [17-19, 27], researchers are yet to empirically study why *citizens* adopt social media to publicly voice concerns on governments' social media accounts [30]. The second one is that many if not most studies focus on specific national contexts (be it Spain, Portugal, Germany, or Italy [3, 9, 14, 15, 45]) with results possibly being biased towards features of specific national contexts; comparative studies are notably absent in the literature. The third one, which is related to the second 'gap' in the literature, is that current adoption and diffusion studies predominantly focus on individual users' attributes (such as perceived usefulness, perceived ease of use) with above-individual attributes of institutions (including trust in institutions, [13, 31, 38]) being scarce.

This study addresses the abovementioned gaps in the academic literature by testing hypotheses regarding trust, democracy and citizens' intentions to initiate conversations with government on social media, using primary survey data that were gathered in Canada, Greece, The Netherlands and Paraguay (for an explanation of the case selection, refer to section three). The following research question is used: to what degree does trust in a country's institutions affect citizens' use of social media to initiate interactions with government, and what role does a nation's degree of democracy play?

We aim to contribute to the literature by comparing antecedents of citizens' adoption of social media in citizen-state relations in four countries in Europe and the Americas (with lower and higher democracy scores). We use a deductive, quantitative methodology to contribute to early stage theory formation.

The rest of this article is structured in the following manner. After a review of the literature on social media in state-citizen relations from the citizen's point of view, we develop hypotheses (section two). We discuss the overall research design, country selection, measurement issues and data gathering procedures (section three), which are at the heart of the presentation of results and data analysis (section four). We end the article with a discussion of the findings, suggestions for further research and an overall conclusion (section five).

2 CENTRAL CONCEPTS AND HYPOTHESIS DEVELOPMENT: UNDERPINNINGS OF A THEORY ON CITIZENS' ADOPTION OF SOCIAL MEDIA IN STATE-CITIZEN RELATIONS

2.1 *Definition of social media in citizen-state relations*

Social media can be defined as platforms on which users can distribute texts, pictures, videos, or URLs, and on which other users can

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rate ('like'), share or respond to ('comment') content [32, 42, 53]. When applied in relations between citizens and state actors, social media allow (1) authorities to disseminate information more dynamically than by posting messages on websites, and (2) citizens to express concerns and initiate public debate among fellow citizens and public authorities. In practice, nowadays, platforms are increasingly accessible through mobile apps. Although many platforms also enable one-to-one communication ('direct messaging'), in this study we focus on the many-to-many public communication functionalities of social media. Throughout the study, we focus on citizens' public expressions concerning public services quality issues citizens may be confronted with and that render contributors both eligible to recognition and praise and vulnerable to criticism (by fellow citizens, politicians, and officials). In doing so, we view social media both as an instrument that may potentially empower citizens and enable governments to listen to citizens' concerns, as well as an instrument that potentially exposes citizens' intentions and emotions and hence potentially makes citizens vulnerable (without citizens necessarily realizing this themselves at the time they are speaking up on particular topics).

2.2 *Hypotheses development: underpinnings of a theory on trust in institutions and adoption of social media citizen-state relations*

Meijer *et al.* [31] suggest that a sound citizen-state relation in which information is shared between citizens and state actors, requires trust. Notwithstanding intuitive appeal, the use in empirical studies of statements that refer to trust is complicated by the fact that trust is notoriously hard to define [13, 38]. In this study, we conceptualize trust as an attribute of a relation between actors A and B (where B can be an individual or institution, [20]), and define trust as A's expectation that B will not exploit A's vulnerabilities, while B has the power and ability to do so [38]. Trust has been identified as a precursor of adoption of electronic services by citizens generally [10, 11, 21, 24, 51]. More particularly, Homburg *et al.* found that in Chinese citizen-state relations, citizens' trust in individual officials was positively associated with citizens' adoption of social media platform Weibo for reaching out to government (which underlines the importance of densely knit personal *quanxi* relationships in China), whereas citizens' trust in government institutions was not significantly associated with adoption [20].

In the context of citizen-state relations, we identify two connotations of trust: (1) a citizen's *trust in government* where government is an institution that provides public services and creates public value [10, 11, 29, 53], and (2) *trust in the conglomerates of Internet Service Providers (ISPs), social media businesses and regulatory agencies that govern privacy and safety of transactions* [24, 41, 51]. Both forms of trust can be related to institutions: either trust in government as an public service provider that acts competently, fairly and responsively, or trust in the governance of organizations (ISPs, social network companies, regulators) that provide the required infrastructure and communication services for digital citizen-state interactions.

Based on these concepts we infer that the more citizens perceive that any risks resulting from initiating a discussion with government will not harm them, the more likely they are to actually use social media to voice concerns over public service issues they may be confronted with. This leads to the formulation of H1 and H2.

- H1: Controlling for other variables, the higher a citizen's trust in government, the higher the likelihood a citizen uses social media to address concerns or issues in citizen-state relations
- H2: Controlling for other variables, the higher a citizen's trust in social media technological and business infrastructures, the higher the likelihood a citizen uses social media to address concerns or issues in citizen-state relations

We define 'democracy' as a set of principles and practices that institutionalises and protects the people's voice in collective decision-making. Principles and practices include – but are not limited to – free, fair and competitive elections with which representation is established and representatives act in accordance to citizens' preferences, respect for basic human and minority rights, due process and equality before the law, and a government apparatus that is capable of implementing policies in accordance with political decisions made by representatives.

It has been argued that social media can have both positive and negative impacts on democracy, depending on whether social media empower ordinary citizens or political elites [35]. Best and Wade [8] found that there is a positive correlation between Internet penetration and democracy in countries across the globe, with the strength and sign of correlation displaying considerable variation across regions. We extend this finding to our line of reasoning by inferring that relations between trust and social media adoption will be stronger in democracies than in flawed democracies (hypothesis three).

- H3: Controlling for other variables, the relations between trust in government and trust in social media technological infrastructures will be stronger for citizens living in democracies than for citizens living in flawed democracies.

2.3 *Controls: demographics and adoption and diffusion variables*

We control for two types of variables: demographic variables and known individual-level adoption and diffusion variables (Table 1). Demographic variables are included based on previous e-government adoption studies [44, 50, 51], individual-level adoption and diffusion variables are included based on related studies of social media adoption in citizen-state relations in specific national settings [17-19].

3 RESEARCH STRATEGY AND MEASUREMENT ISSUES

3.1 *Questionnaire design and data gathering procedures*

Considering the deductive character of the research objective, we chose a *large-n* research design and opted for an online survey questionnaire to gather quantitative data among citizens living in various countries around the world. The research question necessitates a comparison of survey data gathered in democratic and countries with various degrees of democracy. We selected four countries in Europe and the Americas with similar population sizes,

Table 1: control variables

Group	Variable	Definition
Demographic and personal attributes	Gender [44, 50, 51]	Characteristics of men and women one identifies with most
	Age [44, 50, 51]	Difference between now and one's birthyear
	Education [44, 50, 51]	Highest level of education (primary, secondary, tertiary) one has completed
Individual level adoption and diffusion variables	Perceived effectiveness [10, 24, 41]	One's a belief that posting a message about an issue on social media will help solving a problem that specific citizen is confronted with
	Ease of Use and Skills [10, 11, 41]	Perceived efforts it takes to post a message about an issue on social media
	Social Influence [11, 20, 21, 24, 40, 41, 50]	Degree to which a citizen perceives that important others believe he or she should use social media to speak up
	Fear of consequences [20, 22, 26, 49, 54]	A citizen's general feelings of anxiety that result from consequences that are beyond the control of that particular citizen

Table 2: country selection, based on the Economic Intelligent Unit's democracy index

COUNTRY	POPULATION SIZE	DEMOCRACY SCORE	REGIME TYPE
Canada	38 million	9.15	Democracy
Greece	10 million	7.29	Flawed democracy
Netherlands	17 million	8.89	Democracy
Paraguay	7 million	6.24	Flawed democracy

and used the Economist Intelligent Unit's 2018 democracy index [1, 16] to select one country that qualifies as a full democracy and one country that qualifies as a flawed democracy per continent, under the condition that data gathering was possible. This led to the selection of Canada, Paraguay, the Netherlands and Greece (Table 2).

Within each country, we contracted Qualtrics to distribute an online questionnaire to a target population of above-eighteen year olds. The original questionnaire was drafted and tested in the English language (and used for the Canadian questionnaire). For use in the various target populations, the questionnaire was translated into Spanish, Dutch and Modern Greek for use in Paraguay, the Netherlands and Greece, respectively. The data were gathered in the summer of 2020.

3.2 *Measurement of social media in citizen-state: the pothole vignette*

The country selection yields challenges with respect to the measurement of especially the dependent variable (use of social media in citizen-state relations). As public tasks may vary from country to country (with medical insurance, local tourism marketing and water sanitation being examples of services that may be produced by public sector in one country and by markets in other countries), as may devolution of public tasks within a country, the use of *generic* items like "I would use social media to report complaints to the government 1=totally disagree 5=totally agree" is prohibitively problematic as respondents may interpret the notion of 'government' differently across various countries in the country selection, or even within those countries. In a similar fashion, different countries may display various sensitivities (gun control, Royalty, racial inequality, pro-life/pro-choice debates, for instance) that renders any analysis difficult when not controlled for in the analysis of responses. Steiner, Atzmüller and Su argue that in these circumstanced, the use of vignettes is called for. Vignettes are systematic descriptions of situations that are presented to respondents to elicit beliefs, attitudes or intended behaviors with respect to the situations presented in the description. Vignettes can be used in comparative research to control for local variations of situational content, and responses are less likely to be affected by social desirability than in regular questionnaires [48, 52].

In our study, we presented respondents with a vignette in which a neutral and general public issue was presented to respondents [4]: protagonist Trudy is confronted with a pothole in a public road [2, 36, 37, 43] and uses social media to speak up about the pothole under his or her own name (that is, he or she does *not* react anonymously; see Appendix A for the vignette) [17-19]. The items measuring the respondent's prospective behavior (''I would do the same as Trudy did", ''I would have also posted a message on the agency's social media page" and ''I would have done the same as Trudy did when confronted with the same situation") were used as a

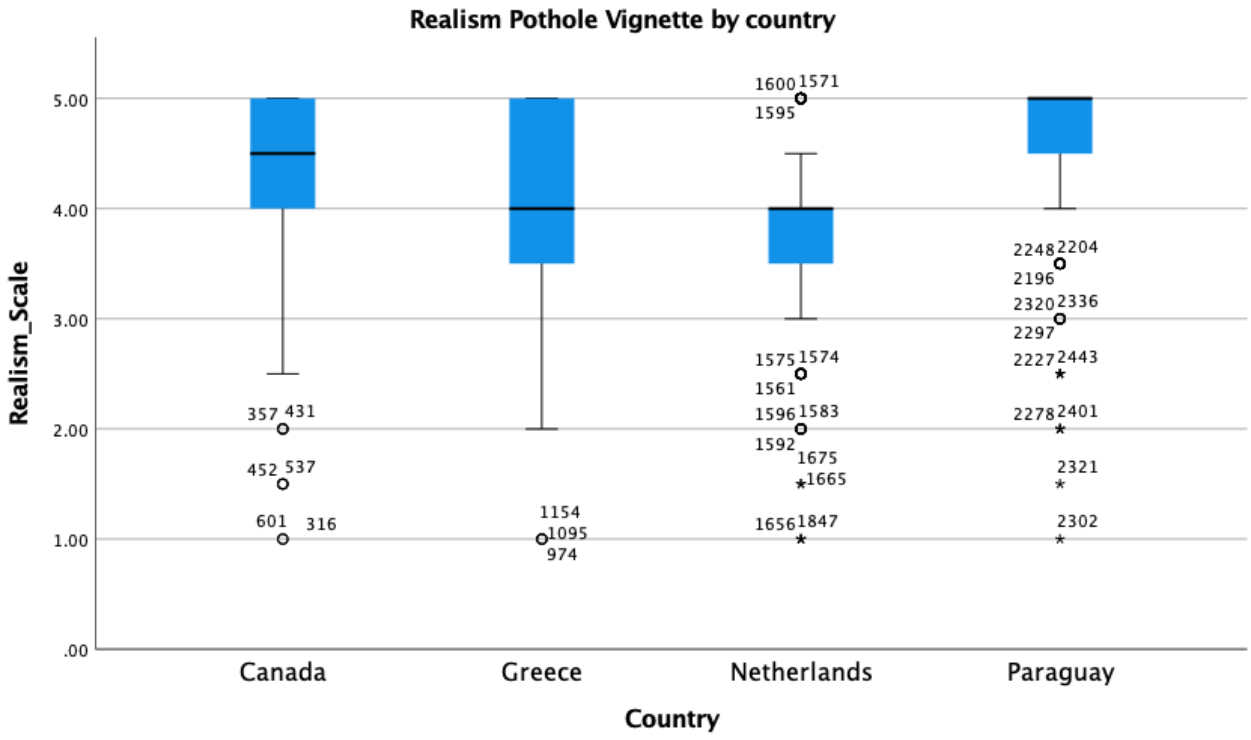


Figure 1: Vignette realism score by country

proxy for respondents' actual social media adoption behavior, being the dependent variable in this study. Additionally, two items ("the situation is realistic"' and "I can imagine this situation happening to people") measured the perceived realism of the vignette [34, 46] for validation purposes. The resulting two-item, 1-5 realism scale (Cronbach's alpha = .811) resulted in satisfactory realism scores (overall mean realism score M = 4.23, SD = .81) for respondents from all four countries (Figure 1).

3.3 *Measurement of independent variables*

Performance expectancy, ease of use, social influence, fear of consequences trust in government and trust in social media organizational and business infrastructure were measured with existing yet slightly contextualized Likert items to make a good fit with the context of social media use in citizen-state relations (see Appendix B for details).

3.4 *Data screening and brushing up procedures*

Data were screened for usability prior to conducting any statistical analyses. Case screening resulted in the discovery of zero variance in the responses of one Greek, three Dutch and two Paraguayan respondents (which suggests unengaged response behavior), on the basis of which the data of these respondents were removed from the data set. We did not identify any obvious outliers in age. Variable screening did not result in the discovery of missing values. In total 1215 useful observations could be recorded in the dataset.

3.5 *Scale construction: exploratory factor analysis and reliability analysis*

As there is scarce existing empirical research on social media in citizen-state relations in a global context, and to discover the underlying structure of the measured items, we carried out a factor analysis (principle component analysis with varimax rotation). As many items showed a correlation of at least .3 within at least one other item, factorability was assumed.

The KMO measure for sampling adequacy was .872 (well above the required minimum of .6) and Bartlett's test of sphericity was significant (χ^2 (300) = 19387.98, p < .0001). All communalities were above .3, which further confirmed that each item shared at least some common variance with at least one other item. Based on these considerations, factor analysis was deemed to be suitable with all items. In the course of the exploratory factor analysis with Varimax rotation, a simple seven factor structure could be realized with which 75.7% of total variance could be explained. Reliability of the items loading on specific factors was checked and this resulted in satisfactory results (all Cronbach's alpha levels above .7). Results of the factor analysis and results of the reliability tests of the constructed scales is reported in Table 3.

3.6 *Common method bias*

As any single source survey study, the methodology used in this study brings with it the risk of common method bias [39]. As the total variance in the unrotated principal component analysis of all Likert items in the data set accounted for only 26,7% of all

Table 3: factor analysis and reliability results Canada, Greece, Netherlands, Paraguay (n = 1215)

	1	2	3	4	5	6	7	Cronbach's alpha
PE1	.810							.902
PE2	.816							
PE3	.853							
PE4	.845							
EoU1		.852						.918
EoU2		.836						
EoU3		.867						
EoU4		.770						
FC1		.792						
FC2		.858						
TiG1			.858					.921
TiG2			.895					
TiG3			.914					
TiG4			.895					
T1				.803				.897
T2				.848				
T3				.854				
T4				.815				
SI1					.808			.861
SI2					.839			
SI3					.786			
FoC2						.786		.737
FoC4						.835		
FoC6						.797		
V1Road1							.887	.924
V1Road2							.849	
V1Road3							.891	

variance, we concluded that none of the factors explain the majority of variance and that common method bias was not likely to have occurred during the data gathering.

4 RESULTS

4.1 Descriptive statistics: demographics

More than half of respondents (54.7%) identified with the male gender, and ages ranged from 20 to 87 (males: $M = 41.2$, $SD = 15.8$; females: $M = 39.3$, $SD = 15.0$). The highest level of completed education was elementary school for 1.9% of respondents, secondary education for 32.3% of respondents and postsecondary (college or university) for 65.8% of respondents. Education was dummy coded (0 = primary or secondary education, 1 = tertiary education). Details of demographics are reported in Table 4.

Mean scores of responses to vignettes are also depicted in Figure 2. The scores measure the degree to which respondents in various countries indicate that they would have reported a pothole using social media under her or his own name.

4.2 Hypothesis testing

4.2.1 Model Assumptions. In order to test the hypothesis we used OLS multiple linear regression. Before the actual regression was implemented, we checked the following model assumptions for multiple regression analysis. Multicollinearity was checked by inspecting the correlations of the independent variables and by inspecting the variance inflation factor (VIF) values of each independent variable. As none of the correlations are above .7 and all VIFs were below 4, this assumption is met. Homoscedasticity was checked using a scatter plot of standardized residuals and predicted values; no anomalies were found. Independent errors were checked using the Durbin-Watson statistic, and the value of 1.860 revealed no problems associated with this assumption. The assumption of normally distributed errors was tested via the inspection of unstandardized residuals. Inspection of the Q-Q plots revealed a relatively normal distribution, and we concluded that this assumption was also met.

4.2.2 Main effects per country. In Table 5 the results of four separate multiple regression analyses (with unstandardized, non-centered scores on social media use in four vignettes as dependents, standardized coefficients) are summarized. Overall, results indicate that social media adoption is explained by perceived effectiveness (Canada, Greece, the Netherlands but not in Paraguay), ease of use (Canada and Paraguay, but not in Greece and not in the Netherlands), social influence (Paraguay), and trust in social media business and organizational infrastructure (all four countries), but not by trust in government (no country).

Using these data, it is possible to test hypotheses 1 and 2.

Table 4: mean scores of variables by country, standard deviations in parentheses

	Canada (n = 309)	Greece (n = 308)	Netherlands(n = 300)	Paraguay (n = 298)	Combined (n = 1215)
Gender (1 = female)	.62	.45	.32	.42	.45
Age	50.65 (14.7)	34.10 (10.3)	45.08 (17.17)	31.27 (9.58)	40.33 (15.4)
Education (1 = higher)	.74	.69	.45	.74	.65
Social Media Use (pothole)	3.40 (1.12)	3.92 (.91)	3.03 (1.09)	4.27 (.83)	3.65 (1.10)
•					
1. Perceived effectiveness	2.52 (1.02)	3.15 (.98)	2.79 (.94)	2.86 (1.10)	2.83 (1.04)
2. Ease of use	3.96 (.86)	4.54 (.59)	3.98 (.77)	4.49 (.74)	4.24 (.79)
3. Social influence	2.34 (1.05)	2.74 (1.05)	2.54 (.90)	2.96 (1.16)	2.64 (1.07)
4. Fear of consequences	2.78 (.91)	2.77 (.91)	2.78 (.79)	2.60 (.99)	2.73 (.90)
5. Trust social media organizational and business infrastructure	2.48 (.99)	2.95 (1.00)	2.68 (.90)	3.18 (1.04)	2.82 (1.02)
6. Trust in government	3.21 (1.09)	2.68 (1.03)	3.25 (.89)	2.12 (1.01)	2.82 (1.11)

A significant regression equation was found to predict social media adoption in each of the four countries, with trust in government not significantly predicting social media adoption (Canada: ß= -0,036, p = n.s.; Greece ß= 0,106, p = n.s.; Netherlands ß= - 0.107, p = n.s.; Paraguay ß= -0,051, p = n.s.). Therefore, hypothesis one receives no support. Trust in social media business and organizational infrastructure significantly predicted social media adoption (Canada: ß= 0.262, p < 0,001; Greece ß= 0,135, p < 0,01; Netherlands ß= 0,208, p < 0,001; Paraguay ß= 0,225, p = 0,001), providing support for hypothesis two.

4.2.3 Testing of mediation by democracy. In order to test hypothesis three, we dummy-coded DemocracyDUMMY (0 for flawed democracies Greece and Paraguay, 1 for democracies Canada and the Netherlands) and regressed mean centered significant predictors and an interaction term. As no significant impact of the interaction term was observed, hypothesis three received no support: obviously, the significant impact of trust in social media business and organizational infrastructures was not stronger in democracies than in flawed democracies (Table 6 and Figure 3).

5 DISCUSSION AND CONCLUSIONS

Around the world, public authorities have embraced a 'government 2.0' rhetoric [5, 7, 31] and have been looking for possibilities to reach out to citizens, foster transparency and boost responsiveness. Technological opportunity in the form of social media platforms has enabled especially local governments to actually realize this vision and since about a decade, governments' presence on social media platforms is hard to ignore [3, 9, 14, 15, 44]. Until date, scarce studies are available that go beyond using secondary data and use metrics to explain citizens' adoption of social media to interact with public authorities. This study can be seen as one of the first studies that develops and tests citizens' social media adoption theory using data from respondents from around the globe. Findings indicate that trust in Internet providers and social media businesses, perceived effectiveness, ease of use and social influence are conducive to citizens using social media to interact with public authorities, whereas trust in government was not found to be significantly related to citizens' use of social media in citizen-state relations. The

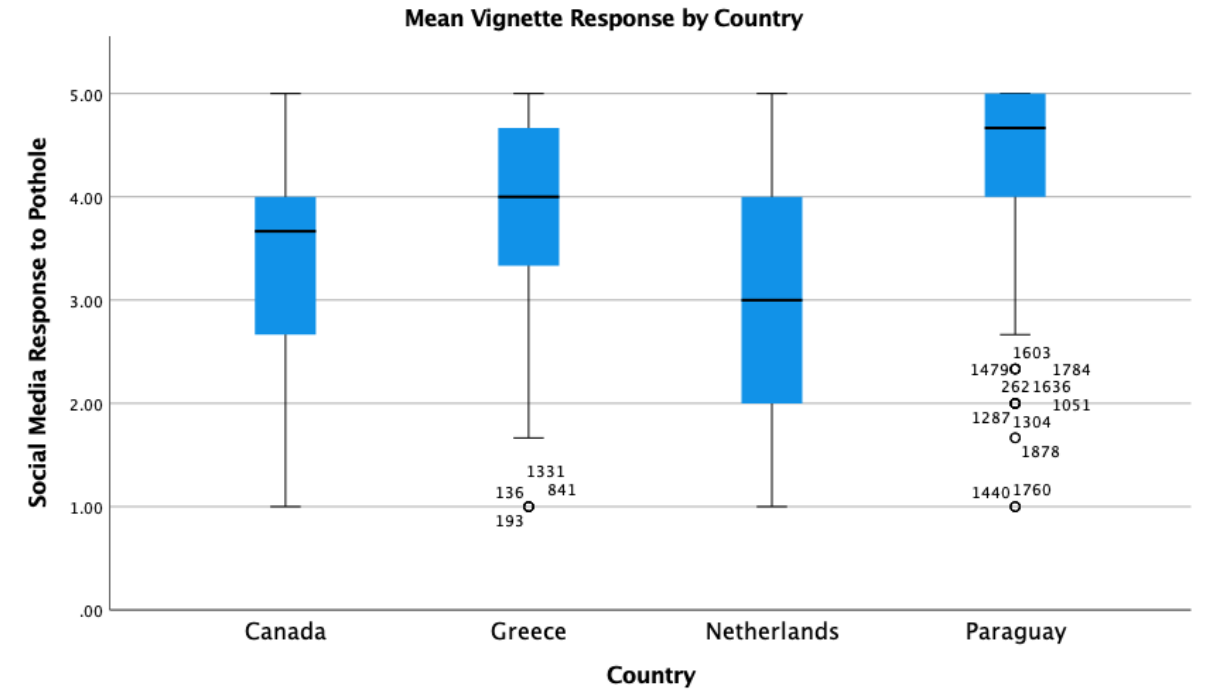


Figure 2: means of vignette responses in Canada, Greece, Netherlands, Paraguay (n = 1215)

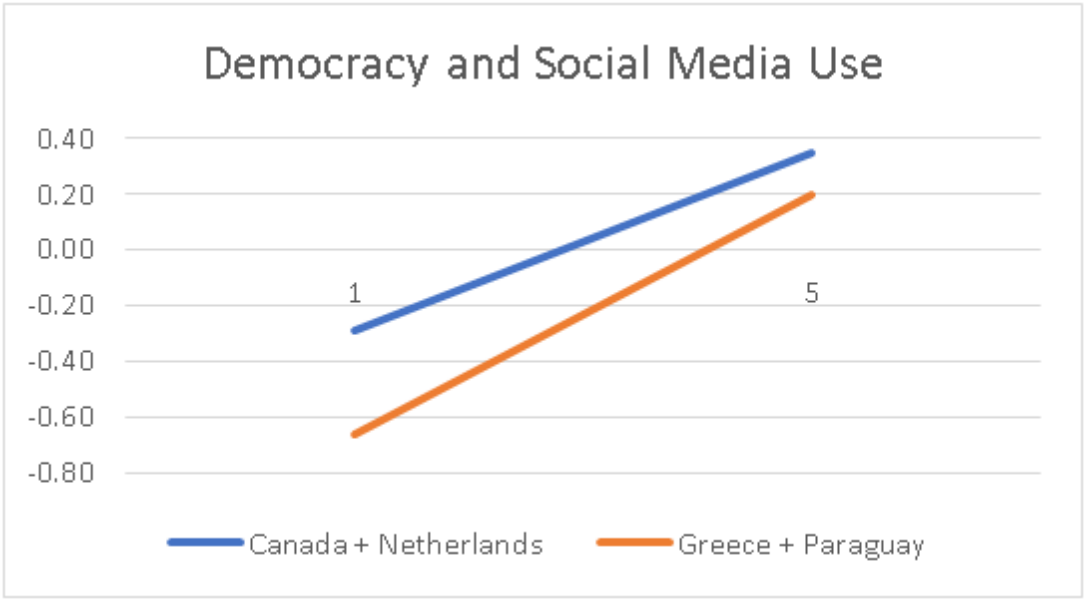


Figure 3: plot of interaction slopes

Table 5: regression results by country, standardized coefficients, * p < 0,05, ** p < 0,01, *** p < 0,001

	Canada				Greece				Netherlands				Paraguay			
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Gender (1 = female)	.003	.008	.008	.002	.067	.062	.053	.049	.030	.059	.060	.047	.091	.095	.096	.088
Age	-.106	.054	.054	.075	.108	.087	.084	.082	.031	.145*	.148*	.167**	-.008	-.045	-.045	-.019
Education (1= higher education)	-.003	-.008	-.008	.024	-.048	-.042	-.041	-.038	-.024	.000	.008	.002	-.014	.011	.012	.025
Perceived effectiveness		.311***	.309***	.286***		.285***	.264***	.259***		.319***	.327***	.279***		.106	.104	.090
Ease of Use		.240***	.239***	.210***		.046	.054	.033		.089	.097	.060		.171**	.171***	.136*
Social Influence		.142*	.143*	.049		.180**	.145*	.109		.136*	.142*	.109		.224***	.222**	.171**
Fear of Consequences		-.045	-.045	-.022		-.085	-.090	-.084		.101	.099	.085		-.106	-.108	-.108
Trust in Government			.005	-.036			.142*	.106			-.070	-.107			.011	-.051
Trust in SM Infrastructure				.262***				.135**				.208***				.225***
F	1.153	13.664***	11.900***	13.608***	1.884	10.450***	10.157***	9.750***	.244	9.929***	8.917***	9.511***	.841	7.255***	6.331***	7.350***
R^2 (adjusted)	.01	.24	.24	.29	.01	.19	.21	.27	.00	.17	.17	.20	.00	.12	.12	.16

Table 6: regression results with DemocracyDUMMY interaction term, centered variables & standardized coefficients, * p < 0,05, ** p < 0,01, *** p < 0,001

	Flawed Democracy (Greece, Paraguay) – Democracy (Canada, Netherlands) comparison	
	Main effects	**Interactions**
C_Perceived effectiveness	.164***	.156***
C_Ease of Use	.171***	.091***
C_Social Influence	.139***	.119***
C_Trust in SM Infrastructure	.227***	.158***
DemocracyDUMMY (Canada, Netherlands = 1)		-.270***
C_Trust in SM Infrastructure * DemocracyDUMMY		.056
F	99.423***	91.012***
R^2 (adjusted)	.245	.308

latter finding contradicts conjectures indicating that trust in government increases the probability that citizens invest in citizen-state relations [9, 31].

Arguably one of the more interesting findings of this study is that citizens' trust in proprietary social media infrastructures affects citizens' digital engagement and participation, and this holds equally in democracies and in flawed democracies. It must be noted that

social media platforms such as Twitter and Facebook were designed as artefacts with which market segmentation algorithms transform users' interactions and engagement into monetary revenues; they were never intended to accommodate citizen political engagement. If we however observe and accept that social media platforms are, for many citizens, a preferred communication channel for interaction with governments on public service quality concerns, and we know that citizens' trust in the safety and robustness of social media platforms determines whether citizens actually voice their concerns and interests, then social media platforms can be seen to constitute a contemporary public sphere and there will be a case to mitigate social media risks and promote citizens' trust in social media platforms. This calls for initiatives by both national and supranational governments to contest monopolies and stimulate competition in emerging information markets. Specific measures could include investing in social media education so that people understand benefits and risks of having an online presence, and requiring social media companies to be publicly accountable on how citizens are profiled, how companies deal with citizens' privacy rights, and how algorithms channel information flows to social media users [47].

As any other study, this study does not come without limitations. A first limitation is that the explained variance of the model is limited; only 16 – 30% of the variance in responses to the vignettes could be explained using the variables that were included. This is definitely less than explained variance in explanatory e-government services adoption studies (Carter and Bélanger's [11] study yielded 85% explained variance, Carter, Schaupp, Hobbs and Campbell [10] managed to explain 63%, and Kurfali *et al.* [24]'s explained variance was 58%. It must be noted though, that the population of these studies was more homogeneous than our global population, and, arguably more interestingly, studies focusing on explaining the adoption of social media by individual users display lower R^2 values; Khan's study on why individuals comment on Youtube videos yielded a R^2 of 22% [23], Homburg *et al.*'s study on Chinese citizen's adoption of Weibo to interact with governments produced a R^2 of 39% [20], and Al-Debei, Al-Lozi and Papazafeiropoulou's study on generic user's Facebook continuation decisions managed to explain 34% of total variance. Obviously, social media adoption theories in general, and social media adoption studies in citizen-state relations are in need of inclusion of more variables to potentially boost explained variance. A possible source of influence is Malinen's review article, in which she identifies variables such as user motivation, user personality traits and cultural values held [28]. Future research could arguable blend existing adoption models with the kind of variables suggested by Malinen.

A second limitation is the bias that was noted in the results section and that had to do with the high proportion of highly educated respondents, and the fact that the survey was conducted online, which means that only those respondents are included which already have specific ICT skills and access to resources. Although this is a characteristic this study shares with many other studies, and practicalities render alternatives to high volume electronic surveys rather prohibitive, considerable care must be undertaken to generalize findings of potentially biased surveys to larger populations.

In conclusion, we can say that our results explain why citizens across geographic boundaries and political regimes choose to use social media platforms to speak up and interact with public authorities. As such, this study follows up on previous studies' recommendations to further investigate why citizens show limited interest in engaging in dialogues, or speaking up in the first place. Our results suggest that, although responses are different in various countries and are likely to be contingent upon the type of problems people are confronted with, citizens' use of social media in citizen-state relations are explained by trust in platforms and technological infrastructures that make social media possible. On a theoretical level, this study contributes to our understanding of 'pull'-factors of electronic citizen-state interactions. As regards practical implications, authorities should realize antecedents of citizens' social media behaviors and take these into accounts when realizing 'government 2.0' strategic visions.

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APPENDIX A: MEASUREMENT USED IN QUESTIONNAIRE [17-19]

Perceived effectiveness
PE1 Posting messages on governments' public social media accounts would help in solving my problems
PE2 Posting messages on governments' public social media accounts increases my chances of realizing my objectives
PE3 Posting messages on governments' public social media accounts allow me to solve my problems more quickly
PE4 Posting messages on governments' public social media accounts would help my effectiveness in dealing with problems
Ease of use
EU1 Learning how to use social media is easy for me
EU2 I find social media are easy to use
EU3 It is easy for me to become skillful at using social media
EU4 I find it easy to get social media tools to do what I want to do
Facilitating conditions
FC1 I have the resources necessary to use social media
FC2 I have the knowledge necessary to use social media
~~FC3 Using social media is not compatible with the rest of my online activities (R)~~
~~FC4 I can get help from others when I have difficulties using social media~~
Social influence
SI1 People who influence me think I should use public social media to communicate with my government
SI2 People who are important to me think I should use public social media to communicate with my government

SI3 In general, most people around me use public social media to communicate with their government
Trust in social media organizational and business infrastructure
T1 I feel assured that legal and technological structures adequately protect me from problems on social media
T2 I feel confident that encryption and other technological advances on social media make it safe for me to use it
T3 In general, social media are now a robust and safe environment
Trust in government
TIG1 I feel that my government communicates information honestly
TIG2 I feel that my government is capable of doing its task
TIG3 I feel that my government is fair
TIG4 I feel that my government wants what is best for its citizens
Fear of consequences
~~FOC1 Any problems resulting from the actions by the characters in the stories will never go away~~
FOC2 Something terrible would happen if I did what the characters in the stories did
~~FOC3 While what the characters in the stories did could be harmful, I would be okay (R)~~
FOC4 I am afraid of what may happen if I did what the characters in the stories did
~~FOC5 Any problems resulting from what the characters in the stories did will go away in time (R)~~
FOC6 Doing what the characters in the stories did could cause serious problems
~~FOC7 My computer/telephone/tablet could be compromised if I did what the characters in the stories did~~
Use
USE1 I would do the same as Trudy did
USE2 I would have also posted a message on the agency's social media page
USE3 I would have done the same as Trudy did when confronted with the same situation
Realism
REALISM1 The situation is realistic
REALISM2 I can image this situation happening to people

APPENDIX B: VIGNETTE [17-19]

Trudy lives in a small urban community and travels to a neighboring city four times a week by a public road. Trudy notices that due to weather conditions, the condition of the road deteriorates up to the point where there are big cracks and holes in the road. As Trudy travels down this road regularly, she knows where the cracks and holes are, but she realizes that other people might crash and hurt themselves. Trudy is worried about what might happen to fellow-citizens and uses the public social media account of the public works agency responsible for road maintenance to post pictures of the holes and cracks in the road, and to notify the public works agency of the bad condition of the road under her own name.

Semi-supervised learning approaches for predicting South African political sentiment for local government elections

Mashadi Ledwaba
Vukosi Marivate
shadiled19@gmail.com
vukosi.marivate@cs.up.ac.za
Department of Computer Science, University of Pretoria
South Africa

ABSTRACT

This study aims to understand the South African political context by analysing the sentiments shared on Twitter during the local government elections. An emphasis on the analysis was placed on understanding the discussions led around four predominant political parties – ANC, DA, EFF and ActionSA. A semi-supervised approach by means of a graph-based technique to label the vast accessible Twitter data for the classification of tweets into negative and positive sentiment was used. The tweets expressing negative sentiment were further analysed through latent topic extraction to uncover hidden topics of concern associated with each of the political parties. Our findings demonstrated that the general sentiment across South African Twitter users is negative towards all four predominant parties with the worst negative sentiment among users projected towards the current ruling party, ANC, relating to concerns centered around corruption, incompetence and loadshedding.

CCS CONCEPTS

• **Computing methodologies** → **Natural language processing**; Supervised learning by classification; • **Information systems** → *Sentiment analysis.*

KEYWORDS

local government elections, semi-supervised learning, sentiment analysis, topic modelling

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1 INTRODUCTION

After months of attempts to defer the 2021 planned local government elections in South Africa, the Constitutional Court handed down an order on the 3rd of September 2021 that the elections will take place. Since then, social media platforms such as Twitter have been growing with engagements, analyses, polls, and opinions pertaining to political parties and the elections. With accessible social media data at our disposal, this study aims to understand the South African political context by analyzing public sentiment, particularly when discussing the leading political parties – ANC, DA and EFF. Given the rivalled rise of the newly formed political party, ActionSA, to contend alongside the three giants and with it receiving growing interest from South Africans in a short space of time, it was decided to also include it as the fourth party of the study.

South Africa has seen insurmountable political unrest in the last couple of years. With the country's disquieting protests for basic service delivery failures, high unemployment rates and corruption, elections become an important part in ensuring democratic governance and that the right individuals are elected to take on the social and economic challenges that the country is currently facing. This study is important because shared and disseminated sentiment or sentimental language (because it evokes emotion) can influence people's perceptions, behaviour and voting decisions towards certain political parties. This can help us predict voting intentions and ultimately, parties that stand a good chance of winning the elections. The research questions this study aims to answer regarding South African political sentiment for the elections are as follows:

- What is the prevalent sentiment towards the four main political parties for the 2021 local government elections?
- What are the major topics of concern in the negative sentiment tweets towards the political parties?
- Does sentiment towards a political party drive voting intentions and thus voting results?

To achieve the objectives set out above, Natural Language Processing (NLP) was used to extract the public opinions of South Africans on Twitter towards the political parties to detect negative and positive sentiment. The analysis presents the application of Semi-Supervised Learning (SSL) using graph-based methods to overcome the challenge of using social media data to achieve NLP tasks, where a large amount of the data is unlabelled. This paper presents the analysis in the following structure: a review of related work and methods used in the study, methodology followed, results

of the sentiment analysis and topic modelling and lastly, conclusion and limitations of the study.

2 LITERATURE REVIEW

Social media platforms such as Twitter, Facebook and Youtube have paved the way for government to interact and develop relationships with citizens. Growth towards e-governance and social networks has been an important driver for public participation, transparent and collaborative governance [12]. The adoption of social media in governance has been widely studied for its effectiveness in the dissemination and communication of information as opposed to traditional government websites [29], to provide information on opinions of citizens towards government decisions and policies [24], its influence on citizens' perception and behaviour [11] and its effectiveness during crisis management [8]. The focus of this study is on the use of social media to analyse the sentiment of South African citizens in the context of local elections.

2.1 Sentiment Analysis

Sentiment analysis is a NLP task of extracting subjective information or opinions expressed in text data – commonly negative and positive sentiment [23]. It is a growing field that has been applied in various industries. Sanders et al. [22] used sentiment analysis within the health sector to uncover the public's attitude towards wearing of masks during COVID-19. Mishev et al. [13] applied it for text feature extraction to acquire financial signals driven by sentiment and, Bermingham et al. [2] presents work on monitoring political sentiment to predict elections for the Irish General Elections.

2.1.1 Sentiment Analysis in Politics. There has been growing application in the use of various social media platforms to understand and predict behavior within the political context [4, 6, 9]. Franch [6] demonstrated that the use of tweets in order to infer political sentiment gives a better idea of the political landscape of a country than traditional polls, which often suffer from sample and method bias, and are expensive to conduct than using the freely accessible 'wisdom of crowd' offered by social media platforms.

Oyebode et al. [18] presented a comparative study between three lexicon-based classifiers and five machine learning classifiers to determine sentiment in political posts. These were associated with two of the major political parties contending for the Nigerian presidential elections – All Progressives Congress and People's Democratic Party. For the study, 22 497 posts relating to the presidential candidates of the two political parties were extracted from their indigenous social media platform (Nairaland). 1041 tweets were randomly chosen from the set and annotated as positive, negative, and neutral to ensure that the annotated set has a balanced representation. VADER and Textblob lexicon-based models were used for the sentiment classification. The team also addressed the gaps in the coverage of lexicon-based methods by adding 8 748 more features to the VADER lexicon. The obtained results demonstrated that the extended VADER lexicon outperformed the other two (VADER and Textblob) as well as the machine learning approach.

There are only a few cases of published work centered around South African political sentiment using machine learning approaches. Kotzé et al. [10] presented work on using social media data to extract sentiment and perceptions towards one of South Africa's Afrikaner minority communities - Orania. Twitter Archiver was used to collect over 10 000 tweets relating to the community. Due to lack of trained data, a lexicon-based approach was followed for the sentiment analysis. Different sentiment analyzers that employ lexicon dictionaries for sentiment classification were used with the lexicons containing words associated with negative, positive, and neutral sentiment. The lexicon dictionaries that were formulated from actual tweets (such as the NRC word-emotion lexicon and AFINN) outperformed the ones that were extracted from other domains such as the Opinion Lexicon which is based off retail reviews.

The identified gap with the work presented shows that a lexicon-based approach can work well in identifying the polarity of a tweet, however, these publicly available lexicons are not trained on the context of the work studied. Political and social language differs between different social structures and countries therefore, it would be valuable to self-train data on domain-specific text data for the problem. This is typically where semi-supervised learning would be best suited. Given the low-resource gap of sentiment detection tools available where models are pre-trained on political activities in South Africa, this study will be employing semi-supervised methods to intelligently learn the political context relating to the recent local government elections to predict sentiment expressed by South Africans.

2.1.2 Sentiment Analysis Approach: Semi-Supervised Learning. There are different methods to automatically detect subjectivity in text data such as pre-trained lexicon-based methods discussed in related work above, machine learning approaches or a hybrid of the two. Even though lexicon-based methods are quick to implement and have been pre-trained on large sets of data, the downside in their use is that they do not cover all domain-specific words. Given that the context of the South African political language is unique and has its own nuances, it would be more suitable to self-train the model on the elections data.

Most of the online pool of data comes unlabelled, making supervised learning a challenge as it would require labels that represent sentiment. Considering the cost implications in employing human expert annotators and the time constraints for this study, a machine-labelling approach was explored i.e., semi-supervised learning. Semi-supervised learning fits in between supervised and unsupervised learning. It is typically applied when there is a large amount of unlabelled data that is easily accessible than labelled data. The method makes use of the small set of trained labelled data to derive labels on the large amount of the unlabelled data. Zhu et al. [30] describes semi-supervised classification as having labelled dataset D_L and unlabelled dataset D_U such that you obtain a better performance than you would if you trained a classifier on D_L alone. This approach is particularly suited in this study where there are low resources of pre-trained political sentiment analyzers. The semi-supervised method that will be explored to predict tweet sentiment is a graph-based method known as label propagation.

2.2 Label Propagation

Label Propagation (LP) is a transductive learning approach that makes use of known labels in the training process to propagate

labels to unlabelled data. LP uses graphs and a small set of labelled nodes in an n-dimensional space connected by edges to find labels for all the nodes in the space given the similarity between the nodes. The algorithm computes a probabilistic transition matrix T which gives the probability of a label jumping from node x to node y i.e., T_{xy}. If the probability is high, then x and y are similar, and the algorithm iteratively propagates labels to training examples by spreading label information through the graph until it achieves global convergence as proposed by Zhu et al. [30].

LP has proven to be a robust model in many cases such as Tai et al. [26] where a sentiment lexicon for sentiment analysis was automatically constructed using LP on unlabelled Twitter data within the financial domain. Experimental results from the study showed that the automatically constructed sentiment lexicon outperformed general-purpose sentiment dictionaries. Other studies from [20, 21, 28] also present success in the use of LP for polarity analysis in different domains.

3 METHODOLOGY

This section outlines the experimental set-up aligned to the proposed method to answer the research questions posed. These steps include the data collection process and how it was annotated, data pre-processing and processing steps, sentiment analysis and topic modelling.

3.1 Data Collection and Annotation

Twitter data was collected pre-elections from the beginning of September to end of October 2021. Twitter was chosen in this study due to the ease of extraction of tweets using open-source tools as opposed to Facebook which has more scraping restrictions to protect user data from being leaked. A majority of leaders of the four political parties are more engaged on Twitter, possibly due to their high follower count shown in [1] giving them more reach to citizens. To collect a wider sample of data and counter limitations of each tool, two scraping tools were used - Twint and Twarc.

Twitter relevant information relating to the four political parties was extracted using various hashtags such as #MyANC and #EFFSouthAfrica as well as party leader names (e.g., JSteenhuisen and HermanMashaba). It is important to note that even though ActionSA is not the 4th biggest political party after ANC, DA and the EFF, it was added to the study mainly due to the wide political engagement, social media hype and trends that were present preceding the elections on Twitter relating to the party coupled with it's president being a former member of the DA. Additional data for six other political parties was also collected and the more general tweets relating to the local government elections (using e.g., #LGE2021). This additional data was used to enrich our elections corpus for representation however, sentiment was predicted for tweets only associated with the four main political parties. The collected tweets were filtered for non-English tweets and duplicates. From the corpus specific to the four political parties, 1669 tweets were randomly sampled for manual annotation of positive and negative sentiment using, as a guide, an online sentiment lexicon dictionary by Mohammad [15] comprising 54,129 uni-grams of negative and positive sentiment-associated words. Mohammad [14] provides semantic-based questionnaires and techniques also used to guide the annotation process. These annotations were validated by a political commentator and editor who is not affiliated with either of the four political parties but is well-versed in political language and semantics.

Four 'different' datasets were set aside and are given identifiers (A-D) for simplicity of explaining:

1. Dataset A: The complete dataset (labelled and unlabelled) with all the political parties' election-related data used for data representation purposes.
2. Dataset B: Part of Dataset A related only to the four main political parties that will be used for sentiment predictions. Tagging the correct tweet to each political party was very important in this case. To do this, it was ensured that tweets tagged to one political party did not contain any other information about another party or mixed sentiment about two or more political parties using a keyword search and tweet mentions. This method slightly reduces the dataset for the individual parties as was expected given contending parties and conflicting interests where users usually express their opinions towards more than one party in the same tweet. An example tweet of mixed sentiment and different subjects from Dataset B: *"Looks like DA is set to lead SA after the anc. Meanwhile @Julius_S_Malema is happy to remain a loud propagandist."*
3. Dataset C: Randomly sampled from Dataset B and manually annotated to train the semi-supervised model.
4. Dataset D: Randomly sampled from Dataset B and manually annotated and set aside as the hold-out test-set used for model evaluation and acceptance purposes.

Table 1 shows a detailed summary of the categorization of datasets.

3.2 Pre-processing

A primary challenge associated with NLP tasks relates to handling out-of-range or non-standard text data. Social media text makes it even more of a challenge as out-of-range data comes in many forms – emojis, punctuation, misspelling, URL's, colloquial language, and other non-standard forms of texting. To handle these, various pre-processing methods were applied to make the text data suitable for analysis and predictability. These included the removal of unwanted texts and symbols in the tweet such as usernames, URL's, hashtags, numbers, and punctuation. The text was standardized by making it all lower case, contractions where expanded, ticks and the successive letters removed, and extra white spaces removed. Successive words like 'action' and 'sa' were joined to not lose the representation of ActionSA in some tweets. Stop-words were also removed from the text. These are frequent low-level information words that form part of the language syntax but do not add any semantic meaning to the text such as 'the', 'a', 'because' or 'have'. Lastly, the text was tokenized and lemmatized. The former is to reduce inflection in words with the same meaning being used in different forms due to grammatical correctness of sentences by representing them in their common root form e.g., the words; *'corrupt', 'corrupts', 'corrupted', 'corrupting'* stem from the one word *'corrupt'*.

Table 1: Local elections datasets

Dataset	Purpose	No. of tweets	Labelling method	Positive sentiment	Negative sentiment
A	Processing elections data - all political parties	681,029	Automatic	N/A	
B	Sentiment predictions for the four political parties	401,916	Automatic	N/A	
C	Label propagation model training	1669	Manual	720	949
D	Label propagation model testing	372	Manual	181	191

3.3 Data Processing – Word Embeddings

Word embeddings are used to create numerical features i.e., vector representation of the text data to transform the text into a machine-readable format. Two word-embedding models that were explored for the representation of the elections data were TF-IDF Encoding and Word2Vec Embeddings.

3.3.1 TF-IDF. Term Frequency Inverse Document Frequency (TF-IDF) is an information retrieval technique that measures the relevance of a word in a corpus based on the number of times it appears. TF-IDF determines the relative frequency of words in a document compared to the inverse proportion of those words across the entire corpus of documents [19]. TF-IDF aims to reduce the weight of words that occur frequently in the corpus that do not provide relevant information about the document such as stop-words. For a term t in document d, the TF-IDF weight $W(t, d)$, is given as:

$$W(t, d) = TF(t, d) * IDF(t)$$

where:

- Term frequency: $TF(t, d)$ is the number of occurrences of the term t in document d.
- Inverse document frequency: $IDF(t) = \log(\frac{n}{df(t)})$ measures how significant the term is in the corpus where n is the total number of documents in the corpus and $df(t)$ is the document frequency of term t.

3.3.2 Word2Vec Embeddings. Word2Vec representations are computed from prediction-based models. Word2Vec was pre-trained on over 100 billion words from the Google News dataset and uses a shallow two-layer neural network to derive vector representations [5]. The difference between Word2Vec and TF-IDF is that Word2Vec measures the semantic and syntactic similarities between documents which considers the context that words are used in when representing them therefore, words that share the same context will have similar vector representations. Word2Vec uses two different methods to create the vector representations – Continuous Bag of Words (CBOW) and Skip-gram. CBOW tries to predict the next word in a sentence by considering the context that the target word is being used in as the input into the network. Skip-gram uses the target word to predict the context and produce the representation. Skip-gram takes in as input the one-hot-encoded vector input of the word and gives as an output the probability score of the word being used in the same context as the output layer. CBOW does the opposite by taking in the one-hot-encoded context words to give the probability score of the output word being in the center of the context.

To represent the elections data in vector form, both TF-IDF and Word2Vec (Skip-gram and CBOW) models were fit to Dataset A (the complete dataset across all political parties) allowing for the models to be trained for sentiment predictions.

3.4 Modelling

3.4.1 Supervised Learning. To develop a baseline to benchmark the Label Propagation model against, a Support Vector Machine (SVM) model is trained. The SVM model is trained on Dataset C (the labelled training set) using the word embeddings and validated using a 5-fold cross validation method. The models are further tested on the hold-out set from Dataset D and the performance yielded by each of these methods was compared for model selection purposes. Metrics used for the evaluation of the models were precision, recall and F1 score [25].

3.4.2 Semi-Supervised Learning. The semi-supervised learning method takes place in the following steps:

1. Un-labelling 50% of the manually labelled data. These training examples unlabelled were randomly sampled from Dataset C.
2. Training the semi-supervised model on a combination of the remaining 50% of labelled training examples and the above-mentioned unlabelled training examples i.e., training the model on Dataset C where 50% of the data is unlabelled.
3. Propagation of sentiment labels to the unlabelled examples.
4. Evaluating the transduction of the actual labels that were removed in step 1.
5. Evaluation of the semi-supervised model against the baseline supervised models.
6. Testing model performance against the hold-out set.
7. Using the semi-supervised model to label an additional batch of randomly sampled data from the unlabelled Dataset B and retraining the model and using it to label another batch, iteratively testing it against the hold-out set until Dataset B is completely labelled.

The modelling process of the semi-supervised learning is summarized in the following flow diagram:

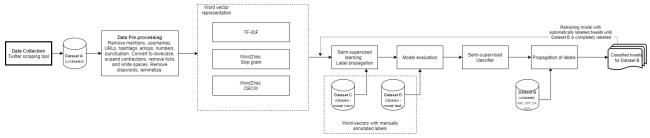


Figure 1: Methodology flow diagram for SSL

3.4.3 Topic Modelling. The second research question involves uncovering the topics that drive negative sentiment to enable us to better understand the public's main concerns with each of the political parties. The method used to find the hidden topics in the tweets associated with negative sentiment was Latent Dirichlet Allocation (LDA). LDA is a commonly used unsupervised method for latent topic extraction. LDA views documents as a probabilistic distribution of a set of topics and each topic as a distribution of words. Wang et al. [27] proposed a model on topical n-grams which generates uni-grams and bi-grams based on the context of a document e.g., the model could get the correct context of the bi-gram 'white house' as an association to politics rather than real-estate. Within the South African political context, LDA was used between two national election cycles (2014 and 2019) to uncover the predominant recurring topics and themes in news articles in the different election periods [16].

4 RESULTS

4.1 Word-Embedding

Table 2 is a comparison of the topmost cosine similarities to the name of the political party from the Word2Vec embeddings - CBOW and Skip-gram. It is observed that Skip-gram produced more contextual words commonly associated with each of the political parties than CBOW.

4.2 Modelling

Table 3 shows the mean of cross-validation F1 scores using 5-folds for the baseline and semi-supervised models trained using TF-IDF and Word2Vec representations. The validation scores shows that the models generalise well, with Word2Vec trained models yielding better performance in most cases than TF-IDF models.

Table 4 shows a comparative breakdown of the results of the tuned classification models by sentiment polarity. The models for sentiment predictions generally perform well against the independent hold-out set. This could be attributed to having a good vector representation providing rich context of the elections. Cases where the baseline model outperformed the semi-supervised model in precision resulted in significantly unbalanced prediction errors between the false negative and false positive sentiment predictions. The Skip-gram semi-supervised model shows good performing results in most of the metrics categories with more balanced prediction errors on the hold-out set and was used going forward to label the rest of the unlabelled Dataset B (dataset for each of the main political parties).

4.2.1 Automatic Labelling of Data. Three labelling iterations were conducted using the best performing semi-supervised model with the Skip-gram representation. The first iteration used randomly selected 1000 training examples from the unlabelled Dataset B for each of the four political parties. Ideally, we want the model to generalise well across the different parties therefore, the random samples came from the four respective sub-datasets of each political party i.e., 250 data points sampled from each political party. The model is used to propagate labels onto the 1000 examples and then retrained on a combined set of the newly labelled 1000 examples and the initial training set, and tested against the hold-out set to ensure acceptable predictive performance. This procedure was followed to label an additional 10 000, followed by 20 000 random training examples from each political party's respective datasets.

4.2.2 Sentiment Analysis Results. The final retrained model after the third labelling and retraining iteration showed acceptable results against the independent hold-out set:

The remaining examples of the datasets for the four political parties were automatically labelled using the semi-supervised model. From the obtained sentiment results (Table 6), it is observed that the general sentiment of the South African political context for the local government election relating to the parties is negative. ANC is the current ruling party and is the most discussed party generally generating more tweet data than the other contenders therefore, the results will be interpreted in terms of the sentiment relative to the number of tweets generated for the party (i.e., sentiment percentage). Tweets associated with the ANC show the worst negative sentiment percentage compared to all the parties which highlights the level of dissatisfaction with the ruling party. The newly formed party, ActionSA, has a more positive tweet percentage compared to the other parties.

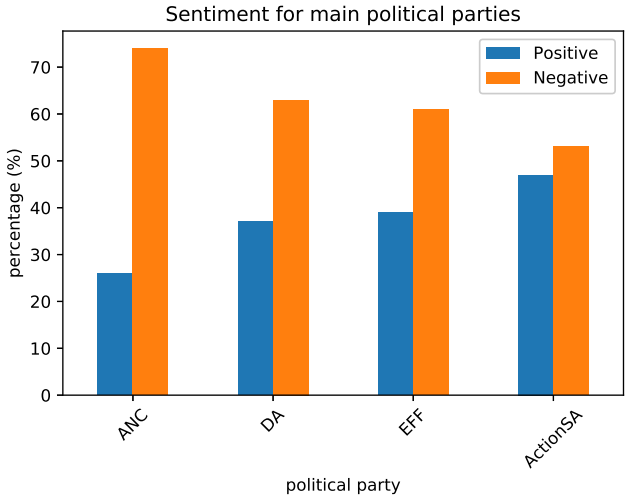


Figure 2: 2021 local government election sentiment results

4.2.3 Topic Modelling. The task of uncovering topics associated with the negative sentiment expressed towards each of the four political parties was done using the initial TF-IDF model. The results shown and discussed for each political party include a word cloud showing the importance of the words in the context or topics. Another method to present the recurring topics for the political

Table 2: Cosine similarity comparisons between CBOW and Skip-gram Word2Vec

Search word	CBOW	Skip-gram
'anc'	*myanc, cancer, corrupt, crook, ret*	*myanc, ancorruption, ancterriosim, ancriminals, lamasela*
'da'	*ff, vf, nmb, coalition, ct*	*ff, ffplus, vfplus, midvaal, cassim*
'eff'	*actionsa, da, malema, mighty, waya*	*effmustrise, groundforces, effwayawaya, stockvel, flopper*
'actionsa'	*action4sa, asa, herman, split, party*	*action4sa, itstimeforaction, voteactionsa, mashaba, letsfixsouthafrica*

Table 3: Model validation results

Model	Validation score
TF-IDF (SL) - baseline	0.85
TF-IDF (SSL)	0.82
SKIPGRAM (SL) - baseline	0.89
SKIPGRAM (SSL)	0.90
CBOW (SL) - baseline	0.85
CBOW (SSL)	0.87

parties is to extract the frequently occurring sequence of words (n-grams). To get more context, 4-grams were extracted.

ANC. The negative sentiment projected towards the ANC is associated with themes centered around corruption, incompetence and loadshedding, where the latter was a predominant theme uncovered in the 2019 national elections as well [16]. The extracted top 4-grams show the extent of the public's dissatisfaction with ANC where corruption is a major theme across most of the top 4-grams. Other themes in the topic model covered unemployment concerns, Covid and lockdowns.

DA. Negative sentiment tweets for the DA include the names of Gareth Cliff and John Steenhuisen as observed in the 4-grams for the party. Those negative tweets are likely to be linked to an interview a week before elections between Gareth Cliff, Johan Steenhuisen and community activist Mudzuli Rakhivhane where Gareth Cliff made a statement insinuating that racism in South Africa is not as big of a problem as service delivery failures. Cliff's dismissive notion resulted in a social media outcry from the South African public with most of the outrage centered on racism – a recurring theme associated with the DA. The theme of racism is also associated with an election poster that was erected in Phoenix referencing the events of the July unrest. The poster caused major social media uproar branding DA as a racist party for calling community members involved in the violence that unfolded as heroes.

EFF. Concerns associated with the EFF were issues around the looting of VBS with requests from users for the party to pay back the money. Expropriation of land has always been one of EFF's main policy agenda and continues to be a major topic in the party as can be observed in the most frequent 4-gram associated with negative sentiment tweets for the EFF. Another recurring topic under the EFF is on their open-border policy. A number of South African patriots have expressed concerns about the policy and sent cautionary warnings of withholding their votes due to the party's stance on illegal immigration after the party's president mentioned at an EFF Presser that neighbouring countries should "find creative ways" to enter South Africa.

ACTIONSA. The main concern in the negative sentiment tweets expressed towards the newly formed party is centered around their stance on illegal immigration, which has been viewed by many as draconian and xenophobic. Another topic of concern expressed in negative sentiment tweets concerned omission of the party's name on the ballot paper for the elections. ActionSA's 4-grams covers themes on immigration and expropriation of land - a topic commonly associated with the EFF. The latter is due to expressed concerns of ActionSA's lack of planning and public interest when addressing topics related to land reform in South Africa.

5 CONCLUSION AND DISCUSSION

This study illustrated how social media sentiment analysis and topic modelling was used to understand the opinions shared regarding four different political parties in the South African context. Furthermore, based on this analysis, context into the positive and negative sentiments were highlighted. To predict political sentiment, Twitter data was processed and a small subset of the data manually labelled for positive and negative sentiment using a lexicon dictionary as a guide. A semi-supervised approach was followed to predict political sentiment using the graph-based method, label propagation, to learn from and propagate the small manually labelled sentiment to the unlabelled data. This method was used to address the gap in the current under-resourced sentiment models for the South African political landscape. The label propagation model using Skip-gram vector representation resulted in the best model performance across different metrics compared to TF-IDF and CBOW representations. This model was used to label the sentiment examples for the four political parties. The sentiment scores in this study indicated that the current ruling party (ANC) had the greatest negative score, with ActionSA constituting most of the positive sentiments as compared to any of the other political parties in this study. Topic modelling was used to extract topics uncovering the main concerns associated with each of the party's negative tweets with the main concerns towards the ruling party being centred around corruption, incompetency, and Eskom.

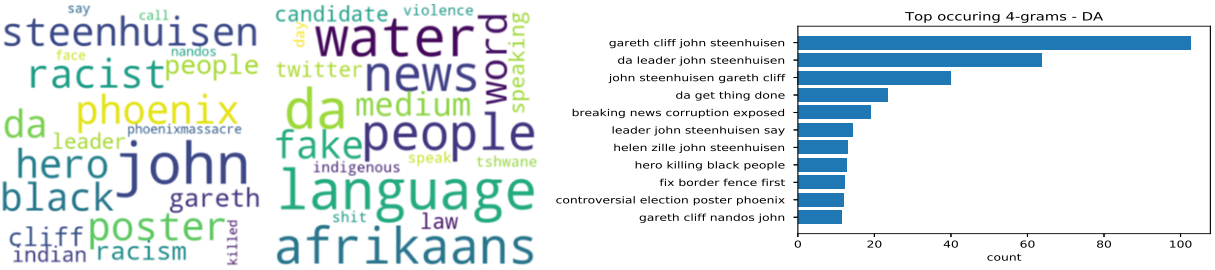
Table 4: Model performance against hold-out set by sentiment polarity

Model	Precision		Recall		F1 Score	
	Positive	Negative	Positive	Negative	Positive	Negative
TF-IDF (SL) - baseline	0.93	0.89	0.87	**0.94**	0.90	0.91
TF-IDF (SSL)	0.88	0.93	**0.92**	0.90	0.90	0.92
Skipgram (SL) - baseline	**0.95**	0.89	0.87	0.91	**0.91**	0.92
Skipgram (SSL)	0.89	**0.94**	**0.92**	0.91	**0.91**	**0.93**
CBOW (SL) - baseline	**0.95**	0.88	0.87	**0.94**	0.90	0.91
CBOW (SSL)	0.94	0.89	0.88	**0.94**	**0.91**	**0.93**



(a) (b) (c)

Figure 3: ANC negative sentiment topics word cloud (a),(b) and ANC recurring themes using 4-grams (c)



(a) (b) (c)

Figure 4: DA negative sentiment topics word cloud (a),(b) and DA recurring themes using 4-grams (c)



(a) (b) (c)

Figure 5: EFF negative sentiment topics word cloud (a),(b) and EFF recurring themes using 4-grams (c)



(a) (b) (c)

Figure 6: ACTIONSA negative sentiment topics word cloud (a),(b) and ACTIONSA recurring themes using 4-grams (c)

Table 5: Confusion matrix of final SSL model against hold-out set

	Positive (prediction)	Negative (prediction)	All
Positive (actual)	150	31	181
Negative (actual)	14	177	191
All	164	208	372

The appointment of Cyril Ramaphosa came with a promise to deal with the country's insuperable corruption and three years later, corruption is still a major concern for the South African public as seen through topic modelling. The negative sentiment expressed towards the ruling party does not come as a surprise given these are only a few of the many recurring issues that the ruling party is having challenges addressing. Most of these issues are mainly attributed to incompetency, leading to failure to address issues of employment, service delivery, crime and issues faced by majority of the poor in the country. Internal factional battles within the party have also not made it easy for the party to deal with critical issues of the country.

The last research question was whether sentiment towards political parties drives voting intentions. Some studies have shown the predictability of sentiment analysis for election turnout [3, 9, 17]. For our local government elections, this question can be answered by referencing the voting results as an empirical study would require additional information to be collected to extensively answer. Given the observed high negative opinions expressed towards the ruling party, it can be assumed that this sentiment and the concerns it encapsulates are reflected by the public's actions at the ballot stations. The ANC has recorded its worst voting results with an all-time electoral low below 50%. The ruling party managed to maintain votes in the poor regions of the country such as regions within the Eastern Cape but suffered major losses in regions where they previously had a stronghold such as Soweto and eThekwini. ActionSA unseated the ruling party in some of its major voting districts. For a party that is less than a year old, there has to be positive contributing factors that the public resonates with to give it such a huge support.

The elections saw the worst voter turnout post-apartheid with youth voter turnout being the worst and the youth are majority who have access to social media platforms and vast online information capable of making informed voting decisions. The low voter turn-out is a troubling concern which, the ruling party's Deputy Secretary General, attributed to failures of the ANC in a statement on the local government elections [7]: *"it is in the main an unambiguous signal to the ANC from the electorate. The low voter turnout, especially in traditional ANC strongholds, communicates a clear message: The people are disappointed in the ANC with the slow progress in fixing local government, in ensuring quality and consistent basic services, in tackling corruption and greed."*

6 LIMITATIONS AND FUTURE WORK

This study gave us a good sense of the political climate for local government elections however, the use of social media to determine political sentiment excludes a great number of South Africans without access to technology or Twitter.

The dataset that was used for sentiment predictions of the respective parties disregarded multi-sentiment tweets where one tweet contains expressed sentiment about more than one political party. This reduced the data associated with each of the political parties. Proposed future work to address this would be using an automatic approach such as target-dependent sentiment analysis tasks which can handle different sentiment projected towards different subjects in the same tweet.

Another limitation in the study is that only positive and negative sentiment were used which means the model is not trained to identify tweets that may not be expressing neither positive nor negative sentiment.

Due to time and cost constraints, we did the manual annotation of the tweets ourselves. Even though they were verified by a political commentator, we are not experts in political linguistics.

Based on [30] and literature [20, 21, 26, 28] presenting the success of Label Propagation, it was the only semi-supervised approach that was explored in the study. As part of future proposed work, it would be good to also test different ways of propagating labels onto unlabelled data and doing a comparative study such as using other graph-based methods or wrapper-based methods like self and co-training approaches.

To further improve model performance, we could also investigate a 'transfer-learning' approach by continuing the training of the powerful pre-trained Google models on our elections dataset to create an even better vector representation and also using these for topic modelling.

Table 6: Sentiment classification for the four political parties

Political party	Total labelled	Positive sentiment	Negative sentiment
ANC	195,342	51,407 (26%)	143,935 (74%)
EFF	87,430	33,825 (39%)	53,605 (61%)
ActionSA	60,990	28,756 (47%)	32,234 (53%)
DA	58,154	21,545 (37%)	36,609 (63%)
Total	401,916	135,533 (34%)	266,383 (66%)

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Managing The COVID-19 in Canada: Exploring Twitter Communication by Government and Health Officials

Arbi Chouikh
Université Laval, Québec, QC, Canada
arbi.chouikh.1@ulaval.ca

Ghofrane Medini
ENSI, University of Manouba, Manouba, Tunisia
gofimedini@gmail.com

Sehl Mellouli
Université Laval, Québec, QC, Canada
sehl.mellouli@fsa.ulaval.ca

Sharon Strauss
University of Toronto, Ontario, Canada
sharon.straus@utoronto.ca

Christine Fahim
Knowledge Translation Program, Li Ka Shing Knowledge Institute, Unity Health Toronto, Ontario, Canada
Christine.Fahim@unityhealth.to

ABSTRACT

Since the unfolding of the COVID-19 virus as a global health crisis that threatens public health, government and health officials in Canada and in many other countries used Twitter as an instrument for health communication. It has been a relevant mean for informing and raising public awareness about precautionary measures to better mitigate the pandemic. In Canada, governments and public health institutions at federal, provincial and territorial levels have been using Twitter to spread COVID-19 related public health information to their citizens during the first, second and third waves of the pandemic. In this study, we aimed to investigate the use of Twitter by governments and health institutions at the Federal government of Canada, and Canadian provinces and territories. Specifically, our main purpose is to explore insights from Twitter online public discourse harnessed by the government and the public health institutions in Canada through their official accounts. These insights will be studied from three analysis: activity, engagement, and trends. To do so, we collected 32,198 tweets published from a total of 62 government (i.e. 29 Twitter accounts) and health accounts (i.e. 33 Twitter accounts) including institutions (e.g ministries) and officials (e.g Prime Ministers accounts) Twitter accounts between 01 September 2020 and 31 August 2021. Our results show that the health and government institutions have been more active during the third wave of the pandemic than the second wave. The results also show that among all the Twitter accounts, the federal representatives and the representatives of the provinces of Ontario, Alberta, and British Columbia respectively have been more active. Finally, the results demonstrate that the Twitter users in Canada have been more engaged with the government accounts at the federal level than at the provinces and territories level.

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1 INTRODUCTION

COVID-19 is a global public health emergency and an international concern [5] that threatens millions of people across the world. As of January 11, 2022, there were a total of 305,914,601 confirmed COVID cases and 5,486,304 COVID-related deaths worldwide[1]. Several public health measures have been adopted by public health and government authorities to minimize the rate of infection [11]. Public health agencies have sought to provide information related to the evolution of the pandemic with regard for example to the daily number of cases or the daily number of deaths, the preventive measures to follow (i.e. social distancing and self-isolation) [2] and the vaccination programs [15]. One of the sources that public health agencies use to provide this information is social media.

Social media are defined as web 2.0 based platforms that enable people to interact and share information through media. During emergencies, social media plays an important role in risk communication and management and has become an increasingly important channel to communicate COVID-19 information to the public. Since the outbreak of the novel coronavirus, it is of immediate importance that governments investigate public discussions about COVID-19 that are taking place in social media that people use to share news, information, opinions, and emotions about COVID-19 [9]. To this end, this paper focuses on the information posted on social media by governments and how citizens engaged with these posts. To conduct our research, the platform we chose is Twitter. Twitter has become increasingly important in conducting research, since it embeds studying global communication on a large scale [1]. Twitter is a micro-blogging and social networking service that allows users post and interact with 280-character messages known as tweets [10].

[1]WHO Coronavirus (COVID-19) Dashboard | WHO Coronavirus (COVID-19) Dashboard With Vaccination Data

Tweets have become a key tool for public health dissemination, as seen during the COVID-19 pandemic. It was used by governments to spread information about the COVID-19 pandemic to the public, to help them understand the public attitudes and behaviors during such a global health crisis [5, 11], to increase public awareness [2], and to inform people by sharing information with their fellow citizens faster. Many studies focused on how people have been using Twitter during a pandemic. Wang et al. in [15] and Rao et al. in [9] examined the tweets posted by the WHO, the federal agencies, the government stakeholders and the state-level public health agencies (i.e. Dep of Health) in the USA as a part of their public health communication to mitigate the spread of the COVID-19 pandemic. Rufai and Bunce in [10] studied the Twitter use by the leaders of the G7 countries in response to the COVID-19. Among the targeted leaders, the Canadian Prime Minister Justin Trudeau's Twitter account sent the most tweets about COVID-19 [13], which could also motivate this study. More specifically in Canada, Hodson et al. in [4] studied the social media comments directed at the Canadian Chief Public Health Officer (CPHO) during the first wave of the COVID-19 pandemic on Twitter and YouTube to understand the public response to government efforts to provide pandemic-related information. For instance, most of public health and government authorities have Twitter accounts. However, their activity could vary depending on the account type (i.e. individual or institutional), the sector (i.e. government or health), the demography and the geolocation. Government and health officials at federal, provincial, and territorial levels in Canada have used their Twitter accounts to publish news about the pandemic, inform the public about the public health measures and raise their awareness about considering those measures such as social distancing and masks [6]. While most studies have focused on investigating the COVID-19 Twitter public discourse in general independently from the types of the accounts (individual, organizational, etc.), few studies focused on the government use of Twitter during the unfolding of the COVID-19 global pandemic. Thus, our purpose in this study is to generally explore the use of Twitter in Canada by the government and health institutions at the federal, provinces and territories levels in terms of activity during the second and the third waves of COVID-19. The use of Twitter in the context of this paper will be studied through the metrics of: activities, engagement, and trends (i.e. according to the Canadian political system, while the provinces exercise constitutional powers in their own right, the territories (Northwest Territories, the Yukon and Nunavut) exercise delegated powers under the authority of the Parliament of Canada)[2]. The activities refer to the daily tweets that the health and government officials have been posting during the pandemic; the engagement refers to the reactions of the public with the posted tweets; and the trends refer to the hashtags that have been used the most by the government and health officials when tweeting about the COVID-19 pandemic.

This paper is organized as follows. Section 2 details the adopted methodology. Section 3 describes the obtained results. Section 4 is a conclusion.

[2]https://www.canada.ca/en/intergovernmental-affairs/services/provinces-territories.html

2 METHODS

2.1 Data target

In this study, we retrieved data from Twitter based on the "Representational State Transfer (REST)" component of the Application Programming Interface (API). REST is used to retrieve past tweets matching criteria within a search window available for Twitter searches API to access tweets content and data. To provide insights regarding the Twitter discourse of the public institutions in Canada during the COVID-19 pandemic, we defined two categories of Twitter accounts: provincial/territorial and federal government ministries accounts, respectively, and provincial/territorial and federal public health organisms accounts, respectively. For each category of accounts, we looked at accounts of ministries, public health organisms, and their respective leaders. We chose these accounts since government and public health authorities used them to disseminate COVID-19 related information to the public in Canada.

2.2 Data collection and pre-processing

For the provincial/territorial and federal government official accounts of Canada, we downloaded tweets from the official department/organizational accounts (e.g., @Canada, @ONgov, @GouvQc) as well as the individual accounts of the corresponding organizations' leaders (e.g., Canada's Prime Minister Justin Trudeau, Ontario's Prime Minister Doug Ford, and Quebec's Prime Minister François Legault). We replicated this model for the public health officials' accounts, downloading tweets from organizational handles (e.g., @GovCanHealth, @ONThealth, @sante_qc) as well as the leaders of these organizations (e.g., Canada's Minister of Health the Honourable Patty Hajdu, Ontario's Minister of Health and Long-Term Care the Honourable Christine Elliot, and Quebec's Minister of Health and Social Services Christian Dubé). Based on the Twitter accounts list of the government and health bodies and officials, we collected 114,694 tweets between 01/09/2020 and 31/08/2021, that are considered as the starts and the ends of the second and their waves in Canada, which is the total period of the study. We retrieved 97,810 unique tweets, among which 25,303 tweets refer to the second wave (i.e. dating between 01/09/2020 and 31/12/2020) and 72 507 during the third wave (i.e. dating between 01/01/2021 and 31/08/2021). In addition, a total of 41,267 tweets include hashtags while 56,543 do not. As one of our aims in this study is to identify the themes that have been covered by official tweets, we used the hashtags as the key element to identify the themes [8, 13]. Thus, to keep only the tweets including hashtags that refer to COVID-19 context, we kept only the tweets with hashtags referring to COVID-19. These hashtags referring to COVID-19 were collected from the literature [7, 8, 16] and from existing datasets found in Kaggle[3] [4]. We obtained 32,364 tweets related to COVID-19 (i.e. 9,150 for the second wave and 23,214 for the third wave). After that, we kept only tweets that are written in French and English, resulting in a final set of 32,198 tweets where 28.28% refer to second and 71.72% to third waves, as shown in Figure 1. Finally, we converted all the tweets to lowercase to avoid duplication due to text case and we deleted the retweets symbol (i.e. RT) and the emojis since they will not

[3]https://www.kaggle.com/komalkhetlani/tweets-about-covid19-all-over-the-world
[4]https://www.kaggle.com/delvso/148-million-unique-covid-tweets-ngrams-hashtags

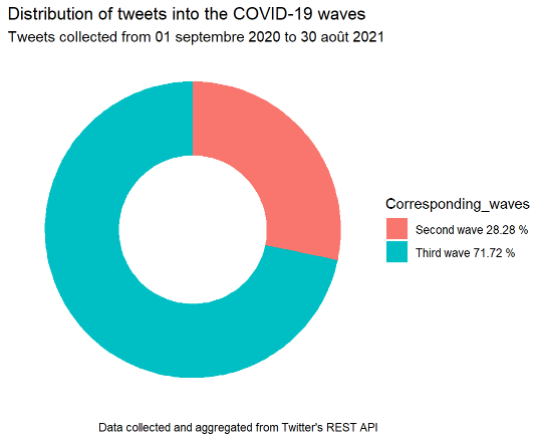


Figure 1: Distribution of the waves of the tweets

bring any additional information in our analysis (Chandrasekaran, Mehta, Valkunde, & Moustakas, 2020).

2.3 Data analysis

The analysis process is on three perspectives: activity analysis, engagement analysis, and trends analysis. We present these three perspectives hereafter.

2.3.1 Activity analysis. We apply this analysis to measure how the public health bodies (individuals and organizations) and government officials (individuals and ministries) have been active by tweeting during the outbreak of the COVID-19. The activity analysis aims to measure the accounts activities during the second and the third waves in Canada. We consider the following dimensions:

- The level: federal, provincial, and territorial;
- The sector: government and health; and
- The type of the account: individual and institutional.

2.3.2 Engagement analysis. The engagement analysis could identify, for example, the most active users who participated in a discussion about a particular topic or interest, the most influential users, or the frequency of liked and retweeted data over time. Measuring the engagement could reflect the influence of certain users as much as they are engaged. It could also reflect the public extent of the public interaction of a given topic [3]. Thus, In this study, we aim to explore the public reactions with the government and health officials tweets that refer to the COVID-19 pandemic. To make this analysis, we use two engagement metrics: the number of retweets, the number of likes, and the public engagement. The function of retweet helps users to share a tweet with all their followers so that the information could be quickly widespread to the audience. Users could also “like” tweets, which could be considered as a sign of appreciation that users express toward tweets. Finally, to aggregate these metrics, we set the measure of "public engagement" which represents the sum of the likes and the retweets numbers.

2.3.3 Trends analysis. Policymakers might be interested to know the trends and the topics that were discussed [12]. The trends analysis will be based on the hashtags. Hashtags are used to index keywords or topics in Twitter. In fact, hashtags are one of the main features that are used to index keywords or topics on Twitter. Hashtags have like pictures, a "classificatory function" of indicating what a social media post is about [17]. As a result, this enhances the capacity to describe the online information [14] and identify the "textual aboutness" of social media posts [17]. This function allows Twitter users to easily follow topics of their interest, so these hashtags are called "trends". The hashtag trends analysis aims to show how the COVID-19 discourse evolved during the study period. The hashtag analysis was conducted by presenting the most popular hashtags in our dataset and by eliminating all the hashtags that were used to filter the tweets (e.g. covid19, coronavirus, etc.). In doing so, we were able to observe the topic shift in the second and the third wave of the pandemic.

3 FINDINGS

3.1 Activity analysis

As shown in Figure 2, we observe in (1) a global more activity of Twitter accounts (at all levels) during the third wave than the second wave. This could be explained by the global lockdown and the several public health measures that have been taken by health and government agencies in the third wave compared to the second wave. The measures were more severe in the third wave. We observe also that the federal officials and officials from Ontario, Alberta, British Columbia and Manitoba have been more active in Twitter during both waves among all the officials in Canada (as depicted in (2)). Considering these specific accounts, we observe that they have been more active on Twitter during the third wave, which could also be explained by the public health measures taken during the third wave, including flights restrictions. When it comes to the sectors, we observe that while government officials have been slightly more active than public health officials during the second wave, health officials have been significantly more active during the third wave (as shown in (3)) which could be explained by the major health crisis period and the public health measures that have been taken in consequence. In addition, health and government institutions’ accounts have been more active during the two waves of the pandemic (as shown in (4)).

3.2 Public engagement analysis

We consider the public engagement of Twitter users towards the tweets that have been published by officials and institutions in Canada during the second and the third waves of the COVID-19 pandemic. In this context, we observe, for the overall number of tweets, a more significant public engagement during the third wave than the second. As shown in Figure 3, the government bodies received more engagement during the third wave compared to health bodies This could be explained by the fact that citizens are more interested and expressive with the political instances such as the government representatives when it comes to more severe measures. However, health bodies received more engagement than government bodies in the second wave. Finally, the representatives of Ontario, Alberta, and British Columbia governments got considerable engagement compared to the other governments. This could be explained by the fact that those provinces have been more active as demonstrated in 3.1, so that they got more public reactions.



Figure 2: Global tweets frequencies

Furthermore, those provinces are more populated than the rest of the Canadian provinces and territories [5].

3.3 Trends analysis

As represented in Figure 4 (1), during the second wave of COVID-19, the most used hashtags at a global level by health and government bodies refer to public health measures, using the hashtags #publichealth, #socialdistancing, #stayhome, avoid3cs, #handwashing and #wearamask. Other tweets include covid updates, using the hashtag #covidalert and #alertecovid. Health and government bodies used also to raise the awareness of their fellow citizens about the public health measures, by using hashtags like #staysafe and #stopthespread. We also observe that some provinces used their proper hashtags like #protectingmanitobans, #maskon and #safeathomemb. In addition, we can depict that there is public concern about the mental health, as many tweets include psychology and mental health related hashtags like #mentalhealth. This could confirm that the pandemic outbreak has many major impacts not only on the economy and the physical health, but also on the mental health, so that government representatives are increasingly aware about. During the third wave of the COVID-19 pandemic, many vaccination hashtags emerged, such as #covidvaccine, #covid19vaccine, #covid19vaccines and #vaccines. These hashtags have been incorporated in the tweets that health and government bodies tweeted to inform about vaccination processes and effectiveness. They used also to encourage the public to get vaccinated, with hashtags like #stickittocovid and #mywhy. Also, the variants of the pandemics make the public concerned, officials use hashtags like #variantsofconcern to express their preoccupation about the OCVID-19 variants and informed about more public health measures, including flights restrictions and procedures like the online forms included in the app ArriveCan, so that the hashtag #arrivecan have been frequently used, as shown in Figure 4 (2).

4 CONCLUSION

This study is a preliminary research. It aims to globally analyze the insights from Twitter online public discourse harnessed by the government and the public health representatives in Canada through their official accounts. This analysis has been conducted through three different perspectives: activities, engagement, and trends. For the activities, we observed that the government and the public health representatives in Canada were more active during the third wave than the second wave. However, we observed that not all governments and the public health representatives are active at the same level. For the engagement, we observed that when it comes to severe measures, people were more engaged with politicians than with health bodies. Finally, for the trends, we observed that the focus of the discourse changed between the second and the third wave; for the second wave, the discourse was more about the safety measures to undertake and the third wave was more about vaccination.

[5] https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000901

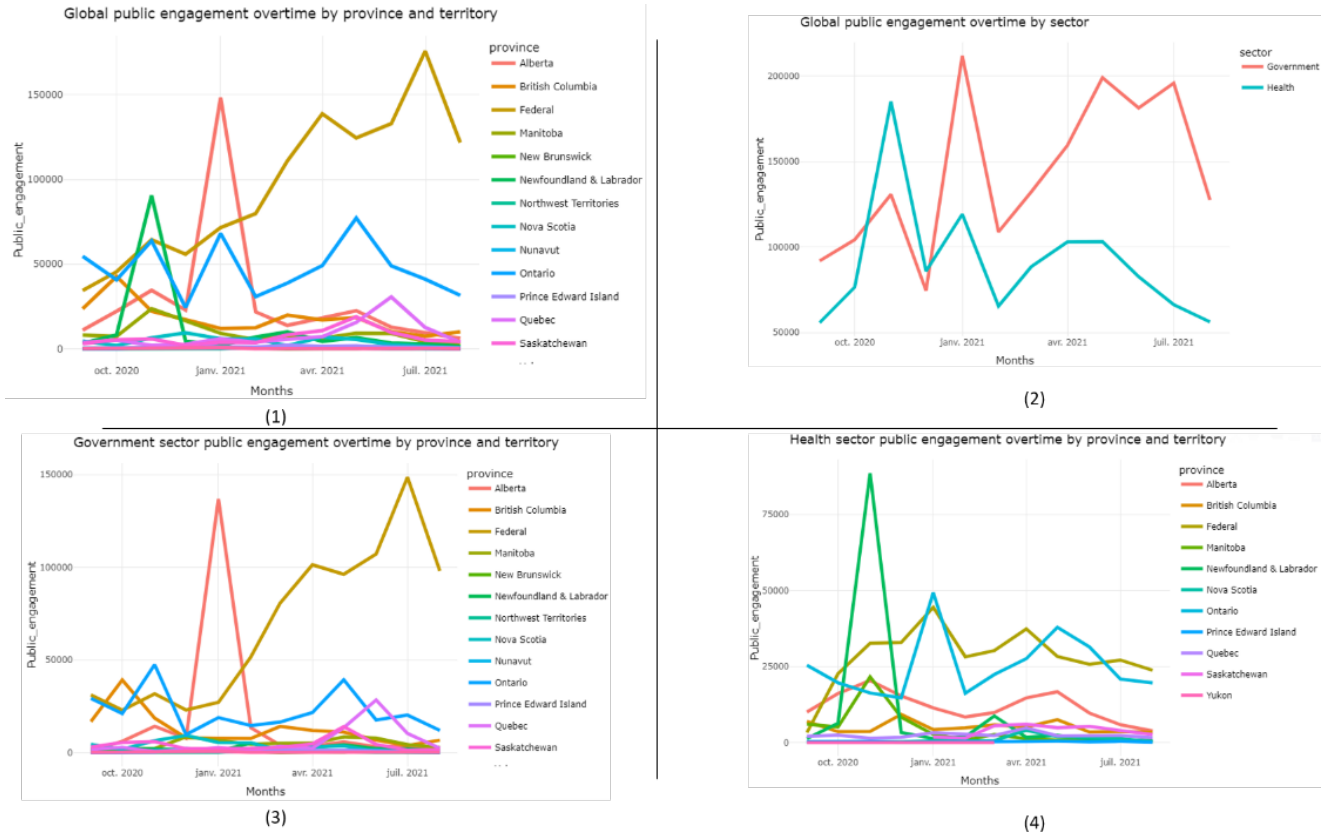


Figure 3: Public engagement overtime

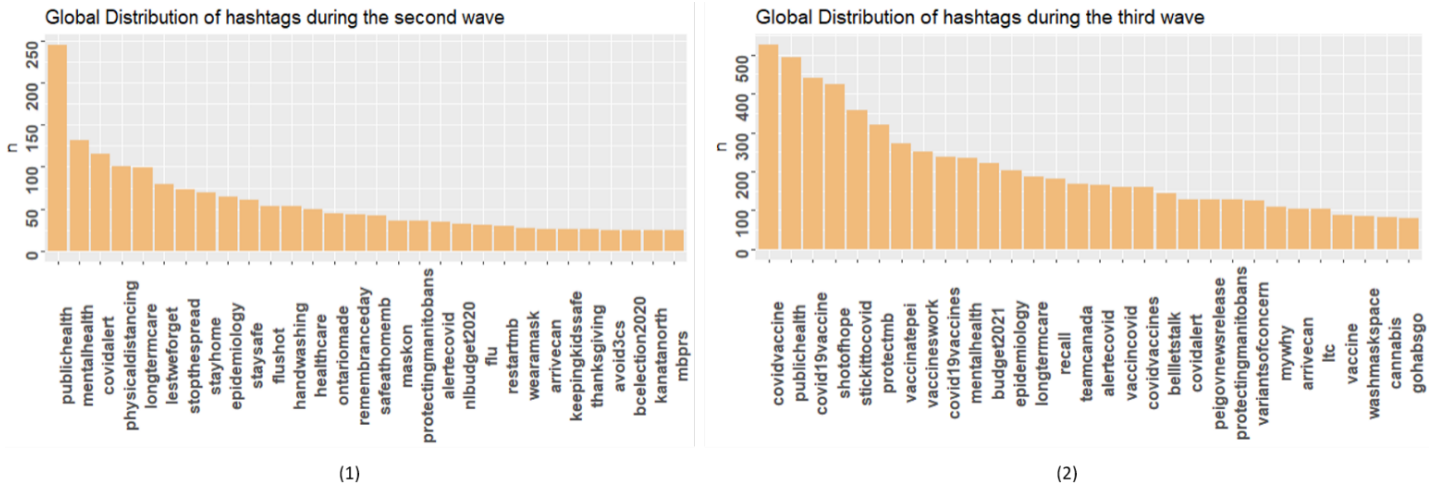


Figure 4: Global distribution of hashtags

As future research directions, we identify three directions. First, we saw in this study that some government bodies were more active than others. So, we propose to extend this study with a deeper analysis to understand the differences between the government bodies. Second, it will be interesting to apply machine learning techniques to better understand and classify the related public discourse (topics and indicators). Finally, all the discourse related to COVID-19 taken on social media may influence individuals'

behaviors that can be either influenced by the conspiracists and non-conspiracists. We propose as a third research avenue to assess the influence that the online discourse can have on the individuals' perceptions and behavior.

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How Does Social Media Influence Government Trust Among Chinese Youth Groups? A Chain Mediation Study Based on Trust Theory and Planned Behavior Theory

Yuanyuan Guo*
Beijing Normal University, Department of Government Management
guoasuna@gmail.com

ABSTRACT

Recent theoretical developments have revealed that women's government trust is higher than men and political participation may mediate social media and government trust. Political knowledge and political efficacy may also play such a role. Based on the trust theory and planned behavior theory, this paper makes a multi-group analysis with gender as a grouping variable through a structural equation model. This paper analyzes the intermediary chain role of political knowledge, political participation, and political efficacy between social media and government trust of the youth groups in Beijing. Results show that social media directly affects young females' political participation and has no such effect on young males. In both groups, political knowledge and political participation have a mediating chain role in social media and government trust. These results implicate that the government should pay attention to the development of social media, make good use of the indirect effect of social media on youths' government trust, focus on promoting correct and healthy political knowledge on social media, cultivate youth political consciousness, create more opportunities for youth political participation, and let the youth understand the significance of political activities, so as to achieve the purpose of improving government trust.

CCS CONCEPTS

• **Social and professional topics**; • **Computing / technology policy**; • **Government technology policy**; • **Governmental regulations**; • **Applied computing**; • **Law, social and behavioral sciences**; • **Sociology Additional**;

KEYWORDS

Women Study, Youth Study, Social media, Government Trust

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*Yuanyuan Guo, Ph.D candidate in Department of Government Management, Beijing Normal University. Address: Xinjiekouwai Str.19, Haidian Strict, Beijing, China. E-mail: guoasuna@gmail.com

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1 INTRODUCTION

With the rapid development of the Internet and the constant renewal of media, Internet users in China are increasing yearly. At now, the proportion of Internet users reached 99.2%. The rapid popularization of the Internet has made social media develop rapidly and has gradually penetrated the daily life of young people. Social media is becoming the primary tool for young people, especially college students. More and more youth groups communicate with social media to make their own 'voices'. Youth groups is important. Their government trust is closely related to building a socialist modernization power in China. As an essential communication tool, social media such as Weibo, We Chat, QQ, and TikTok subtly influence the government trust of youth groups. This seems to be a common problem in the research of government trust. It is crucial to study the impact of social media use on government trust. In addition, Chinese female population accounts for nearly half of China's population. However, the proportion of women's political participation is very low. Evidence shows that the factors affecting female government trust may differ from those affecting male government trust [1]. Therefore, this paper attempts to find out the main factors affecting the government trust of young female groups by comparing with the data of young male groups. And put forward suggestions to improve youth's political participation and political trust.

This paper uses the empirical research method to take 386 young people in Beijing between 18 and 35 years old as research samples. Through the structural equation model for multi-group analysis, this paper tries to understand the influence of social media use of young male and female groups in Beijing on government trust and the intermediary chain role of political knowledge, political participation, and political efficacy. There are three research questions in this paper. Firstly, does the use of social media influence young male and female government trust? Secondly, what are the difference and common points in these influence mechanisms? Thirdly, are political knowledge, political participation, and political efficacy chain mediating factors between social media and political trust?

2 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Based on trust theory and theory of planned behavior, this paper integrates and expands these two theoretical models and constructs

the theoretical framework of social media use and government trust. Through literature review, this paper puts forward the research hypothesis.

2.1 Trust Theory and Theory of Planned Behavior

In the 1950s, Deutch [2] initiated the trust research in social psychology. Since then, trust has attracted the attention of scholars in various disciplines. Although all disciplines are studying "trust," there is no uniform definition of "trust." Scholars have different definitions of trust according to different research fields and different research perspectives. According to Deutsh, trust refers to an individual's confidence in the intention and ability of affiliated partners and a belief that affiliated partners will become as they wish. Zand [3] pointed out that trust is the composition of a series of behaviors. When an individual suffers losses, these behaviors are often not controlled by the individual, thus increasing the risk of the trustor. Moorman et al. [4] believe that trust refers to the willingness to rely on trading partners who have confidence in them. Carter and others believe that trust can be divided into trust in the Internet, government, and perceived risk. In the subsequent research, they increased one variable: trust the technology. The government has invested a lot of time and resources to increase citizens' trust in public management and maintain a long-term relationship of mutual trust with citizens [5]. The literature on public administration points out that citizens worldwide have reduced their trust in the government [6].

In psychology, the theory of planned behavior (TPB) is a theory that connects individual beliefs and behaviors. The theory points out that the intention of attitude, subject norm, and perceived behavior control jointly shape the individual behavior intention and behavior. Ajzen proposed this theory in his article 'From intention to action: theory of planned behavior.' This theory is developed from rational behavior and various theories of attitude. According to the theory of rational action, if people evaluate the suggested behavior as positive (attitude), and if they think that their important and others want them to perform the behavior (subjective norm), it leads to higher intentions (motivation). They are more likely to do so. Many studies have confirmed that attitude and subjective norms are highly correlated with behavioral intention and subsequent behavior. In addition to attitude and subjective norms, the theory of planned behavior also adds the concept of perceived behavioral control, which originates from self-efficacy theory (SET). Bandura proposed Self-efficacy in 1977 from social cognitive theory. According to Bandura, expectations determine the effect and behavioral response. Bandura divided expectations into two different types: self-efficacy and outcome expectations. He defines self-efficacy as believing that people can successfully perform the behavior needed to produce results. The result expectation refers to a person's estimation that a given behavior will lead to some results. He noted that self-efficacy was the essential prerequisite for behavioral change, as it determined response initiation. Previous surveys have shown that people's behavior is strongly affected by people's confidence in their behavioral ability. Since self-efficacy theory helps explain various relationships among beliefs, attitudes, intentions, and behaviors, SET has been widely used in health-related fields, such as pre-adolescent sports activities and mental health and sports.

Based on these two theories, this paper proposes an integrated theoretical framework (Figure 1). This paper studies the impact of social media on government trust based on trust theory and planned behavior theory. Government trust can be seen as the idea of citizens. Citizens learn political knowledge through social media, thereby administering subjective norms. This subjective norm will indirectly affect citizens' actions, both political participation. Political participation will improve citizens' political efficacy and indirectly enhance government trust.

2.2 Social Media and Government Trust

Chinese citizens prefer social media like QQ, WeChat, Weibo and TikTok, etc. The use of social media mainly consists of two aspects. One is citizens' access to external information [7], and the other is citizens' demand for establishing and consolidating social relations [8]. In recent years, the interaction between social media and government trust has been one of the most critical and dynamic research areas in public administration. Evans et al. [9] conducted an exploratory process-oriented study examining the relationship between social media and government trust. They found that most cities have multiple accounts on social media. These cities maintain strict control over the content, account creation, and employee and audience participation to ensure compliance with federal, provincial, or state legislation and reduce technology and content-based risks. These cities use social media to disseminate information, respond to service requests, and provide problem management. For operational purposes, social media results are occasionally measured. Only two cities have developed special procedures to manage social media as records. Contrary to previous studies, this study shows that trust relations require agents (institutions) and clients (citizens). Chen and Sun [10] explore how modern Chinese media influence citizens' trust in government. They found that China's official media positively impacts government trust. In addition, postmaterialist values, performance evaluation, and sustained multiple roles are bridges between the positive effects of official media on government trust. Compared with cultivating and guiding values, the role of official media in promoting government performance plays a more critical role in enhancing citizens' trust in government. According to these works, the first hypothesis in this paper is:

Hypothesis One: Social media has a direct impact on government trust.

Some studies further show that different genders may have different degrees of government trust. Lu et al. [1] found that social media significantly impacts trust in government. And this effect will vary according to gender. They also found that information sources played a role in explaining Chinese netizens' attitudes toward the government. The critical mechanism of Internet usage affecting trust in government is the change of netizens' evaluation of government performance, respect for government authority, and internal efficiency. Tom and Per [11] found that women trust the government more than men, and that under different occupational

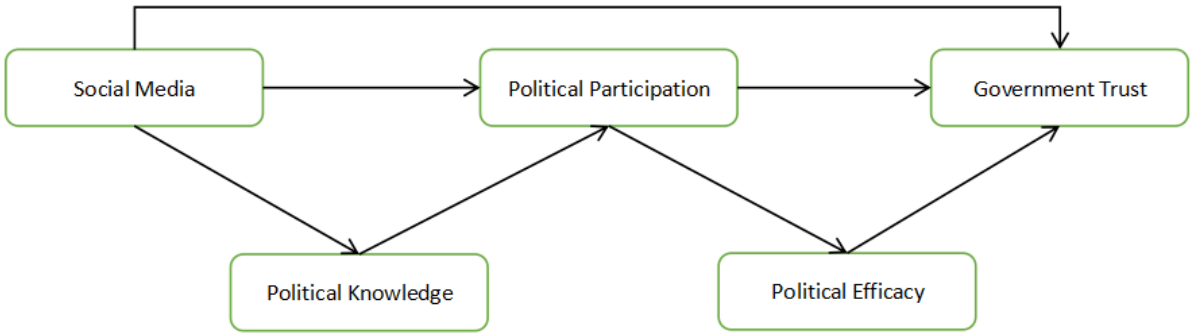


Figure 1: Integrated theoretical framework of government trust research

structures, people with higher social status are more rational, objective and willing to trust the government. Therefore, this paper also proposes the following assumptions:

Hypothesis Two: Social media has a greater impact on young female's government trust than on young male's government trust.

2.3 Research on Mediating Effect of Political Knowledge, Political Participation and Political Efficacy

Political knowledge refers to the information obtained by citizens about the government, government officials, and government events so that citizens can have a certain understanding of government operation, political participation, and political affairs. Political efficacy refers to a person's ability to think that his participation affects the political system and government decision-making. It also means a person's feeling or belief that their political behavior can influence the whole political process. Many studies have shown that political knowledge, political participation, and political effectiveness have a single intermediary role. Few scholars study the chain mediating relationship among them. Hollander [12] pointed out that the combination of high political self-efficacy and low trust in the government is the best condition for political mobilization. However, the research results on the interaction between self-efficacy and trust are mixed. His study examined whether talk broadcasts associated with political mobilization in recent studies have mobilized those who believe they can influence public affairs but lack trust in government. He tested these expectations according to the overall participation measurement standard and the four factors constituting the measurement standard. Compared with other variable combinations, he found that few people supported talk broadcast as a more powerful predictor of high-efficiency/low-trust respondents' participation. However, the interaction between talk radio exposure and political conservatives received some support among all the variables involved. This paper argues that political knowledge, political participation and political efficacy may all be the intermediaries between social media and government trust, and they may have chain mediating effects. Therefore, this paper proposes the following assumptions:

Hypothesis Three: Political knowledge, political participation and political efficacy have chain mediating effect between social media and government trust.

3 METHOD

The questionnaire in this study is combined with the mature scale of existing research and the self-made scale adapted according to the research content. Specifically, answers to the scales were recorded on a 5-point Likert scale ranging from 1 ("Strongly disagree") to 5 ("Strongly agree"). This questionnaire contains five dimensions of measurement: the use of social media, political knowledge, political participation, political efficacy, and government trust. The research object of this paper is the youth group aged 18 to 35 in the Beijing area.

In the questionnaire survey process, the researchers first selected 100 respondents to carry out the pretest of the questionnaire to test the reliability and validity of the questionnaire and adjust the content of the questionable questionnaire in time. After the pretest, the overall reliability of the questionnaire is 0.801, and the reliability of each dimension is 0.735, 0.802, 0.851, 0.702 and 0.710, respectively. These results show that this questionnaire has good reliability. The KMO value of the questionnaire is 0.777, p-value is 0.000, indicating that the questionnaire validity is good, suitable for further analysis. This questionnaire launched on February 28th, 2021, and ended on April 29nd, 2021. In this study, multi-stage stratified sampling method was adopted to ensure the representativeness of samples. The researchers finally selected 460 samples from 16 districts in Beijing. According to the meticulous degree of users' answers, 386 questionnaires were selected for analysis after the strict screening. Among them, 223 citizens are female, 163 citizens are male.

4 RESULT AND DISCUSSION

This paper used AMOS23.0 to conduct multi-group confirmatory factor analysis and multi-group structural equation model with gender as the grouping variable. The descriptive analysis table is as follow (Table 1):

According to the modified confirmatory factor analysis, PK1 and GT1 are deleted. After calculating, the standardized result path

Table 1: Descriptive analysis

		Frequency	Percentage
Gender	Female	223	57.8
	Male	163	42.2
	Total	386	100.0
Education	High school and below	12	3.1
	Bachelor	181	46.9
	Master	126	32.6
	Doctor	67	17.4
	Total	386	100.0
Annual Income	Above 200,000RMB	52	13.5
	100,000-200,000RMB	115	29.8
	30,000-100,000RMB	97	25.1
	Less than 30,000RMB	122	31.6
	Total	386	100.0

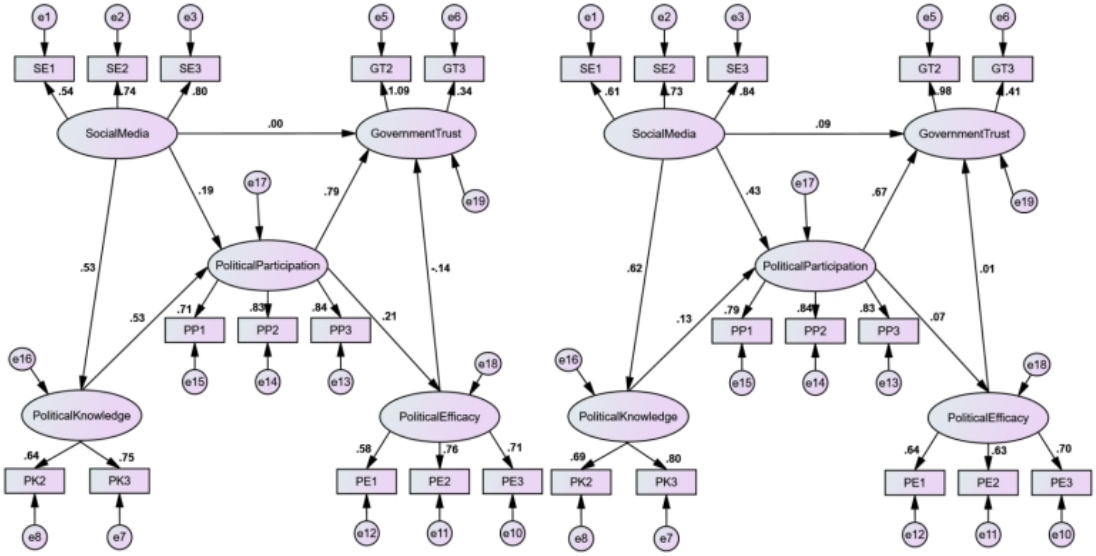


Figure 2: Initial Structural Equation Model (Left is Male Group, Right is Female Group)

diagram of the initial structural equation model of the male group and female group are shown in Figure 2:

In the initial structural equation model (Figure 2), from the p-value of the factor load of each path, most paths in the male group passed the significance test, and the p-value was less than 0.05. There are only three paths (Political Participation <—Social Media, Government Trust <—Political Efficacy and Government Trust <—Social Media) that are not manifest and do not pass the significance test. From the p-value of the factor load of each path, most paths in the female group passed the significance test, and the p-value was less than 0.05. There are only four paths (Political Participation<—Political Knowledge and Political Efficacy<—Political Participation and Government Trust<—Social Media and Government Trust<—Political Efficacy) that are not manifest and do not pass the significance test. The chi-square value of the model is 220.067, the degree of freedom is 116, and the p value is 0.000. The model has a total of 11 fitting indicators, 8 of which (χ^2/df=1.897, RMSEA=0.048, GFI=0.920) are completely up to standard, and 2 of them are basically up to standard (AGFI=0.874, NFI=0.883). It shows that the model fitting effect is good, and the model can be modified.

After modified the structural equation model (Figure 3), from the p-value of the factor load of each path, most paths in the male group passed the significance test, and the p-value was less than 0.05. There are only three paths (Political Participation <—Social Media and Government Trust <—Social Media and Government Trust<—Political Efficacy) that are not manifest and do not pass the significance test. From the p-value of the factor load of each path, most paths in the female group passed the significance test, and the p-value was less than 0.05. There are only three paths (Political Efficacy<—Political Participation and Government Trust<—Social

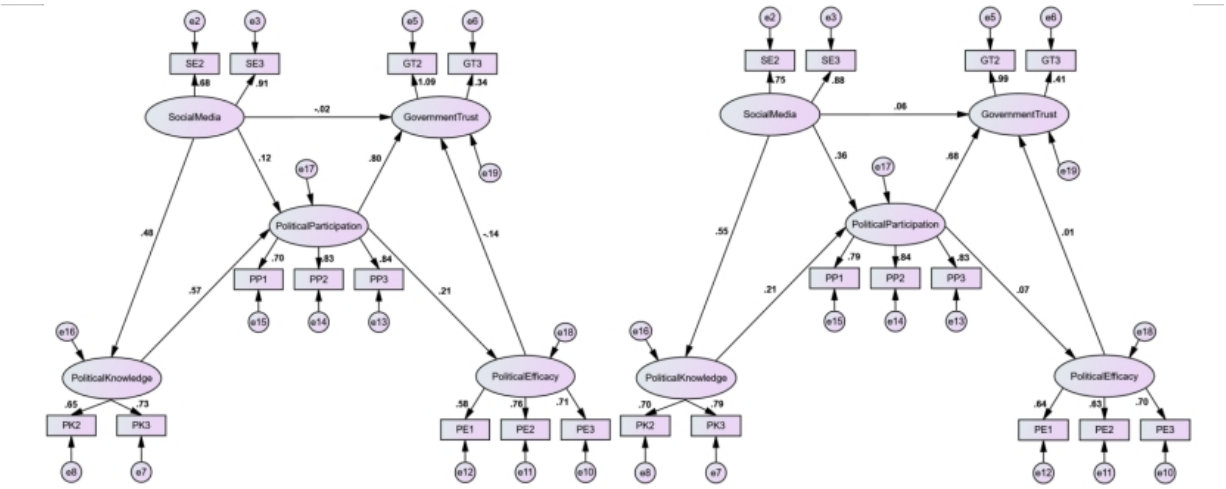


Figure 3: Modified Structural Equation Model (Left is Male Group, Right is Female Group)

Table 2: Path coefficient of modified Structural Equation Model

			Group	UNSTD	S.E.	C.R.	P	STD
Political Knowledge	<—	Social Media	Male	.645	.151	4.279	***	.485
			Female	.664	.112	5.946	***	.552
Political Participation	<—	Social Media	Male	.184	.161	1.142	.253	.122
			Female	.424	.118	3.581	***	.356
Political Participation	<—	Political Knowledge	Male	.649	.160	4.062	***	.572
			Female	.207	.104	2.000	.045	.209
Political Efficacy	<—	Political Participation	Male	.215	.105	2.056	.040	.205
			Female	.085	.110	.772	.440	.067
Government Trust	<—	Social Media	Male	-.041	.111	-.367	.714	-.021
			Female	.107	.112	.950	.342	.064
Government Trust	<—	Political Participation	Male	1.021	.091	11.211	***	.800
			Female	.962	.103	9.356	***	.684
Government Trust	<—	Political Efficacy	Male	-.169	.070	-2.395	.067	-.139
			Female	.007	.068	.109	.914	.007

Media and Government Trust<—Political Efficacy) that are not manifest and do not pass the significance test.

In the male group, social media has a direct impact on political knowledge. For each unit increase in the latent variable of social media, the latent variable of political knowledge will directly increase by 0.485 units (Table 2). In the female group, social media has a direct impact on political knowledge too. For each unit increase in the latent variable of social media, the latent variable of political knowledge will directly increase by 0.552 units (Table 3). Social media has both direct and indirect effect on political participation. Every 1 unit increase in social media latent variables, political participation latent variables will direct increase 0.356 units and indirect increase 0.116 units.

The chi-square value of the model is 151.176, the degree of freedom is 94, and the p value is 0.000. Compared with the initial model, the chi-square value of the modified confirmatory factor analysis model decreased significantly, and the values of each fitting index also increased. The model has a total of 11 fitting indicators, 10 of which are completely up to standard (χ^2/df=1.608, RMR=0.049, GFI=0.939), and 1 (AGFI=0.899) is basically up to standard. It shows that the model fitting effect is good, and the model correction is meaningful.

Based on the above results, both male group and female group, the hypothesis one and hypothesis two have not passed the test. Contrary to the findings of Evans et al. [9], this paper did not find social media has a direct impact on government trust. Song and Lee [13] point out that the direct relationship between citizens' use of government social media and trust in government is not obvious. This finding means that social media in government can only increase citizens' trust in government by achieving some expected results. In the era of social media, public use of social media to access various public issues affects their trust in government. Domestic and foreign academic circles have conducted a lot of discussions on this. For example, according to the 2010 China Social

Table 3: Table of standard effects

	Group	Standardized Direct Effects	Standardized Indirect Effects	Standardized Total Effects
Social Media → Political Knowledge	Male	.485	.000	.485
	Female	.552	.000	.552
Social Media → Political Participation	Male	.122	.277	.399
	Female	.356	.116	.471
Social Media → Political Efficacy	Male	.000	.082	.082
	Female	.000	.031	.031
Social Media → Government Trust	Male	-.021	.308	.287
	Female	.064	.323	.386
Politic Knowledge → Political Participation	Male	.572	.000	.572
	Female	.209	.000	.209
Politic Knowledge → Political Efficacy	Male	.000	.117	.117
	Female	.000	.014	.014
Politic Knowledge → Government Trust	Male	.000	.442	.442
	Female	.000	.143	.143
Political Participation → Political Efficacy	Male	.205	.000	.205
	Female	.067	.000	.067
Political Participation → Government Trust	Male	.800	-.028	.772
	Female	.684	.000	.684
Politic Efficacy → Government Trust	Male	-.139	.000	-.139
	Female	.007	.000	.007

Survey data, public access to social information through the network is negatively correlated with government trust. The more frequently the public uses social media to obtain information, the lower their trust in the government. From these results, it is clear that social media indirectly impacts government trust. Its impact mechanism must be mediated by political knowledge and political participation. Since the political efficacy doesn't have a mediate effect, hypothesis three (Political knowledge, political participation, and political efficacy have mediating chain effect between social media and government trust) partly pass the test. Political knowledge and political participation are chain intermediaries of social media and government trust. This is a new finding too. Most scholars study the role of a single intermediary. Few scholars study the impact of chain intermediaries. Chain mediation can better explain why social media affects government trust and avoid missing variables.

There are some differences in the results between young male and female groups. In the young male group, social media has no direct impact on political participation. However, in the young female group, social media has a direct effect on political participation, with a factor load of 0.356, indicating that political participation will increase by 0.356 units per 1 unit increase in social media latent variables. This finding is partly in line with previous findings [14–16]. Some scholars believe that social media has a positive impact on political participation without controlling gender and age. However, after controlling the gender and age, the results of the male and female groups are very different. Social media does not affect men's political participation because men will not change their judgment on political participation even if external factors influence them. On the contrary, young women may be more receptive to the call of social media and increase their political participation through social media. Besides, political knowledge is an intermediary between social media and political participation. In the young male group, political knowledge is fully mediated because social media has no direct effect on political participation. In the young female group, political knowledge is a partial intermediary because social media has a direct impact on political participation. Contrary to the findings of Hollander [12], this paper did not find political effectiveness have mediating effect between social media and government trust.

A further novel finding is the impact of political participation on political effectiveness. In the young male group, the factor load of the influence path of political participation on political efficiency is 0.205, indicating that the latent variable of political participation will increase by 0.205 units per 1 unit increase. There is no such effect in the young female group. Young women's political participation will not improve their political efficacy. And their political efficacy will not affect their government trust. The possible reason is that young women's overall political participation is less, resulting in their inability to change the existing political system in the process of political participation, more unable to affect the government's political decision-making. Their government trust and political efficacy have no relationship. It is most important to encourage young women to participate in politics at the current stage. In the future, when the proportion of young women's political participation reaches a certain level, it will naturally form the impact of political participation on political efficacy.

5 CONCLUSION

The most exciting finding of this study lies in the different effects of social media use of young female and male groups on political

knowledge, political participation, political efficiency, and government trust. Gender is an important variable that affects the trust relationship between social media and government. Different genders have different level of political participation and government trust. In addition, another interesting finding of this study lies in the intermediary chain role of political knowledge and political participation in social media and government trust. Most of the previous studies focused on the study of single intermediaries without considering the influence of chain intermediaries. In female groups, political knowledge and political participation have a full mediating effect and incomplete mediating effect. Social media directly influence women's political participation. However, political knowledge and political participation are only fully mediated in the male group. The use of social media in male groups must be through political knowledge to affect their political participation. This shows that if the government wants to influence youths' political participation and government trust through social media, it must pay attention to the role of social media in spreading political knowledge, effectively supervise social media in spreading positive and healthy political knowledge, improve youths' political knowledge level and cultivate citizens' awareness of political participation.

The policy recommendations of this paper have two aspects. The governments should pay attention to the development of social media. Although social media has no direct effect on government trust, it indirectly affects it. Social media is the cornerstone of government trust. Social media directly affects young people, especially women, access to political knowledge. A good network culture environment is an essential part of improving the political knowledge level of youth groups. The openness and anonymity of social media itself attract the broad participation of youth groups. However, it cannot be ignored that the virtuality of this kind of network society will also bring some adverse effects. For example, social media may lead to the widespread dissemination of false and untrue political information. Bad political information transmitted in social media will imperceptibly affect youth groups' political values and confuse their political cognition. Therefore, the government must supervise and regulate social media, strengthen the legal and moral construction of social media, standardize the use of social media, and create a good network political environment. In addition, the government should effectively integrate the various resources of social media, actively carry out the construction of social media political learning atmosphere, occupy the main position of network political culture, and form the correct direction of public opinion. For example, in the period of annual two sessions, the government can take full advantage of the social media, organize and carry out related activities, enhance interactive participation, cultivate a participatory political and cultural environment, cultivate the initiative of young people to learn political knowledge.

Besides, the governments should start from institutional construction to form a working management mechanism for training and selecting female cadres. Organizations at all levels and women's federations can establish relevant systems, gradually realize the process of training women cadres, institutionalization, and install and improve the supervision mechanism. In addition, the government should ensure the proportion of women's political participation. Further, formulate and take corresponding measures to ensure the proportion of women entering the decision-making core institutions. The cadre allocation of the party and government departments at all levels, especially the policy implementation agencies and leading groups, should have clear and rigid proportional provisions on the number of female cadres. Effectively guaranteeing them from the policy and law and resolutely implementing it.

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E-petitioning as Online Collective Action in We the People: The Case of the Legalization of Marijuana in the US

Catherine Dumas
Simmons University, United States
catherine.dumas2@simmons.edu

ABSTRACT

The purpose of this research is to find further evidence that e-petitioning is a form of online collective action. From 2011- 2020, individuals have been able to express their policy preferences on We the People (WtP), the first web-enabled petitioning system for the US federal government. This Internet-based platform created by the Obama Administration allowed people to create and/or sign petitions and solicit support for policy suggestions. Using WtP petition data, this case study examines a set of petitions that were initiated by NORML, a national organization that advocates for marijuana law reforms, and other organizations starting the day WtP was launched on 9/22/2011 that include policy suggestions relating to marijuana legalization. Using data mining techniques, namely market basket analysis and social network analysis, I found evidence of the mobilization of online "communities" for various policy suggestions to address the issues surrounding the legalization of marijuana in the US.

CCS CONCEPTS

• **Computing methodologies**; • **Empirical studies**; • **Real-time systems**;

KEYWORDS

Electronic Petitioning, Online Collective Action, Market Basket Analysis, Social Network Analysis, Marijuana Legalization

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1 INTRODUCTION

In September 2011, President Obama's administration initiated the first web-enabled petition system for the US federal government called We the People (WtP) (https://petitions.whitehouse.gov/) as part of the Open Government Partnership (OGP) launched in July 2011. Obama's first National Action Plan for the OGP was released in September 2011 featuring WtP as an innovative tool for citizen engagement [1]. WtP gives individuals the opportunity to petition the US federal government to undertake actions suggested by the petitioner and to register signatures from supporters. New users must create an account with an email address, first name, last name, and zip code (WtP stopped asking for a zip code from the user in April 2017).

When a petition garnered at least a certain threshold[1] of signatures within 30 days it became eligible to receive a response from the Obama Administration. Under Obama, usage of WtP had become increasingly popular attracting a growing amount of petitioning activity. As of November 2016, WtP had generated over 28 million users, more than 475,000 petitions, and 38.5 million signatures [2]. The system was simply ignored during the Trump Administration. Currently, under the Biden Administration, the WtP system is nowhere to be found on the White House website and no reason has been given for its removal [3].

During Obama's Administration, few successful e-petitions on WtP have been followed by actions that are consistent with those requested by the petitions, some with attribution to the petition. For example, on December 27, 2014, Leelah Alcorn, a 17-year-old transgender youth committed suicide after leaving a note on her Tumblr blog describing how her parents forced her to attend conversion therapy. On January 3, 2015, the petition "Enact Leelah's Law to Ban All LGBTQ+ Conversion Therapy" was created on WtP, attracting over 120,000 signatures within the 30-day period required for a response from the Administration. In a statement that was posted alongside the petition, President Obama condemned the practice of conversion therapy [4]. President Obama responded by supporting state-level efforts to ban conversion therapy for minors; prior to this petition, the White House had no official stance on the issue [5].

Data from e-petitioning platforms can provide the opportunity to study e-petitioning behavior. The purpose of this research is to explore in greater detail the dynamics of e-petitioning signing behavior. Do people use e-petitioning to promote their policy preferences? If this is the case, then we should be able to see some signs of collective action and mobilization as a part of that promotion effort. In this case study, I investigated e-petitioning signing behavior to determine whether it is possible to find evidence of online activism in WtP.

In the case study that follows, I explore how electronic petitioning functioned as online collective action by the National Organization for the Reform of Marijuana Laws (NORML, founded in 1970) and other organizations in mobilizing support for policy suggestions to the US government related to the legalization of marijuana. The goals of this research are to determine if there is

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[1]The threshold started at 5000 and increased to 25,000 on October 3, 2011. On January 15, 2013, the threshold was increased again to 100,000.

evidence of collective action using the WtP platform and to investigate the possibility of communities forming around particular policy issues. I am particularly interested in the following research questions: 1) Do people sign petitions and return to the site to sign other petitions related to a particular policy suggestion? 2) Is there evidence of e-petitioners forming core groups or "communities" that are characterized by a particular policy suggestion?

2 BACKGROUND

2.1 Offline collective action

Marwell & Oliver define collective action as "actions taken by two or more people in pursuit of the same collective good" [6]. These goods have benefits but cannot be sold to private buyers [7].. According to Olson [8]:

A common, collective, or public good is here defined as any good such that, if any person X, in a group X1, . . ., X4, . . ., Xn consumes it, it cannot feasibly be withheld from others in that group. In other words, those who do not purchase or pay for any of the public or collective good cannot be excluded or kept from sharing in the consumption of the good, as they can where noncollective goods are concerned (p.14).

Since public goods cannot be withheld from anyone in the group, individuals in a group have the choice of whether or not to participate in the collective action for the public good. If they decide not to participate, they still benefit from the public good generated by the others in the group. This is what is referred to as the free-rider problem in collective action theory [8] [9] [10]. There may be different reasons for deciding whether or not people opt to free-ride or participate in collective action but it comes down to individuals forming a "binary decision: contribute or free ride" [11].

The other central component of traditional collective action theory is Olson's main points regarding collective action and group size in his book The Logic of Collective Action, which are that "large or latent groups will not organize for coordinated action merely because, as a group, they have no reason for doing so" [8] "groups with larger members will generally perform less efficiently than groups with smaller numbers of members" [8] and "small groups can provide themselves with collective goods without relying on coercion or any positive inducements apart from the collective good itself" [8]. Olson describes "latent" groups as individuals who are like-minded when it comes to public goods but lack the organizational formation to effectively communicate and coordinate [8]. Early empirical work supports the theory that smaller groups are more effective at collective action [12] [13] [14] [15].

As traditional theorists suggest, formal organization and small group size were necessary/important for effective collective action in the offline environment [8] [12] [13] [14] [15], however with the advent of the Internet and new information and communication technologies, traditional theories of collective action in the online environment need to be reconsidered. The free-rider problem and the group size of formal organization having to be small for effective collective action are theoretical concepts that are being challenged by "new uses of information and communication technologies in collective action" [11].

2.2 Online collective action by organizations

Bimber's more recent work [16] looked at different prompts for collective action in online digital media: organization-prompted, socially prompted, and self-directed collective action behavior.

According to Bimber:

Organization-prompted behavior is that in which a decision to participate is prompted by a request from a mobilizing organization: an interest group, civic organization, union, social movement organization, or campaign organization. Organization-prompted behavior presents the citizen with a choice about whether to comply with a request whose author is identifiable. That author is also likely to enjoy some authority or legitimacy to the recipient as an organization dedicated to the issue—the National Rifle Association, Greenpeace, National Association for the Advancement of Colored People (NAACP), Amnesty international [16].

Bimber sees this as the "classical understanding of organization-driven political mobilization" [16]

This case study on issues related to marijuana legalization in the US provides evidence of organization-prompted online collective action.

2.3 E-petitioning and slacktivism

Some scholars are skeptical about the actual impact of online activism on political participation, claiming that online activism is less effective than offline activism [17] [18], that the online activities replace traditional offline participation leading to lower overall levels of participation [19] [17] and that activism involves physical risks and not just online clicks [20]. The term "slacktivism" is the conjoining of the two words "slack" and "activism". There is an argument in the collective action literature that claims digital or online activism is nothing more than "slacktivism" because it is easy and makes people feel good about themselves, but has no impact on political outcomes [17] [21] [22]. Morozov [17] talks about e-petitioning as not only being a marginal activity but potentially problematic for democratic action because he suggests that it will discourage people from engaging in real, physically significant protests. One might undermine this argument by finding behavior patterns that indicate that signers are doing more than just clicking on one petition and never coming back to sign again. Signing multiple petitions on similar policy issues indicates that users are looking for ways to express their opinions, searching through petitions and signing the ones that are relevant to their opinion expression. Are individuals strategically engaging in systematic collective action in support of their policy preferences, that go well beyond simply pressing the "like" button on Facebook pages and single petition signatures often criticized by those advancing "slacktivist" hypotheses (e.g. [17] [21])?

Previous research on the US e-petitioning platform, We the People (WtP), found evidence that people signed more than one petition related to gun control laws after the Sandy Hook school shooting [23] [24]. Dumas [25] also found a group of white supremacists who strategically and systematically used WtP to broadcast their message of hate by creating and signing petitions on a monthly basis for a period of four years. The results of these studies support claims that e-petition data can provide information about how mobilized collective action can take place on e-petitioning platforms. The case

study that follows provides further evidence that e-petitioning is a form of activism that is more than just clicking a button online.

3 CASE STUDY: THE MARIJUANA PETITIONS

The case study that follows focuses on 25 marijuana petitions that were created on We the People that contain policy suggestions relating to the issues of the legalization of marijuana in the US. Marijuana is a name used for cannabis, a substance made from the cannabis plant that contains THC (tetrahydrocannabinol) that is used as a psychoactive drug or medicine [26]. The US federal government first regulated marijuana in 1937 when Congress passed the Marijuana Tax Act to regulate and tax it rather than make it illegal [27]. In 1952, the Boggs Act required mandatory sentences for offenses involving marijuana [27]. In 1970, Congress passed the Controlled Substance Act (CSA) that created categories or "schedules" to classify drugs with no medical use and that had the potential for abuse [27]. As a part of President Nixon's war on drugs, the CSA placed cannabis on Schedule 1, making it a controlled substance, illegal for recreational use or medicinal use [27]. In 1996, the state of California passed Proposition 215, the first legislation to legalize medical marijuana at the state level [27]. A 2009 memorandum from the Department of Justice titled "Investigations and Prosecutions in States Authorizing the Medical Use of Marijuana" stated that "the federal government should not focus federal resources on individuals whose actions are in clear and unambiguous compliance with existing laws" [28]. In 2010, the federal government raided and arrested growers in medical marijuana states across the country [28]. In June 2011, the Justice Department issued another memorandum clarifying the 2009 policy saying that marijuana patients would be free from prosecution, but not the industrial growers [28]. On November 6, 2012, Colorado became the first state to allow recreational use of marijuana by passing Amendment 64. The issues related to the legalization of marijuana remain topics of significant public discourse in the US.

Techniques from market basket analysis were used to explore questions about whether individuals who signed one marijuana petition also signed other marijuana petitions. Methods from social network analysis were used to determine if there are groups of individuals who signed the marijuana petitions, thus suggesting the creation of "communities" of individuals whose actions were similarly aligned in support of policy suggestions surrounding the legalization of marijuana in the US.

The analysis that follows considers the set of 25 petitions that were created and signed by individuals making policy suggestions to the US government about the legalization of marijuana. I was explicitly interested in exploring answers to the following research questions:

- RQ1. Do people sign petitions and return to the site to sign other petitions related to a particular policy suggestion?
- RQ2. Is there evidence of e-petitioners forming core groups or "communities" that are characterized by a particular policy suggestion?

3.1 Data Description.

The dataset for this case study consists of 25 petitions that contain the word "marijuana" and that successfully achieved 150 signatures within 30 days, making them available for the public to see and sign. The first four petitions in this set of 25 petitions were created on 9/22/2011 when the WtP platform went live.

Within the dataset consisting of the 25 petitions that have valid zip codes[2] there is a total of 246,919 signatures in the of which 223,917 are valid and 100,298 are unique signature identifications.

3.1.1 Launching WtP. On the day that WtP was launched, September 22, 2011, individuals started to mobilize on the petitioning site in favor of the legalization of marijuana in the US. Four petitions were created on September 22, 2011 and four were created the following day September 23, 2011. In a period of 39 days after WtP was launched, there were a total of 25 petitions created that were associated with the topic of marijuana (see Figure 1).

By reading the text of the title and the body of each of the 25 marijuana petitions in this case study, I sorted the petitions into thematic clusters. For inter-rater reliability, a separate coder repeated this process. The inter-rater reliability level of agreement was 70.7%. We came to a final agreement on a total of seven categories for the 25 marijuana petitions. Table 1 shows the final reconciliation on issue categories for the 25 marijuana petitions and the number of petitions in each category.

Table 5 (See Appendix A1) contains the petition ID, type (policy issue/ other related topics), petition title, the date the petition was created, the date that the petition became public for people to sign on the WtP site (reachedPublic), the approximate amount of time that it took for the petition to reach the 150 signatures necessary to be put on the WtP site for people to sign (Reached 150 signatures (in days or hours)), the signature count and the threshold needed to be eligible for a response from the Obama Administration for the 25 marijuana petitions.

The length of time between when a petition was created and when it became public on the website to be seen and signed varies, but for the most part is short. Recall that when a petition is created, it has 30 days to garner 150 signatures and become public on the site for other people to sign. Petition 1 "Legalize and Regulate Marijuana in a Manner Similar to Alcohol." was created on 9/22/11 at 10:03 and became public for individuals to sign at 10:53, 50 minutes later. There were nine petitions that became public within hours of the time they were created (see Table 2 Appendix A1, petitions 2, 3, 6, 13, 15, 16, 18, 19 & 23). Here we can see evidence of small groups of individuals who are signing petitions within hours of creation. For the rest of the petitions, the length of time between creation and becoming public ranges from one day to 20 days. The average length is 3.9 days for the remaining 16 marijuana petitions to achieve the 150 signatures needed to become public for people to sign.

The data set includes petitions with different thresholds. Recall that petitions must reach a certain number of signatures in order to become eligible for a response from the Obama Administration. The threshold initially was set at 5000 signatures when the WtP site became active on September 22, 2011. The threshold for petitions 1- 12 to receive a response was 5000 signatures. The threshold was increased to 25,000 on October 3, 2011 (less than two weeks after WtP was launched) so petitions 13-25 needed to reach 25,000 signatures to become eligible for a response. On January 15, 2013, the threshold was increased again to 100,000.

[2]A distinct signature ID consists of unique first and last initials followed by a five-digit zip code. Any ID that does not include a valid five-digit zip code was eliminated.

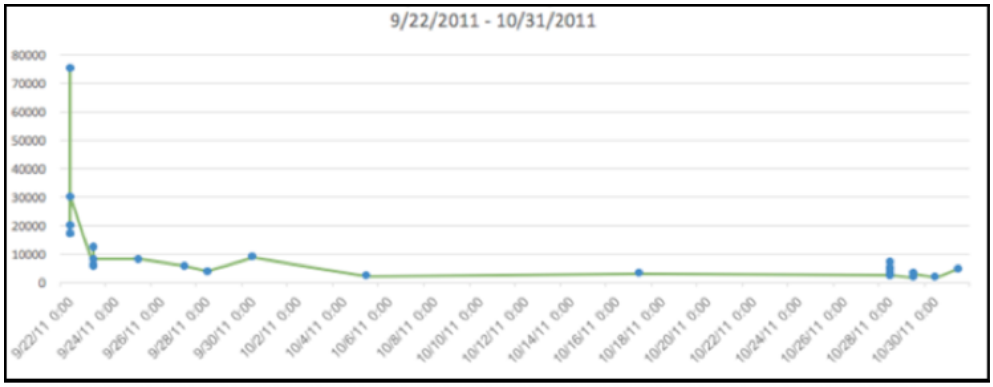


Figure 1: The 25 marijuana petitions with signature count over time

Table 1: Policy Issues/Other Related Topics for the Marijuana Petitions

Policy Issue/Other Related Topics	# Petitions
Approaches/Proposals to Legalize Marijuana	7
State Legalization Efforts	2
Treat Alcohol, Tobacco, and Marijuana the Same	5
Acknowledge Medical Benefits and/or Give Access for Medical Purposes	3
Requested Pardons	2
Objections to WtP Responses to Marijuana Petitions	5
Drug Prevention (Con)	1

Table 2: Eight Marijuana Petitions that Reached the 5000 Signature Threshold and Received the Same Response

ID	Title	Date Created	Signatures
1	Legalize and Regulate Marijuana in a Manner Similar to Alcohol	9/22/11 10:03	75,057
2	Legalize, regulate, and tax marijuana	9/22/11 10:18	20,104
3	Stop interfering With State Marijuana Legalization Efforts	9/22/11 12:44	17,054
4	End the destructive, wasteful and counterproductive "War on Drugs"	9/22/11 16:54	30,018
5	Demand an Amendment to the U.S. Constitution to End Marijuana, Marihuana, Cannabis and Hemp Prohibition.	9/23/11 0:15	6,243
6	Give States the Freedom to Establish Their Own Marijuana Laws.	9/23/11 14:44	12,470
7	Stop denying the medical value of cannabis	9/23/11 20:48	5840

In my research I discovered a webpage on NORML's (National Organization for the Reform of Marijuana Laws) website claiming that they created the first marijuana petition, petition 1, "Legalize and Regulate Marijuana in a Manner Similar to Alcohol." on September 22, 2011. NORML is a non-profit organization founded in 1970 and based in Washington, DC. Petition 1 garnered the most signatures with 75,057, well above the 5000 threshold, perhaps because it was the first petition created by the group of marijuana activists and there was an organized effort to get the petition to their members to be signed. I will discuss this further in the Background section. Out of the remaining 11 petitions with a 5000 threshold, only one petition, namely petition 11, did not reach the 5000 signatures. Additionally, as shown in Table 2, none of the petitions achieved the threshold after it was raised to 25,000.

Petitions 1-10 and 12 were responded to by the Obama Administration. The threshold for petitions 1- 12 to receive a response was 5000 signatures. As I mentioned earlier, the threshold was increased to 25,000 on October 3, 2011 (less than two weeks after WtP was launched) so petitions 13-25 needed to reach 25,000 signatures to become eligible for a response. Eight petitions (1-7 and 12) were responded to by Gil Kerlikowske, Director of the Office of National Drug Control Policy, on October 28, 2011 with the same response (see Table 2).

It appears that some of the users of the platform were not satisfied with the responses from the White House (Gil Kerlikowske). As shown in Tables 1 and 2 (See Appendix A1), there were five petitions that fell into the category "Objections to WtP Responses to Marijuana Petitions". See Appendix A2 for examples of the sentiments being expressed in the body of two of the five petitions.

As mentioned earlier, the first marijuana petition, petition 1, "Legalize and Regulate Marijuana in a Manner Similar to Alcohol." was



Figure 2: Screenshot of NORML's Webpage Discussing the White House's Response to their Petition on We The People http://blog.norml.org/2011/10/29/white-house-response-to-normls-we-the-people-marijuana-legalization-petition/

initiated by NORML (National Organization for the Reform of Marijuana Laws) on September 22, 2011. NORML's mission is "to move public opinion sufficiently to legalize the responsible use of marijuana by adults, and to serve as an advocate for consumers to assure they have access to high quality marijuana that is safe, convenient and affordable" [29]. The petition garnered 75,057 signatures.

On a webpage on NORML's website (See Figure 2) there was a post by Russ Belville, NORML's Outreach Coordinator, discussing the White House response that was given on October 28, 2011 (See Appendix A3 for the full text of the White House response) which reflects disappointment in the White House response to their petition.

Belville's post systematically rebuts the White House response, point by point and ends with 538 responses to the "White House response to NORML's "We the People" marijuana legalization petition in the comments section. Figure 3 is a screenshot of a few of the many (538) comments from people on Belville's blogpost on the webpage shown in Figure 2

The 538 comments are reactions to Belville's blogpost and reflect the frustration of the individuals with the White House's response to the petition NORML created and/or the Obama Administration. Here we see a group of people who are being mobilized by an activist organization to engage in an online conversation about the response WtP gave to the petition created by the organization.

There were two petitions that fell into the "Requested Pardons" category that also received a response from the Obama Administration. Petition 8 "Pardon Marc Emery" and petition 10 "Pardon Jason Spyres (K99397), an Illinois inmate serving a 30-year (now on 9th year) sentence on a marijuana charge." are specific cases of petitions created to support individuals who were incarcerated by the Federal government in marijuana related incidents.

Marc Emery, a Canadian businessman, publisher of Cannabis Culture Magazine, political activist, and the founder and leader of the B.C. Marijuana Party, was extradited to the US in 2010 for selling marijuana seeds to people in the US and was sentenced to five years in prison [30]. The arrest of Marc Emery was highly publicized in Canada and the WtP petition 8 "Pardon Marc Emery" was promoted on several marijuana news aggregate sites, blogsites, and Emery's Cannabis Culture Magazine. Emery's petition received 8,254 signatures with a threshold of 5000. There is a post on the blogsite Toke of the Town discussing Marc Emery's case, the WtP platform and has a link to sign petition 8.

There is a blogsite from Northern Ireland called Cannabis N.I. also discussing Marc Emery's case, the newly launched WtP platform, and has a "SIGN the Petition" link for people to easily access

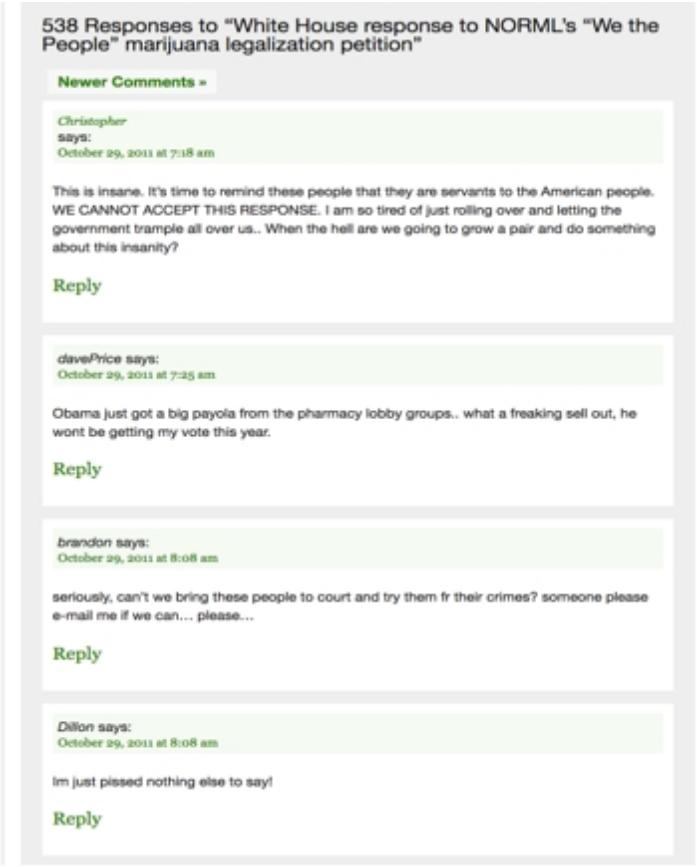


Figure 3: Screenshot of Comments on NORML's Blogpost Shown in Figure 2 http://blog.norml.org/2011/10/29/white-house-response-to-normls-we-the-people-marijuana-legalization-petition/

the petition on WtP and sign Emery's petition. The writers of the blogpost also mention how quickly (nine days) the petition reached the threshold of 5000 signatures and appear to be eagerly awaiting the "official reply from the White House" [31].

There was also a story on CTV Vancouver news website about the anticipated response from WtP to the "Pardon Marc Emery" petition. Weichel writes that "Emery's wife Jodie told ctvbc.ca she's excited to see the president address her husband's incarceration, but she's not getting her hopes up for a pardon." [30].

There was a post Marc Emery's magazine's website Cannabis Culture with the response that WtP gave to petition 8. The writers of the post express their frustration saying that "the answer is mostly a disappointing non-response: the White House has "declined to comment"" [32].

There was also a post of the official response from the White House to petition 8 "Pardon Marc Emery" posted on the Cannabis Culture's webpage. The writers of the post state that "Many of the 19 petitions received the same non-response, refusal to comment" claiming that these actions are "leaving many Americans discouraged yet again in President Obama for claiming that he wants to listen to the American people, but ignoring them when they bring up serious issues." [32]..

In addition to NORML, the marijuana petitions were being promoted by other activist organizations. The largest non-profit organization that works on marijuana policy reform is the Marijuana Policy Project (MPP) which was formed in 1995. MPP's mission is "to (1) increase public support for non-punitive, non-coercive marijuana policies; (2) identify and activate supporters of non-punitive, non-coercive marijuana policies; (3) change state laws to reduce or eliminate penalties for the medical and non-medical use of marijuana; and (4) gain influence in Congress" [33]. Figure 4 is a screenshot of MPP's Blog on their website calling attention to the WtP petitioning site, promoting 12 of the WtP marijuana petitions encouraging people to sign, and providing links that go directly to the petitions on the WtP e-petitioning site. MPP also asks people to share the list of petitions with their social networks such as Facebook and Twitter.

I found additional websites belonging to other organizations and groups in favor of the legalization of marijuana, such as the Montana Cannabis Industry Association (MTCIA) which works on improving the regulation of marijuana in Montana [34], Nugs.com, a medical marijuana and hemp resource providing current news on cannabis [35], and online forums such as Reddit. Users in each of these online platforms are promoting the marijuana petitions.



Figure 4: Screenshot of MPP's blog promoting the signing of 12 marijuana petitions on WtP https://blog.mpp.org/prohibition/we-the-people-11-marijuana-policy-petitions-on-the-white-house-website-you-should-sign-right-now/

Petition 3 "Stop Interfering With State Marijuana Legalization Efforts" was created by Neil Franklin, a retired Baltimore narcotics officer on September 22, 2011 and garnered 17,054 signatures. Franklin was also executive director of Law Enforcement Action Partnership (LEAP) (formerly Law Enforcement Against Prohibition) [36]. LEAP is a non-profit organization formed in 2002. LEAP's mission is:to unite and mobilize the voice of law enforcement in support of drug policy and criminal justice reforms that will make communities safer by focusing law enforcement resources on the greatest threats to public safety, promoting alternatives to arrest and incarceration, addressing the root causes of crime, and working toward healing police-community relations [36].

LEAP "envisions a world in which criminal justice and drug policies keep our communities safer. Ending the War on Drugs and looking beyond the criminal justice system for a range of solutions to address society's ills will better protect human rights, reduce violence and addiction, and build public respect for and trust in law enforcement" [36]. It is not clear if the petition was created by Neil Franklin as an individual, or as a representative of LEAP.

Clearly there is an online mobilization of activist organizations and other groups of people that are interested in marijuana policy reform and are using WtP as a platform to have their voices heard by the Obama Administration.

In the following sections I present the analyses and the results for my research questions (RQ1 and RQ2).

4 METHODOLOGY: DATA MINING TECHNIQUES

Data mining (sometimes called data or knowledge discovery) is the process of extracting information analyzing data from a data set and transforming it into a structure that can be analyzed to see if there is any useful information. Many different methods have been developed to analyze data looking for patterns or trends that cannot be observed through traditional statistical methods. For this study, I use techniques from market basket analysis and social network analysis on the 25 marijuana petitions that are the focus of this study. These techniques will be explained briefly below; for additional information see Easley and Kleinberg [37]; Newman [38]; and Tan et al. [39].

4.1 Market Basket Analysis

Market basket analysis is used to identify patterns of co-occurrences of objects. In the case of e-petitioning, e-petition transactions (or market baskets) contain the set of petitions each user signs. This data collected over time can be analyzed to see which petitions users frequently signed together.

Some definitions that will be useful to help understand the concept of frequent co-occurrence of objects in the context of petition data:

- Itemset: any set of items; each transaction is an itemset (subset of petitions signed by user)

- Support of an itemset S: This is the fraction of transactions which include all the items in S; that is, the support for S is the ratio of the number of transactions that include all the items in S to the total number of transactions.
- Frequent itemset: Any itemset S whose support exceeds a chosen support level. Thus, frequent itemsets represent subsets of petitions that are signed together often by users of the petitioning system.

In addition to frequent itemsets, analysis of market basket data can also reveal other patterns related to co-occurrences. For example, for some items x, y and z, a large fraction of users who sign petitions x and y may also sign z. These patterns are captured through an association rule which is usually shown as {x,y} → {z}. The importance of an association rule is specified using a measure called confidence. The confidence of the association rule {x,y} → {z} is the ratio of the number of transactions that contain all the items x, y and z to the number of transactions that contain the two items x and y. (Formally, confidence gives the conditional probability that the customer's basket contains item z given that it contains both x and y.) Thus, association rules with large confidence values also provide insights regarding co-occurrences.

4.2 Social Network Analysis

Online social media networks (such as Facebook, Twitter, Instagram), and professional networks (such as LinkedIn) are just a few examples. Social network analysis (SNA) helps us to explore the roles of actors or entities and relationships between these actors or entities in these networks. SNA methods are used to try to understand these relationships. SNA is used to study a variety of networks: communication networks, biological networks, economic networks, and terrorist networks [38].

Centrality is commonly used to measure the level of importance or influence of an actor or entity in a social network [39]. Along with Freeman's seminal paper, numerous other papers have acknowledged a variety of centrality measures for social networks [38]. Some of these include degree centrality, closeness centrality, betweenness centrality and eigenvector centrality. (Definitions for these can be found in Easley & Kleinberg [37] ; Freeman [40] ; Newmann, [38]. In the context of this study, the concept of actors or entities having large centrality measure values signifies a more central or important role in determining certain behavior in a given network.

A community (or cluster) is used to identify a group of actors or entities with similar behavior in a social network. Similarity in behavior can be defined in many ways and algorithms are available for partitioning the nodes of a social network into communities according to those definitions [38].

4.3 Results

4.3.1 Applying Market Basket Analysis to Marijuana Petitions. I used techniques from market basket analysis on the data collected for 25 Marijuana petitions. Market basket analysis is used to identify patterns of co-occurrences of objects. In the case of e-petitioning, e-petition transactions (or market baskets) contain the set of petitions each user signs. This data collected over time can be analyzed to see which petitions users frequently signed together.

For this analysis, I wanted to see if I could find petitions that different users may have signed in common. In this analysis of the 25 marijuana petitions, each person who signed at least one of the 25 petitions represents a market basket and the subset of the 25 petitions signed by the person represents the items in that basket. Since a total of 100,298 people (total number of unique signature identifications with valid zip codes for the 25 Marijuana petitions) signed one or more of these petitions, the data set for market basket analysis consisted of 100,298 baskets, with each basket containing at most 25 items (or petitions). I used the arules package in R to identify frequent itemsets, association rules and their confidence values.

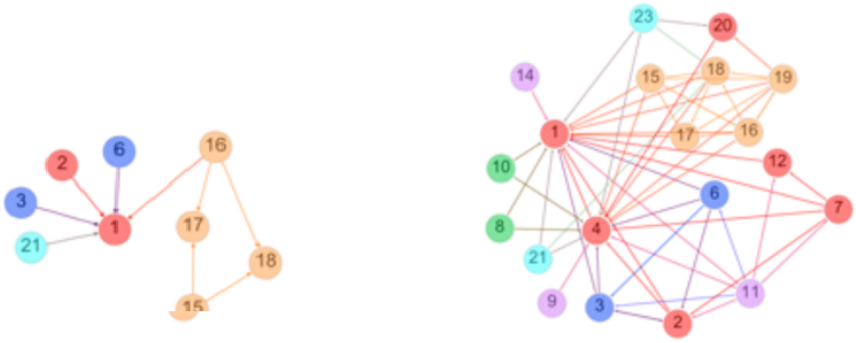
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I computed the confidence values of various association rules of the form {x}→{y}, where both x and y represent the IDs of one of the 25 petitions. For visualization purposes, I considered two different confidences values, namely 70% and 50% using a support of 1%. For each confidence value c, I constructed the following graphs: each node of the graph represents a petition ID and each edge (x,y) implies that the association rule {x}→{y} has a confidence value of at least c. The two graphs constructed in this manner are shown in Figure 5 (a-b) and depict the association between the petitions. Each node contains a petition ID that represents one of the 25 Marijuana petitions.

The nodes contain a petition ID and are colored according to the different category issues: red: is "Approaches/Proposals to Legalize Marijuana"; blue: "State Legalization Efforts"; orange: is "Treat alcohol, tobacco, and marijuana the same"; purple: is "Acknowledge medical benefits and/or give access for medical purposes"; green is "Requested pardons"; and light blue is "Objections to WtP responses to marijuana petitions".

From the structure of these graphs, the following conclusions can be drawn.

At the largest confidence value (70%), there is a small group of four petitions which are characterized by the common theme "Treat alcohol, tobacco, and marijuana the same" (petitions 15, 16, 17 and 18). Petitions 15, 16, 17, and 18 were all created on 10/28/11 within minutes of each other so individuals may have signed them during the same petition signing transaction. Petition 1 "Legalize and Regulate Marijuana in a Manner Similar to Alcohol." was the first marijuana petition created on WtP on 9/22/11 and has the largest number of signatures with 75, 057. Recall that petition 1 was created by NORML on the day the WtP platform went live for the first time for the public to use. Petition 1 plays a central role, that is, five out of eight petitions are connected to petition 1. Petition 21 "Publicly Request the Resignation of Gil Kerlikowske." and petition 16 "Regulate Tobacco and Alcohol in a manner similar to Marijuana and other currently illegal substances." are connected to petition 1



(A)70% (b) 50%

Figure 5: Association rules at various confidence levels for the 25 marijuana petitions. (a) 70% confidence level; (b) 50% confidence level.

and were created on 10/28/11 which is 36 days after petition 1 was created. This means that some individuals who signed petition 1 came back to WtP to sign petitions created over a month later.

When we lower the confidence value to 50%, 11 more petitions join the network. There appears to be co-signing of petitions across all of the six categories of policy issues and suggestions related to the topic of marijuana, since signatures did not necessarily fall within particular categories. As discussed earlier, the first twelve petitions were being promoted online by the activist organizations, blogs and forums regardless of the nature of the petition as long as it was related to marijuana policy reform. As a result, the thematic clusters I created for the marijuana petitions bear little or no relevance to the petitioning signing behavior. With the exception of petitions 16, 17, 18, and 19, there does not seem to be a preference for a particular policy issue but rather the more broader issue of marijuana policy reform. Recall that petitions 16, 17, 18, and 19 were created within minutes of each other so they may have been promoted to the same networks for support.

These petitions are highly connected on the basis of common signers and constitute a frequent itemset. The graphs reveal a pattern of signers signing petitions that relate to the topic of marijuana and not solely based on the thematic clusters that I created for the different policy issues within this data set of petitions. There are some petitions that were co-signed that fell into particular categories of policy issues and suggestions related to the topic of marijuana but for the most part the thematic clusters do not reflect people's preference for particular policy issues.

In the following sections, I will present the results from the social network analysis I conducted on the marijuana petitions.

4.3.2 Applying Social Network Analysis to Marijuana Petitions (RQ2). From the petition data, I constructed social network graphs that will allow us to identify highly central petition signers and groups of similar petition signers. To ensure that my conclusions were not affected by users who exhibited low levels of petitioning activity, I have restricted the network to users who signed at least 12 of the marijuana petitions. In the constructed network, each node represents a person who signed at least 12 petitions. An edge is added between two nodes if the corresponding pair of users co-signed at least 12 petitions. The resulting graph has 1229 nodes and 207,166 edges (see Table 3).

The graph consists of one large component containing all 1229 nodes. Thus, the component (called the giant component) of the network consisted of 100% of all the nodes. The large number of edges indicates that the nodes in the giant component form a cohesive group (Easley & Kleinberg 2010).

In the above discussion, I considered a social network in which each node represents a person who signed at least twelve petitions. Table 3 shows how the number of nodes in the graph drops rapidly as we increase the level of petition signing activity from 1 to 25. (In the table, I use Gi to denote the graph where each node represents a person who signed at least i petitions.) Since this analysis is focusing on a network where each node represents a person who signed at least 12 petitions, the network will be referred to as G12 (see Table 3).

Recall there is a total of 246,919 signatures in the 25 Marijuana petitions of which 223,917 are valid and 100,298 are unique signature identifications. As a result, 123,619 or 55% of the people who signed a petition signed more than one.

Table 3 also shows that out of the 25 marijuana petitions garnering a total of 100,298 unique signature identifications, 39,194 people (39%) signed at least two petitions in the set. Additionally, 24,402 people (24%) signed at least three of the marijuana petitions and 16,169 people (16%) signed at least four marijuana petitions. We see that 11,221 people signed at least five petitions, 7740 signed at least six petitions, and 5688 people signed at least seven petitions. The results indicate that there are individuals who are signing multiple petitions.

4.3.3 Centrality Measures for G12 of the 25 Marijuana Petitions. The network for G12, consists of nodes that represent people who signed at least 12 common petitions, in other words there is an edge between two nodes if they have signed 12 common petitions. Within this network there will also be an edge between two nodes (people) if they have signed 13 to 25 common petitions. The relationship or edge between two nodes is the number of common petitions that

Table 3: Number of Nodes for Different Number (1-25) of Common Marijuana Petitions Signed

Graph	#Nodes	Edges
G1	100,298	N/A[3]
G2	39,194	N/A
G3	24,402	115,383,041
G4	16,169	47,505,401
G5	11,221	20,096,005
G6	7740	8,370,114
G7	5688	4,374,153
G8	4336	2,450,300
G9	3280	1,358,200
G10	2477	728,869
G11	1695	364,928
G12	1229	207,166
G13	909	125,454
G14	686	79,739
G15	530	51,590
G16	417	33,277
G17	322	21,099
G18	248	13,000
G19	184	8012
G20	144	4635
G21	93	2385
G22	63	1158
G23	37	445
G24	16	91
G25	0	0

they signed together, and in this case, they must have signed at least 12 to be a part of the network.

After constructing the network for G12, I computed centrality measures (closeness, betweenness, and eigenvector) for each node to find the nodes that are the most central according to the structure of the graph. These computations were done with the igraph package in R. For each centrality measure, I computed the set of 100 nodes with the highest values. I found 91 out of the 100 nodes (i.e., 91%) appeared in all three sets, indicating that the group of nodes playing an important role in determining the behavior of the network are roughly the same, no matter which of the three centrality measures is used to find such nodes. These people are core or integral to connecting others to the graph because they have signed the most petitions. They are connected to more people in the network which also includes any two nodes who have 12 to 25 common petitions. These people may have created some of these petitions or influenced people to sign petitions by promoting the petitions via their social networks. Perhaps they can be considered "activists".

4.3.4 Community Detection. I used an R package, igraph[4], and a function called cluster_louvain[5] to identify the communities in the graphs. This tool partitions the nodes of the graph into subsets, with each subset representing one community. Communities represent the subgraphs where nodes in a subgraph have more edges to other nodes in the same subgraph as compared to the nodes outside of the subgraph. The relationships between the nodes in these communities are stronger than they were in the original network graph that I constructed because there are more edges between these nodes than the other nodes in the network. We know that in any of these communities, each pair of people signed at least 12 common petitions. Again, as with the original network, there can be an edge between two nodes/people who signed 13 to 25 common petitions. It is not necessary that all the people in the community signed the same set of n petitions. The communities are separated by the petitions that they do not have in common, thus there are fewer edges between the communities. I refer to these communities as "Communities of Signers" (see Table 4).

In the network G12, the community detection algorithm found three communities, denoted by C1, C2, and C3 with signature sizes presented in Table 4. In order to see if there were any patterns of signing behavior within the communities, for each community in C1, C2, and C3, I computed the three most favored petitions (i.e., the petitions which had the three highest signature counts among the people in the community) and the three least favored (i.e., the petitions which had the three lowest signature counts among the people in the community). In order to further qualitatively distinguish between the three communities, I calculated the ratio of the number of people that signed each petition to the number of people in the community. Table 4 shows the results of these computations.

- Red IDs are petitions in the "Approaches/Proposals to Legalize Marijuana" issue category
- Blue IDs are petitions in the "State Legalization Efforts" issue category
- Orange IDs are petitions in the "Treat alcohol, tobacco, and marijuana the same" issue category
- Purple IDs are petitions in the "Acknowledge medical benefits and/or give access for medical purposes" issue category
- Light Blue IDS are petitions in the "Objections to WtP responses to marijuana petitions" issue category
- Grey ID is a petition that is against the legalization of marijuana

The same three petitions were most favored by two out of the three communities, namely, C1 and C3: 4 "End the destructive, wasteful and counterproductive "War on Drugs"", 1 "Legalize and Regulate Marijuana in a Manner Similar to Alcohol." and 3 "Stop Interfering With State Marijuana Legalization Efforts". Petition 1 garnered 75,057 signatures and is one of the most favored in all three communities. Petitions 1, 3, and 4 were all created on the same day which was the day WtP went live. Recall that petition 1 was the first petition created by NORML.

Petitions 17 "Regulate alcohol and tobacco in the same manner as marijuana." and 18 "Respond to the marijuana legalization petition with an argument that doesn't also apply to alcohol." are most favored in C2. Petition 17 was created on 10/28/11 at 20:51 and garnered 7043 signatures. Petition 18 was created on 10/29/11 at 20:53 and garnered 5176 signatures. Petition 17 and 18 were created

[4]Routines for simple graphs and network analysis. It can handle large graphs very well and provides functions for generating random and regular graphs, graph visualization, centrality methods and much more. https://CRAN.R-project.org/package=igraphI

[5]This function implements the multi-level modularity optimization algorithm for finding community structure http://igraph.org/r/doc/cluster_louvain.html

Table 4: Community Size and Three Highest and Lowest Signed Petitions in the Three Communities with Percentages of Signers in G12

Community of Signers	Community Size by Unique Signature Identifications	Most Favored Petitions	Least Favored Petitions
C1	450	4 (93%)	15 (23%)
		1 (92%)	24 (17%)
		3 (88%)	13 (4%)
C2	486	18 (97%)	13 (2%)
		17 (93%)	11 (11%)
		1 (92%)	5 (15%)
C3	293	1 (97%)	13 (2%)
		4 (92%)	24 (23%)
		3 (89%)	15 (39%)

within in seconds of each other and fall into the category of "Treat alcohol, tobacco, and marijuana the same" so the close timing of creation may have had an effect of the signing behavior for these two petitions.

C1 and C3 also have the same three least favored petitions: 13 "Ensure greater emphasis and support for drug prevention." which is the only con petition, 15 "regulate tobacco and alcohol in a manner similar to marijuana.", and 24 "Stop lying". Petition 13 is the least favored in all three communities which makes sense because it is not advocating for marijuana policy reform.

5 DISCUSSION & CONCLUSION

In the marijuana case study, e-petitioning signing behavior provided evidence of online collective action that began with the launching of WtP on September 22, 2011. The launching of WtP made it possible for people to engage in an online national conversation about the legalization of marijuana by creating petitions and mobilizing support for them in the form of signatures from their social networks such as Facebook and Twitter. We saw that one of the largest national marijuana activist organization NORML initiated the dialogue on WtP about marijuana policy reform by creating the first marijuana petition on WtP on the same day the e-petitioning platform was launched. NORML and other organizations such as the Marijuana Policy Project and the Montana Cannabis Industry Association mobilized support for a number of the marijuana petitions by posting links to the petitions on their websites. The mobilization by these organizations must have also been facilitated by using already established communication channels such as email listservs, membership lists, electronic bulletin boards, and social media networks such as Facebook and Twitter. There were also people on blogsites and online forums such as Reddit engaging in the online conversation about marijuana policy reform and mobilizing support by posting links to the marijuana petitions on WtP.

It also appears that some of the users of the platform were not satisfied with the responses from the White House (police chief Gil Kerlikowske) and some were unhappy with the threshold increase to 25,000 in a little over a week after WtP was launched. There were 11 out of 25 (44%) of the petitions that reached the threshold and received a response when the threshold was 5000. When the threshold was increased to 25,000 none of the remaining 13 petitions reached the threshold.

Using techniques from market basket analysis I found evidence of individuals signing multiple petitions within similar policy categories. People were signing petitions and coming back over a month later to sign others in this set. There was some evidence of people co-signing petitions showing a preference for a particular policy issue. At the largest confidence value (70%), there was a small group of four petitions which fell into the "Treat alcohol, tobacco, and marijuana the same" category, but for the rest of the petitions in the graph there did not appear to be a pattern of preference for a particular policy issue. The association rules showed that nine out of the first 12 petitions created on WtP were being signed together. This may have been a result of the online promotion of these petitions by the different activist organizations NORML, the Marijuana Policy Project and the Montana Cannabis Industry Association, as well as the online forum Reddit. Here we see individuals with an interest in the general topic of the legalization of marijuana and are actively seeking other petitions to sign.

Both the market basket analysis and the social network analyses were feasible because a sizeable number of people signed more than one of the marijuana petitions. As shown in Table 4, of the total of 100,298 individuals who signed one petition, 39,194 people (39%) signed more than one petition in the set, and 24,402 people (24%) signed at least three petitions. The highest co-signing activity is when the initial marijuana petitions were created on the same day that WtP was launched. WtP was highly publicized since it was part of Obama's Open Government Initiative. The activist organizations I mentioned earlier appeared to be ready to mobilize as soon as WtP became live for the public to start petitioning.

In the social network analysis, I found groups of individuals ("communities") that signed some of the same petitions and had similarly refrained from signing others. Most of these same people were in the top -100 lists of the three different centrality measures, which would suggest that regardless of how centrality is measured, these particular individuals are core or integral to connecting others in the graph. These highly central people are connected to more people in the network and may have created some of the petitions or mobilized support by promoting the petitions to their social networks. Perhaps the people within these groups can be labeled "activists" since they sign many similar petitions and may be influencing people in their social networks to sign by passing the petition information along asking for support. However, although

social network analysis locates "communities" of individuals based on their structural connections, genuine activism would depend on the presence of communicative ties between these central individuals and those they are connected to with respect to e-petitioning.

The mobilization of support for the marijuana petitions was coordinated by a number of activist organizations who deluged WtP with petitions on the day of its inception as supported by the evidence I found online. The marijuana case study appears to correspond to the traditional theory of collective action. Individuals in this case study are acting collectively by "associating voluntarily with others who share the same interests or identities" [16]. The initial petitions were created and promoted by already established organizations who were advocating for the same cause, and recruiting others through online social networks, websites, blogs and forums. Additionally, after reading the titles and the text of some of the petitions as well as finding conversations that were held online by some of the people in these organizations it became clear that they were frustrated with WtP's decision to raise the threshold and with some of the responses their petitions received.

Finally, I have found behavior patterns that indicate that signers were doing more than just clicking on one petition and never coming back to sign again. Signing multiple petitions on similar policy issues indicates that people are looking for ways to express their opinions, searching through petitions and signing the ones that are relevant to their opinion expression. There is evidence that some people strategically engaged in systematic collective action in support of their policy preferences, that go well beyond simply pressing the "like" button on Facebook pages and single petition signatures, actions often criticized by those advancing "slacktivist" hypotheses (e.g. [41] [42]). In order to explore the slacktivist argument, one of the primary goals for this research was to determine if there was evidence of people engaging in collective action using the WtP platform. This research provides additional insights into the dynamics of e-petitioning behavior. This work will contribute to the scholarship of online activism by demonstrating that there are segments of the population that use e-petitioning to actively mobilize support for their policy preferences.

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A APPENDICES

A 25 MARIJUANA PETITIONS

Table 5: 25 Marijuana Petitions

Petition ID	type	Title	Date created	ReachedPublic	Reached 150 signatures(in days)	signatureCount/Threshold
1	Approaches/Proposals to Legalize Marijuana	Legalize and Regulate Marijuana in a Manner Similar to Alcohol.	9/22/11 10:03	9/22/11 10:53	50 minutes	75057/5000
2	Approaches/Proposals to Legalize Marijuana	Legalize, regulate, and tax marijuana.	9/22/11 10:18	9/22/11 15:54	hours	20104/5000
3	Stare Legalization Efforts	Stop Interfering With State Marijuana Legalization Efforts	9/22/11 12:44	9/22/11 16:23	hours	17054/5000
4	Approaches/Proposals to Legalize Marijuana	End the destructive, wasteful and counterproductive "War on Drugs"	9/22/11 16:54	9/23/11 16:02	1	30018/5000
5	Approaches/Proposals to Legalize Marijuana	Demand an Amendment to the U.S. Constitution to End Marijuana, Marihuana, Cannabis and Hemp Prohibition.	9/23/11 0:15	10/13/11 17:11	20	6243/ 5000
6	State Legalization Efforts	Give States the Freedom to Establish Their Own Marijuana Laws.	9/23/11 14:44	9/23/11 19:17	hours	12470/5000
7	Approaches/Proposals to Legalize Marijuana	Stop denying the medical value of cannabis (marijuana.) Remove it from schedule one of the controlled substances act.	9/23/11 20:48	9/24/11 19:04	1	5840/ 5000
8	Requested Pardons	Pardon Marc Emery.	9/23/11 20:58	10/3/11 11:37	10	8254/ 5000
9	Acknowledge medical benefits and/or give access for medical purposes	Allow United States Disabled Military Veterans access to medical marijuana to treat their PTSD.	9/25/11 2:48	9/27/11 22:28	2	8261/ 5000
10	Requested Pardons	Pardon Jason Spyres (K99397), an Illinois inmate serving a 30 year (now on 9th year) sentence on a marijuana charge.	9/27/11 10:09	9/28/11 20:06	1	5862/ 5000

Table 5: *Continued*

11	Acknowledge medical benefits and/or give access for medical purposes	Release all known beneficial information regarding cannabis (hemp, marijuana) and its derivatives.	9/28/11 13:48	10/4/11 22:44	6	3844/ 5000
12	Approaches/Proposals to Legalize Marijuana	Remove Marijuana from the Schedule 1 list of drugs in the Controlled Substances Act	9/30/11 2:50	10/1/11 14:54	1	8955/ 5000
13	Con drug prevention	Ensure greater emphasis and support for drug prevention.	10/5/11 14:34	10/5/11 21:09	hours	2260/ 25,000
14	Acknowledge medical benefits and/or give access for medical purposes	Fund a clinical trial to determine the effectiveness of high-dose cannabis extracts for the treatment of cancers.	10/17/11 12:03	10/20/11 0:48	3	3144/ 25,000
15	Treat alcohol, tobacco, and marijuana the same	regulate tobacco and alcohol in a manner similar to marijuana.	10/28/11 20:43	10/28/11 22:11	hours	2521/ 25,000
16	Treat alcohol, tobacco, and marijuana the same	Regulate Tobacco and Alcohol in a manner similar to Marijuana and other currently illegal substances.	10/28/11 20:50	10/28/11 23:54	hours	2476/ 25,000
17	Treat alcohol, tobacco, and marijuana the same	Regulate alcohol and tobacco in the same manner as marijuana.	10/28/11 20:51	10/29/11 10:06	1	7043/ 25,000
18	Treat alcohol, tobacco, and marijuana the same	Respond to the marijuana legalization petition with an argument that doesn't also apply to alcohol.	10/28/11 20:53	10/28/11 22:35	hours	5176/ 25,000
19	Treat alcohol, tobacco, and marijuana the same	Regulate cigarettes and alcohol in a similar manner to marijuana since they are more dangerous to your health.	10/28/11 20:54	10/28/11 22:17	hours	3208/ 25,000
20	Approaches/Proposals to Legalize Marijuana	Open for debate the full legalization, taxation, and regulation of Marijuana, and not simply deny the people that debate	10/28/11 22:31	10/30/11 10:50	2	4892/ 25,000

Table 5: *Continued*

21	Objections to WtP responses to marijuana petitions	Publicly Request the Resignation of Gil Kerlikowske.	10/28/11 22:58	10/29/11 17:11	1	2678/ 25,000
22	Objections to WtP responses to marijuana petitions	Replace Gil Kerlikowske	10/29/11 2:30	10/30/11 21:31	1	1669/ 25,000
23	Objections to WtP responses to marijuana petitions	Respond to each of the 7 marijuana related petitions individually instead of one canned response.	10/29/11 14:06	10/29/11 22:41	hours	3294/ 25,000
24	Objections to WtP responses to marijuana petitions	Stop lying	10/30/11 12:35	11/7/11 3:55	8	1836/ 25,000
25	Objections to WtP responses to marijuana petitions	Offer a response to marijuana legalization petitions that isn't written by someone legally required to oppose them.	10/31/11 21:56	11/1/11 16:09	1	4760/ 25,000

B SENTIMENTS BEING EXPRESSED IN THE BODY OF TWO OF THE FIVE "OBJECTIONS TO WTP RESPONSES TO MARIJUANA PETITIONS" PETITIONS

Petition 23 "Respond to each of the 7 marijuana related petitions individually instead of one canned response." Body: "The white house recently responded to 7 marijuana petitions with one canned response. The response did not address each issue separately. It is disrespectful of the thousands of people who signed each petition to dismiss it in such a generic way. We would like to hear from the white house what its position is on each petition."

Petition 25 "Offer a response to marijuana legalization petitions that isn't written by someone legally required to oppose them." Body: "Your response to the petitions regarding marijuana legalization was written by Gil Kerlikowske, who, as the Director of the Office of National Drug Control Policy (ONDCP), is legally required by the Office of National Drug Control Policy Reauthorization Act of 1998 to oppose legalization of marijuana and other illegal drugs, regardless of the facts relating to their use and effects. (See sec. 704 of the act: Among the duties of ONDCP directors is to "take such actions as necessary to oppose any attempt to legalize the use of a substance (in any form) that – (A) is listed in schedule I of section 202 of the Controlled Substances Act (21 U.S.C. 812); and (B) has not been approved for use for medical purposes by the Food and Drug Administration") This is clearly a conflict of interest."

On Using Privacy Labels for Visualizing the Privacy Practice of SMEs

Challenges and Research Directions

Mortaza S. Bargh*
Research Center Creating 010, Rotterdam University of Applies Sciences, Rotterdam, The Netherlands, Email: m.shoae.bargh@hr.nl and Research and Documentation Center, Ministry of Justice and Security, The Hague, The Netherlands, Email: m.shoae.bargh@wodc.nl

Maud van de Mosselaar
Research Center Creating 010, Rotterdam University of Applies Sciences, Rotterdam, The Netherlands, Email: mvandemosselaar@outlook.com

Paul Rutten
Research Center Creating 010, Rotterdam University of Applies Sciences, Rotterdam, The Netherlands, Email: p.w.m.rutten@hr.nl

Sunil Choenni*
Research Center Creating 010, Rotterdam University of Applies Sciences, Rotterdam, The Netherlands, Email: r.choenni@hr.nl and Research and Documentation Center, Ministry of Justice and Security, The Hague, The Netherlands, Email: r.choenni@wodc.nl

ABSTRACT

Privacy is a comprehensive notion which is hard to grasp for the layman. To make the privacy notion tangible, creating transparency about privacy practices is an important necessity. Transparency about privacy practices is traditionally (sought to be) established via providing privacy policies and privacy seals. These traditional transparency mechanisms have resulted in limited success in society, where digital transformation takes place with a fast pace. To address these challenges, privacy visualization via a label representation, like energy and food labels, is considered a promising solution direction. Visualizing privacy, in general, and using privacy labels, in particular, are not straightforward in practice due to, among others, the subjectivity and context dependency of privacy and the adverse (side) impacts of privacy violations. This practicality issue is more evident for Small and Medium-sized Enterprises (SME's) because, compared to large enterprises, they have limited resources for protecting and managing the personal data they process. In this contribution, we investigate the capabilities and limitations of a privacy label and its labeling tool for use by SMEs in three business domains. Accordingly, and within SME settings, we identify the following directions for future research: Enhancing trust in privacy labels, dealing with network aspects, adopting privacy labels and labeling tools, using the labeling process and outcome for auditing own privacy practice, and improving the current privacy labels and labeling tools.

CCS CONCEPTS

• **Security and privacy, Human and societal aspects of security and privacy, Privacy protection**;

KEYWORDS

Online services, privacy label, SMEs, transparency, trust

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1 INTRODUCTION

Digital transformation is accelerating across all sectors of our society. As citizens, on the one hand, we use more and more online services and apps to facilitate our daily life activities. On the other hand, the number of enterprises, organizations, and institutions that utilize digital technology is rising. This rise of digital transformation is noticeable also for Small and Medium Sized Enterprises (SMEs), among which are retail, media and cultural enterprises. Retailers with brick-and-mortar location are not future-proof without an online platform nowadays. Media SMEs, which have been operating in the digital domain for a relatively long time, combine online curations with their traditional media services. In the cultural sector, the digital selection of cultural services, besides the physical interactions, is growing. In the last two years, the online cultural offerings have even been boosted because of the COVID-19 related restrictions imposed on cultural events.

*Corresponding author.

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Often using and offering online services and apps, as a downside, require processing (e.g., collecting, analyzing, and sharing) personal information about individuals such as citizens, customers, and consumers [10]. Inappropriate use of personal information within these online services and apps can lead to the infringement of privacy. Therefore, individuals, civil institutions, supervisory bodies, and watchdogs should (establish) trust in the privacy practice of the providers of these online services and apps (i.e., how the providers protect privacy). Establishing trust in such privacy practices is a key challenge facing the currently ongoing digital transformation.

Creating transparency about privacy practices helps establishing trust and is considered necessary in many privacy laws and regulations such as the General Data Protection Regulation [12]. This transparency is traditionally (sought to be) established via providing privacy policies and using privacy seals. These traditional transparency mechanisms have resulted in limited success in practice [8]. To address these challenges, privacy visualization via a label representation, like energy and food labels, is considered a promising solution direction. Privacy labels can be seen as a means of explaining privacy practices in that how service and app providers process and deal with personal information. However, in practice, visualizing privacy in general and using privacy labels in particular are far from being simple or straightforward. This complexity stems from, among others, the subjectivity and context dependency of privacy and the adverse (side) impacts of privacy violations [5]. This practicality and complexity issue is prominent for SMEs because, compared to large enterprises, they have limited resources for protecting and managing personal data. Having limited resources makes it difficult for SMEs to easily figure out which privacy requirements are (not) implemented in their online services and apps, and to comprehend the corresponding privacy implications. Privacy labels may assist SMEs to gain insight in these privacy requirements and their implications, to prioritize the privacy requirements, and to safeguard the most relevant privacy demands.

Our research objective is to investigate how privacy labels may contribute to the transparency of enterprises about their privacy practices when providing online services (e.g., websites and mobile services) and/or apps, and to study the capabilities and limitations of current privacy labels and identify some directions for future research and development. We limit our focus to SMEs from different business domains because they have limited (inhouse) resources and therefore it is necessary to investigate whether and how they can appropriately exploit these privacy labels to the full potential. As a benchmark, we will use the privacy label and the labeling tool developed in the SERIOUS project executed between 2014 and 2020 [17]. The project was carried out by a partner institution. The privacy label and the labeling tool of the SERIOUS project are developed based on scientific research and are evaluated in a limited scale among university students and some experts from businesses and public organizations. Therefore, there is a need to examine their usage, capabilities and limitations within a wide range of businesses, enterprises and consumers (i.e., conducting a thorough investigation and translation of the privacy label and the labeling tool to the work field). One limitation of the current privacy label is that it does not take the business domain into consideration. Depending on the business domain, one might expect that certain privacy attributes can be more important than others, which requires tailoring of the current label.

Considering the above-mentioned research objective, we investigate the following research questions in this paper:

- What are the advantages and limitations of the SERIOUS privacy label and its labelling tool when used by SMEs?
- Can the SERIOUS privacy tool be used by SMEs to gain insight into their own privacy practice (and to improve their privacy protection practice)?
- In which directions can the current privacy label and labelling tool be improved for use by SMEs? What are the challenges (or research directions) for further developing the label and the labeling tool for use by SMEs?

For this study, we adopt an explorative and qualitative feasibility study. To this end, we use literature study and semi-structured interviews with the employees of three SMEs who were responsible for operation of the online services within those SMEs. These SME employees could be considered as responsible stakeholders within those SMEs to issue and adopt privacy labels for those online services. The structuring of these interviews is informed by our literature study on technology adoption theories.

The organization of the paper is as follows. In Section 2, we explain the study context and the theoretical foundation of the study. In Section 3, we describe how we conducted the semi-structured interviews and analyzed the results. In Section 4, we discuss the results by categorizing the directions for future research and developments. Finally, in Section 5, we draw some conclusions.

2 STUDY CONTEXT AND RELEVANT THEORETICAL PRINCIPLES

In this section we describe the study context, particularly presenting the theoretical foundation of the study.

2.1 Transparency of the privacy practice

Transparency about the privacy practice is traditionally (sought to be) established via providing privacy policies and privacy seals. These traditional transparency mechanisms have resulted in limited success and effect in practice [8]. On the one hand, consumers cannot understand privacy policies due to their lengthy and cumbersome legal content. Therefore, despite being concerned about their privacy, consumers download apps and use online services; and accept their privacy policies blindly, without thinking (seriously) about the privacy ramifications of their decisions. The discrepancy between consumers' privacy concerns and their reckless behavior in blindly using these apps and services is referred to as the privacy paradox [7]. Blindly accepting privacy policies weakens their effectiveness and their legally binding impacts as such consents may not be considered as informed and freely given. The privacy seals are trust seals issued by third parties to assure the consumers of an online service that the service meets a certain standard of privacy protection. On the other hand, privacy seals have their own limitations as they are not correlated with trustworthiness [11] and even those based on crowdsourcing have not been successful so far [8].

Privacy policies and seals may be enhanced by educational mechanisms to raise the awareness of consumers about the privacy practice, thus empowering consumers to take their responsibility for privacy protection. Nevertheless, general knowledge and privacy awareness have no significant role in the privacy paradox as "advanced Computer Science students and even privacy and security experts appear to struggle with the same issues as lay users, exhibiting similar unsafe behaviors", see [8] pp. 192. This low impact of privacy awareness can be attributed to the functional complexity associated with (a) communicating the importance of privacy and privacy risks to users, (b) providing less engaged users with clear decision-making shortcuts to contain privacy risks, and (c) providing highly engaged users with user-friendly and personalized information (thus of varying details) to contain privacy risks (ibid).

2.2 Privacy visualization

Privacy visualizations can be designed and used to communicate some relevant aspects of the privacy practice to the consumers. Based on a systematic literature study, [8] provides an overview of 13 privacy visualizations. As these visualizations are meant for average consumers, they intend to convey those aspects of data practice and usage that are somehow interesting for these consumers. For example, the Privacy Short Notice of TrustArc project analyzed the previous approaches for providing a simplified summary of privacy policies and decided to visualize those aspects that are invisible for consumers of these services like, among others, secondary use and third-party tracking. As privacy concerns are context dependent and subjective [5, 6], it is a challenge to determine the relevant aspects of the privacy practice and, therefore, to adopt a suitable privacy visualization beforehand.

Further, for different reasons, creating transparency about the privacy practice is relevant for both consumers and providers of online services and apps. The consumers, on the one hand, need to gain trust in (the providers of) these services and apps for sharing their personal data with them. The providers, on the other hand, need to gain the trust of consumers, authorities, and society by showing how well they respect and adhere to human values including protecting the privacy of their customers and service consumers. To inform the providers of online services and apps, there have been many design guidelines proposed to facilitate embedding privacy protection principles in the fabric of these apps and services. The development of these so-called Privacy by Design (PbD) guidelines is inspired by privacy laws and regulations as well as by privacy engineering best practices. Based on a systematic literature study, [8] provides an overview of 14 sets of privacy by design guidelines. As the target group for these guidelines are system developers and providers of online services and apps, they cover the privacy protection aspects of the system development process mainly. Further, these PbD guidelines are useful for privacy engineering experts and enterprises who have enough resources to hire such experts and develop (inhouse) privacy protection solutions based on these guidelines. For those enterprises with limited resources, like SMEs, it is a challenge to get insight in these PbD guidelines, yet alone to implement them by themselves (inhouse).

As mentioned above, providing a user-friendly privacy visualization, with varying levels of details, is needed for informing less or highly engaged consumers about the privacy risks and empowering them for actively seeking for appropriate privacy protection measures. In this contribution, we are interested in exploring whether providing such a user-friendly privacy visualization might also be relevant for enterprises with limited resources (like SMEs). The underlying assumption is that the developers and providers of online services and apps with limited privacy protection expertise can use such user-friendly and rich privacy presentations to gain insight into the privacy risks of their online services and apps as well as into the appropriate measures needed for mitigating these privacy risks in them. The need for a privacy visualization for enterprises with limited resources (like SMEs) asks for adequately covering the PbD guidelines in the desired privacy visualization. This adequate coverage of the PbD guidelines can also enable both less engaged and highly engaged consumers to learn about the privacy risks and deal with these risks accordingly, depending on their interests and the levels of their expertise and engagement.

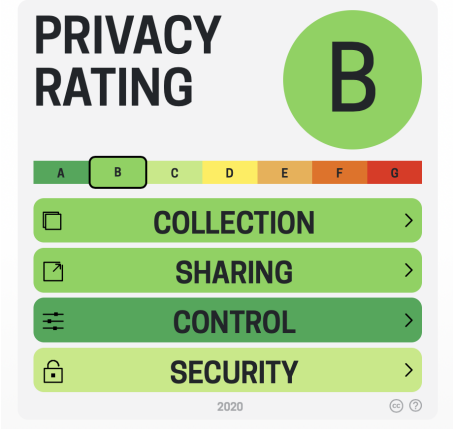


Figure 1: An example of the SERIOUS privacy label (generated with the interactive process of the SERIOUS tool).

2.3 SERIOUS privacy label

In this study we use the privacy label and the privacy labeling tool developed in the SERIOUS project, which take advantage of the features of existing privacy visualizations and the comprehensive features embedded in PbD guidelines [8]. The study in [8] and [9], describes the development process of the SERIOUS privacy label (system) which consist of (a) deriving a set of privacy attributes from existing privacy visualizations and PbD guidelines, (b) ranking these attributes by consumers and experts, and (c) visualizing these ranked and clustered attributes in a letter-color based label, and (d) evaluating the resulting privacy label via user studies (i.e., by consumers). Aiming at simplicity, clarity, recognizability, and attractiveness, the SERIOUS privacy visualization label, as indicated by an example in Figure 1, provides four classes – namely collection, sharing, control and security – to draw the attention of less-engaged consumers to make a quick overall judgment about the potential privacy threats of online services and apps.

Like familiar energy labels, as illustrated in Figure 1, these SERIOUS privacy classes are indicated by combinations of letters and

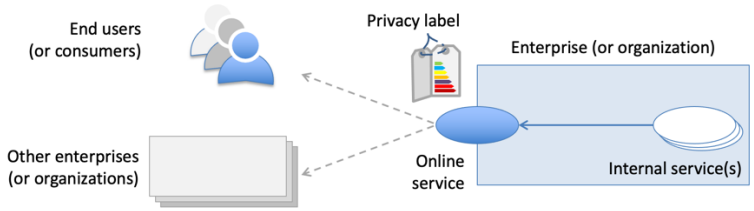


Figure 2: An illustration of the generic setting in which the SERIOUS privacy label is used.

colors, ranging from A plus green for the most positive online services, to G plus red for the most negative ones. The colors also resemble the conventional color scheme of traffic lights. For those highly engaged consumers the SERIOUS privacy rating system provides (a) the scores of the online service or app in the four privacy categories (namely collection, sharing, control, and security), and (b) specific information about every privacy attribute through hovering or clicking these privacy categories.

The generic setting for/in which the SERIOUS privacy label is created/used is illustrated in Figure 2. The label is created within an enterprise for the online service it offers; and used by consumers and the other enterprises to gain insight in the privacy practice of the enterprise.

2.4 SME characteristics

SMEs are defined based on their employment sizes, economic values, assets and sales volumes [1]. They typically employ less than a few hundred employees – like 500 or 200 employees [1, 19]. SMEs offer various advantages such as employment creation at low capital cost, flexibility, and innovation [1]. The role of SMEs is significant for economy due to their entrepreneurial spirit, adaptive capabilities, and competitiveness that act as drivers of economic growth and innovation [13]. SMEs account for 96% to 99% of the economic activities of most OCED nations and about 80% of their economic growth [1]. For North American and European countries, SMEs contribute to their Gross Domestic Product (GDPs) significantly (with 99% of all businesses) and to their job creation (around 70% job creation). Also in Australia, SMEs form the 95% of businesses, contribute to over 57% of the country's GDP, and are a key source of employment [15]. According to [14], in 2019 SMEs account for 65% of the added-value and for 71% of the employment in the business economy of The Netherlands.

A key enabler of innovation for organizations and businesses is the deployment and use of Information and Communication Technologies (ICTs). ICTs refer to a wide range of software, hardware, telecommunications and information management techniques, applications, and devices [20]. They are increasingly used to collect, store, process, and transmit data about every aspect of our personal and business lives. As such, ICTs impact the way that organizations and individuals work nowadays. ICTs enable SMEs to access new market opportunities and specialized information. Those SMEs that adopt ICTs can have increased productivity, increased efficiency of internal business operations, cheaper and easier connection to external contacts, increased business competitiveness, increased vertical integration with other related business, stakeholder and institutions, and improved networking with other parties [15, 20]. Via participating in e-marketplaces, SMEs can attain product differentiation and supply chain entry [15] and business growth may require SMEs to implement ICTs to effectively manage such growth [20].

ICT adoption within SMEs is lower than that in large enterprises. This adversely affects their economic development and weakens their access to global markets. Large organizations have more resources and greater economies of scale and, therefore, they can take greater risks associated with innovation adoption [15]. Often, the difficulty of adopting ICTs for SMEs can be attributed to resource constraints related to financial (ability to invest in ICTs), infrastructural (bandwidth and power) and organizational (lack of skilled staff, lack of coherent strategy, inability to adopt new ICT enabled processes) aspects [19, 20]. Moreover, like in any organization, SME employees often refuse to adopt an innovative technology due to fear of job loss if their working practices change [13]. Despite these constraints for SMEs, there are some advantages for SMEs compared to large enterprises. For example, compared to larger organizations, communication between employees and managers is more effective, and executing and implementing decisions are quicker in SMEs [15].

Given the importance of SMEs in economy, and their differences with large enterprises in adopting innovative technology (and ICT), it is essential to explore and study the issue of ICT adoption by SMEs. Therefore, it is worthwhile to investigate the adoption and acceptance of privacy labels and labeling tools within SMEs.

2.5 Study scope

Barth [8] investigated the similarities and differences between the four perspectives of (a) the principles of existing privacy visualizations, (b) the principles of existing PbD guidelines, (c) the requirements of privacy experts, and (d) the expectations of consumers to arrive at a privacy label that covers the raised privacy issues and to evaluate the resulting privacy label with those who use privacy labels (i.e., consumers). There are two issues, both of which are from the perspective of privacy label producing parties (i.e., the enterprises developing and providing online services and apps), not addressed in current studies. These two issues, which we are interested in here to study further in the context of SMEs, are:

- How the privacy label issuing SMEs perceive the privacy label and the process of the privacy label creation and
- How the created label and the labeling tool – which covers a wide range of PbD guidelines – help these SMEs to get

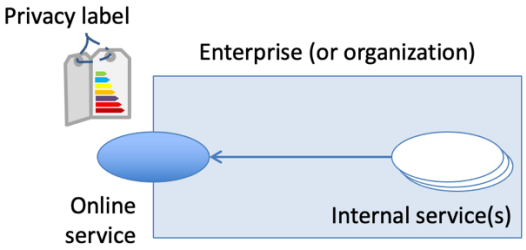


Figure 3: An illustration of the primary scope of this study.

insight into (and resolve) the privacy concerns of their online services and apps.

With respect to the generic setting depicted in Figure 2, the scope of our study is illustrated in Figure 3

2.6 Related work

One way to communicate the privacy risks to service consumers clearly and concisely is via visualizing how service providers handle personal data in their applications, mobile apps, websites, etc. Various privacy labels like nutrition labels have been developed for visualizing the privacy policies and practices of these service providers. For an overview of these labels, the interested reader is referred to (Chapter 6 of [8]), which investigates the most prominent privacy labels such as: the policy coding methodology of the KnowPrivacy project, the Carnegie Mellon's CyLab privacy nutrition label, Mozilla's privacy icons, the privacy icons of the PrimeLife project, the privacy icons of a draft version of the DGPR, to name a few.

The SERIOUS privacy label and labelling tool are developed based on the abovementioned existing privacy visualizations and also based on PbD guidelines (see Chapters 6 and 7 of [8]). To this end, a set of privacy attributes are chosen as basis, subsequently the chosen attributes are clustered based on user studies and expert interviews, and finally the attribute clusters are visualized in a privacy label. To facilitate deriving this label for a given context by the service provider, a web application is developed, see [16]. Finally, the developed privacy label and its tool are evaluated with user studies. Via these user studies, the usability of the privacy label, its perceived usefulness, and its effect on users' trust in an online service are evaluated.

Noting that the participants of the initial user study in [8] were recruited from a university's pool of research participants, from a commercial research participants pool and via social media, we have done a second round of user study within the scope of SMEs in this contribution. Our focus here is laid on how SMEs perceive this label, for which goal and how it may be used, and the issues they might face for creating and using the label in their enterprises. The study of [8], moreover, focuses on how service consumers (i.e., average persons) who receive the label perceive the label in a general business setting.

3 SEMI-STRUCTURED INTERVIEWS

In this section, we provide information about the way that the interviews were conducted, the theoretical principles used for structuring the interviews, and the outcomes of the interviews.

3.1 Guiding principles

The privacy label is issued by the enterprises that offer online services like websites and apps to individuals (e.g., citizens and consumers) in B2C settings and/or to other enterprises in B2B settings. In this study the term enterprise refers to those organizations that (a) use the privacy labeling tool and (b) publish their privacy labels. For these enterprises, there are two technical artifacts to *adopt*: the privacy label and the labeling tool. Therefore, a successful adoption of these two technical artifacts relies on those theories that explain technology adoption by consumers and by/within organizations. As our study focuses on technology adoption within organizations (more precisely, within SMEs), we organized our interviews and analyzed our results based on the corresponding technology adoption theories, as summarized below.

The Technology-Organization-Environmental (TOE) framework [21] is widely used for studying IT adoption in organizations, including SMEs. The TOE framework comprises three main contexts of Technology (T); Organization (O) and Environment (E), each of which contains a set of determinants that impact the adoption of innovation in organizations [2, 3].

- Technology context, which comprises technologies within an organization and those externally available,
- Organization context, which refers to the characteristics of the organization such as its size, communication processes and the amount of slack resource, and
- Environment context, which captures the structure of the industry, pressure from competitors and partners, and the regulatory environment.

The technology context can be characterized by five technology attributes in the Diffusion of Innovation
(DOI) theory [2, 18]. The DOI's technology attributes, which may influence the adoption or rejection of a given technology in organizations, are: Relative advantage (or perceived benefit), complexity (or perceived ease of use), compatibility (or perceived compatibility), trialability (via, e.g., offering the trial versions of the technology and providing information about it), and observability (referring to the visibility of an organization due to its adoption of the technology). The compatibility attribute is about whether the potential changes are compatible with the values, needs and practices as well as whether they are consistent with the existing technological infrastructure of the organization.

The organization context can be characterized by factors such as [2]: Enterprise size and scope (often, the larger organizations are, the better technology adoption is), top management support and CEOs' innovativeness (facilitating the adoption decision), and experience with and knowledge about previous technologies. The environment context encompasses several factors that affect an organization's decision to adopt new technologies such as [2]: Competitive pressure, customer pressure, industry type, the market scope encompassing an organization's operations, and external IS

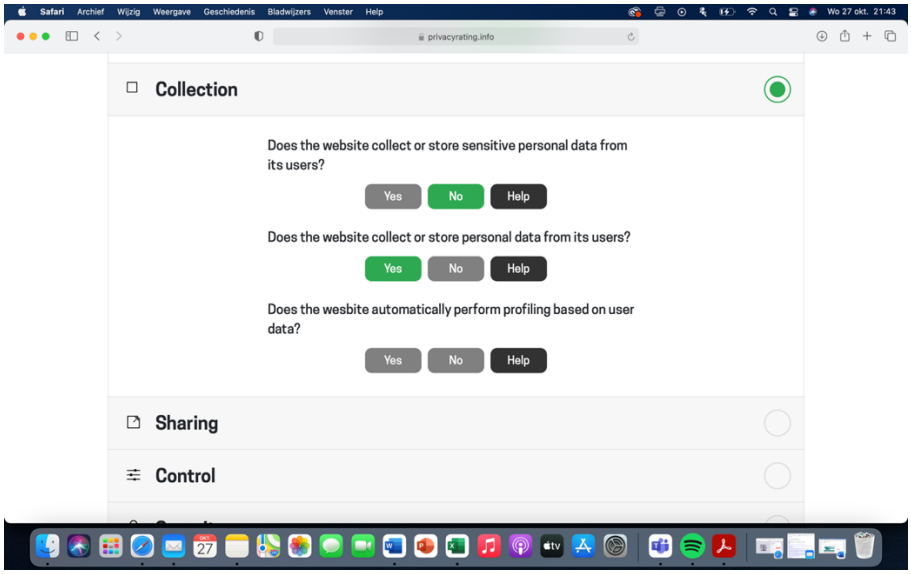


Figure 4: A screenshot of a section of the online tool designed in the SERIOUS project.

support. External IS support may affect adoption of a new technology especially for SME's as they often have limited resources and skills to deploy and use a new technology.

Most of the abovementioned factors are relevant for SMEs, as shown in many studies in recent years. For references to these studies, the interested reader is referred to [2], chapter 2.

Based on the technology adoption factors mentioned above, we prepared some questions to loosely shape our semi-structured interviews. Example questions were: What does privacy mean for your organization? How do you perceive the label and the labeling tool? What are the improvement aspects of the label and its tool? What do you see as the added value of the label and the labeling tool for your organization? How would you be willing to use them? What other facilitators (inside and outside your organization) are needed to use the label and the labeling tool in your organization?

3.2 Interview procedures

We conducted three qualitative studies with three SMEs from three different sectors of retail, culture and media. For each SME, two different sessions were organized. During the first session, the participants of each SME were introduced to the web-based online tool of the SERIOUS project for creating the SERIOUS privacy label. The second session consisted of an in-depth semi-structured interview about the web-based tool and the privacy label for the corresponding SME. Hence, in total, three SME interviews, each in two sessions, have been performed.

3.2.1 First sessions: Introduction round. During the first session, the three SMEs from the retail, media and culture domain, were introduced to the privacy label and accompanying online tool. In each of the first sessions, two researchers were present. The objective of the first session for each SME was to use the online SERIOUS tool and create a sensible SERIOUS privacy label for one online service of the SME. This tool is a web-based interactive questionnaire [16] developed in the SERIOUS project. As illustrated in Figure 4, the SME participants provided their answers, with either yes or no, to some questions posed by the tool in the categories of collection, sharing, control and security. The structure behind the tool is like a flowchart, so the questions that are presented to the user depend on their previous answers.

Due to the COVID-19 restrictions at the time, the sessions took place online via a Microsoft Teams call. Each session took around 30 minutes, where we started with a short introduction of the project, the researchers and the participants. The participants were asked to answer the questions posed in the labeling tool, keeping in mind a specific and relevant online service within their SME. For all three SMEs, this was their website. As stated in the instructions of the tool, the answers should be based on the worst-case scenario (i.e., most severe privacy risks) that can be imagined when operating their websites.

Next, the SMEs were guided through the online tool, interfering as little as possible to receive their genuine reaction to the tool and label as they observe on their own device. During this session, the participants were sharing their screen so it could be recorded by the researchers for later analysis. The result of the first session was a privacy label, as shown in Figure 1, for the website of the corresponding SME. The participants were able to use the resulting label code, which was provided by the tool, to implement the label into their website or download the visualization as a png or svg file. The participants were asked to save the label and share the file with the researchers.

3.2.2 Second sessions: Semi-structured interview. Following the first introduction sessions, a semi-structured interview session was conducted with each partner, so three interview sessions in total. Two researchers were present during each interview session. Again, due to the COVID-19 restrictions at the time, the interviews took place

online via a Microsoft Teams call. The interviews were about 1 hour long each.

The interviews were used to gain a more in-depth understanding of the experience of the participants with the labeling tool and their thoughts about the privacy label. During these interviews a semi-structured interview guide was followed. The topics and questions were constructed based on the guidelines in Section 3.1 and in the following categories:

- Reflection on the first session topics, like on the produced privacy label, the online tool used – the user interaction aspects, and the online tool used – the content of the questions posed by the tool,
- Use of the privacy label (in practice),
- Facilitation of the privacy label deployment (within the organization), and
- Reliability and risks of the privacy label.

3.2.3 Analysis. The analysis of the semi-structured interviews consisted of multiple steps, namely: collection, selection, categorization and validation. First, the recorded interviews were transcribed. This transcription allowed us to extract the relevant quotes and insights from the interviews. Subsequently, three researchers of this project held an online session, again due to the COVID-19 restrictions at the time, to cluster the quotes and insights from the interviews based on the discussed topics and using the online service Miro. The topic clusters were checked and labelled in 27 categories during this meeting, some more relevant and important than others.

Some example categories are: Complexity of the problem (i.e., privacy visualization) vs. the simplicity of the tool, service-specific label or organization-specific label, dependency on external partners and the network effect, and missing question categories. In Section 4.2, we shall group these categories in 5 clusters to structure our recommendations for future research directions.

4 DISCUSSION

In this section we present the preliminary results (derived before our data analysis) in Section 4.1 and provide our recommendations for future research in Section 4.2.

4.1 Preliminary results

From the discussions in the first sessions some preliminary insights were gained, namely:

- Some questions were difficult to understand, sometimes simply because of a language barrier, the help button proved to be useful in these situations,
- Answering questions for the worst-case scenario was applicable when, for example, there were multiple purposes for data collection due to having multiple (external) services linked to the SME websites. In these scenarios, the participant wanted to be able to give more nuanced answers than a hard yes or no, and
- All participants considered the label as a very useful tool, but the following question was mentioned by all SMEs: how will the privacy label be regulated? What is the credibility of the label?

From the interviews in the second sessions some preliminary insights were gained:

- Sometimes the questions could not be answered with a simple yes or no as the issue is complex. The tool asks to answer the questions according to the worst-case scenario, but this is not always right/satisfactory,
- The SMEs provide different online services – such as those for organizing online events, conducting ecommerce transactions, and providing informational – that entail having different and multiple outcomes for the privacy label (or multiple labels). Thus, the question that rises is: should SMEs use separate privacy labels for their different online activities?
- The SMEs use the online services of external parties because they do not have the capacity to provide them inhouse. Thus, the question that rises is: How should these service compositions be included in the privacy label?
- The SMEs do not have an allocated place and/or a responsible person/expert within the organization for handling privacy or possibly the privacy label, and
- As a result of the introduction sessions, the credibility and accountability of the privacy label is important to take into consideration for its implementation and deployment within and among organizations/SMEs.

The initial results and insights were presented during a session with two of the original developers of the SERIOUS privacy label and the SERIOUS labeling tool. The developers provided their feedback to the preliminary insights of this project, these were:

- The network effect was an aspect they did not find and realize during their research, probably due to their focus on the end users instead of on the organization providing the label. They understood the possible implications for the privacy label and endorsed further explorations on this topic.
- They confirmed the relevance of future research on how to implement and position the privacy label in SMEs.

4.2 Recommendations for future research

In this section we provide our recommendations for future research through clustering the 27 categories identified in our data analysis. Note that there are some dependencies among these clusters.

4.2.1 Trust in privacy label. The aim of using privacy labels is to provide transparency about the privacy practice of the organizations providing online services and apps. As such, consumers (e.g., the average users of privacy labels) should trust the labels in being, among others, reliable, truthful, and understandable. Considering the generic setting depicted in Figure 2, a relevant research question is: How can consumers (i.e., individuals and other organizations) trust the privacy label issued by/for an SME?

- Should a standard process be developed for issuing the privacy label? Should the label be issued by a trusted third party or do self-issued labels suffice?
- In the latter case of self-issued labels, is it necessary to introduce a trusted third party to supervise and monitor the process? What are the accountability and compliance issues

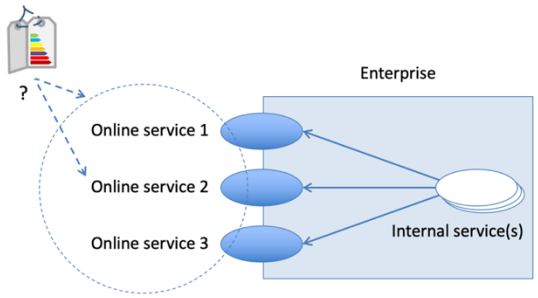


Figure 5: An enterprise offering multiple online services: a privacy label per service or for all services?

for an SME regarding own privacy label(s)? What are measures against these issues? And how can these measures be enforced?

Answering these questions asks for, among others, developing legislative and standardization measures.

4.2.2 Network aspects. An enterprise (or SME) may offer many online services as depicted in Figure 5. The current privacy label (i.e., that of the SERIOUS project) advocates issuing a privacy label for the worst-case online service (from a privacy protection perspective). However, it might be foreseeable or preferable to introduce separate labels for services of an SME. Therefore, a relevant research question is: How can we accommodate the differences in the services provided by SMEs in privacy labels? More specifically,

- Is it sufficient to introduce a privacy label per SME? Or
- Is it necessary (or preferred) to introduce a privacy label per SME online service?

Online services have different requirements about collecting and processing personal information, some require minimal personal information (like informative web-pages of SMEs for publicity purposes) and some require a considerable amount of personal information (like those used for customer relation management). Consequently, the privacy label of the former can be greenish while that of the latter can be more reddish if we follow the same scoring rules for both types of online services. In this case, the consumers should (be able to) interpret the resulting labels according to the context (i.e., the types of the services they represent). This approach might inflict burdens on laymen for the required context dependent interpretation of the labels. Alternatively, one may normalize privacy labels for all types of online services (i.e., a label normalized with respect to the needs of personal information of an online service) so that a semantically uniform label can be created for all services with varying needs of personal information. Hereby the interpretation of the label becomes straightforward for average humans. A relevant research question is: How can we accommodate the different degrees of personal information dependency of online services in such (normalized) privacy labels? More specifically,

- Do we need to define a privacy label per online service type? Or
- Should we define a normalized privacy label across all online services of an SME?

Provisioning the online service of an SME may depend on (online) services provisioned by other enterprises, as depicted in Figure 6. A key research question is: How should the privacy practices of the services of external partners (i.e., the providers of upstream services used by the SME's) be represented in the privacy label? More specifically,

- Should these upstream service providers also have their own privacy labels? If so, what would the SME do if the privacy practices of upstream service providers (negatively) affect the privacy label of the SME? How can these upstream labels be trusted by downstream SMEs?
- How should SMEs deal with the changes of the privacy practices of these upstream SMEs?

One research direction to remedy the need for having the privacy labels of upstream service providers is to develop automated systems, tools and architectures that help estimating the privacy practices/labels based on the operational behaviors of the corresponding services, for an example see [4].

4.2.3 Technology adoption aspects. The privacy label and the tools for creating privacy labels should be adopted by both label issuing enterprises and label consuming parties (individuals and organizations). While this study did not consider how consumers perceive the privacy label as it is, to some degree, done in [8], we observed that label issuing SMEs perceive the privacy labels and the labeling tool useful. Nevertheless, there is a need for further research about the ways for enhancing the label adoption by label issuing enterprises, who may act also as consumers of privacy labels in networked settings. The key research question is: How should the privacy label and labeling tools be implemented within SMEs? More specifically,

- How can the adoption of privacy labels be facilitated for SMEs?
- Should a central organization be set up to help SMEs to manage (i.e., create and maintain) their privacy labels?
- How often should the privacy label be updated? Who is responsible for these updates?
- Can SMEs use the privacy label (and the labelling tool) to get insight into their own privacy practice and how they can use the insight to improve their own privacy practice?

4.2.4 Using for audit purposes. When using the SERIOUS privacy tool to create the SERIOUS label, the provider of an online service must reflect on the key requirements of privacy protection regarding that service or app. Answering the questions of the tool and seeing the colors of the resulting label can lead to gaining insight into the aspects of the privacy protection which are done satisfactorily (i.e., those four classes of the label that are greenish) and unsatisfactorily (i.e., those four classes of the label that are reddish). The providers can compare the status of own labels with those of similar products (of other providers) or with those of the same online service and app in previous times. The former provides a cross-product insight and the latter provides a longitudinal insight into the privacy practice. These insights can be instrumental for SMEs to decide on which mitigations measures are necessary to adopt or whether to promote their services and apps based on the way that privacy protection is done (i.e., as the unique selling point).

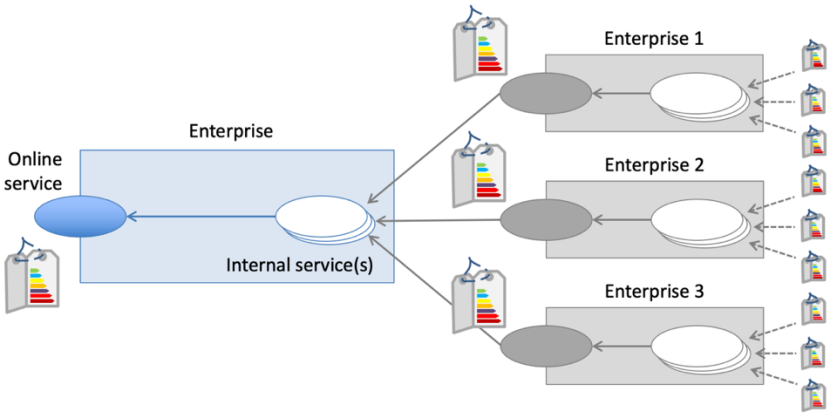


Figure 6: An illustration of the chain of trust issue, the need for trusting the upstream privacy labels.

The key research question is: How can SMEs use the label and tool to gain insight into their own privacy practice? More specifically,

- Do the privacy label and the labeling tool provide enough insight into the privacy practice of SMEs? Are they preferable to similar auditing products?
- How can SMEs use the gained insight to improve their own privacy practice?

4.2.5 Improvement aspects. The current privacy label and tool are a proof-of-concept realization that needs some developments in order to be used by SMEs with limited resources and in different settings (e.g., when offering various services, having composite and networked services, and acting in different business sectors). Therefore, an important research question is concerned with further development of the concept of the privacy label and the corresponding labelling tool. More specifically,

- How the privacy label can be improved for the heterogeneous and constrained SME settings?
- How the privacy labeling tool can be improved for such SME settings?
- Is it possible to automate some aspects of the labelling process, especially in networked service provisioning?

5 CONCLUSION

Privacy visualization via a label representation, like energy and food labels, is considered a promising solution direction to make privacy practices of online service and app providers transparent. In this feasibility study we interviewed three SMEs from retail, media and culture business domains to investigate the capabilities and limitations of the SERIOUS privacy label and its labeling tool for use by SMEs as well as to identify some future research and development directions.

As its outcome, the study identified several potentials and limitations of the SERIOUS label and its labeling tool. Based on these, the identified research and development directions are: Trusting the privacy label, dealing with network aspects, adopting technology within SMEs, using the label and tool for auditing and improving own privacy practice, and improving the current label and labeling tool. SMEs may operate multiple online services and every online service is often provided by multiple service providers. How these differences in services provided by SMEs and the networking characteristic of these services can be accommodated in (deploying) privacy labels are open issues for existing privacy labels. SMEs have limited resources and privacy labels are relatively new concepts. Therefore, one needs to seek for effective ways to promote the use and adoption of privacy label and tools within SMEs. From the interviewees we found that the current privacy label and labeling tool are insightful about own privacy practice (e.g., knowing which parts of the practice require applying mitigation measures). As the current SERIOUS label and tool are proof-of-concepts designed for single enterprise settings, addressing the abovementioned issues asks for their further development, for example, via automizing part of the label issuing process and its usage within networked settings.

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Research for making smart city cybersecurity policy according to communication theory: Focus on the communication structure

Hye Sung, Park
Korea University, School of Cybersecurity
whitecil@korea.ac.kr

Jeong Eun, Seo
Korea University, School of Cybersecurity
sje5279@korea.ac.kr

Hun Yeong, Kwon
Korea University, School of Cybersecurity
khy0@korea.ac.kr

ABSTRACT

With the development of IoT and various data processing technologies, Smart City, a city that provides various services to citizens based on data, is emerging. However, IoT, big data, artificial intelligence, and platform technologies applied to these smart cities pose various risks related to data inherently. Moreover, it exists throughout the data life cycle, from collecting data to processing and managing data. Therefore, a policy that can manage cybersecurity risks implied in smart cities is essential. In addition, smart city cybersecurity policies need to be created through communication by stakeholders, including citizens, rather than making it top-down for effective implementation of the policies. So, through Habermas' communication theory, this paper focuses on the communication structure required for making smart city cybersecurity policies, analyzes cases, and presents a smart city cybersecurity policy-making framework that can be applied.

CCS CONCEPTS

• **Security and privacy** → Human and societal aspects of security and privacy; Social aspects of security and privacy.

KEYWORDS

Smart City, Smart city Cybersecurity policy, Habermas, Communication theory, Framework of making Smart city Cybersecurity policy

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1 INTRODUCTION

Technological advancements in Internet of things (IoT) and data processing have significant influence on the quality of citizens' lives. Smart cities are emerging with technological advancement in information and communication technologies (ICT), and its services become a part of daily life of citizens. The concept of the smart city has attracted attention from many countries as a new alternative to solve the urbanization problems and improve the quality of life of all citizens. Many countries are making efforts to promote smart cities by establishing pilot cities and conducting service contests for smart cities.

Smart cities are based on infrastructures constructed by ICT technologies, platform technology, internet of things (IoT), artificial intelligence, and etc. Inevitably, smart cities have become the target of cyberattacks. For example, there was a case in which one of the cities faced a ransomware attack in the United States [1]. Therefore, it is essential to consider cyber security in smart cities.

Smart cities consist of numerous actors who participate through various devices and services. There are two approaches that can be used to secure smart cities. First, technical and policy approaches identify vulnerabilities of various hardware devices and software, which are the technical elements that make up the smart city. In addition, social norms and policy approaches to smart city participants and their actions that create and use smart cities are needed.

The role of smart city participants is significant in implementing effective smart city cybersecurity policies. It can be said that the role of citizens within smart cities is enormous. Looking at various cyberattacks such as existing ransomware attacks, complying with cybersecurity rules by individuals who use information systems is very important for cybersecurity [2]. Citizens are stakeholders who actively use services within smart cities and play an important role in smart city cybersecurity policies. They are information subjects who need to protect and are also actors in cybersecurity policies. In other words, how citizens perceive and understand cybersecurity policies can lead to the effective implementation of cybersecurity policies.

Many studies have shown that citizens' awareness and understanding of cybersecurity policies are essential in implementing cybersecurity activities [3]. According to these studies, many countries are actively using various methods such as educational programs for cybersecurity. However, education or promotion of policy implementers does not reduce uncertainty about their intention and behavior to comply with the policy [4]. Therefore, it is necessary to make cybersecurity policies by bottom-up method to recognize and understand citizens' cybersecurity policies.

This paper focuses on the smart city cybersecurity policy on communication. Focusing on Habermas' communication theory, this paper will cover the communication structure that should be implemented in the smart city cybersecurity policy. This method establishes a communication structure necessary for establishing a

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smart city cybersecurity policy based on Habermas' communication theory as a theoretical background. In addition, we will analyze Korea's smart city cybersecurity policy based on the established communication structure as an analysis criterion because Korea has an optimized environment for smart cities, with more than 90% of the people using smartphones and having a high-quality ICT infrastructure. In addition, Korea has actively promoted smart city policies since the early 2000s. Therefore, Korea consists of main contents recognized for their necessity, seen as standard smart city policies. After that, this paper will propose a communication structure based on Habermas' communication theory and the results of the case analysis.

2 IMPLEMENTATION OF SMART CITY CYBERSECURITY POLICY THROUGH HABERMAS' COMMUNICATION THEORY

2.1 Communication in cybersecurity policy and Habermas' communication theory

Communication is a management function of exploring, building, and maintaining mutually beneficial relationships between organizations and various actors [5] and is the means that public organizations use to achieve policy objectives [6]. Communication was highlighted by governance, which emerged as a criticism of the government's vertical governance behavior [7]. Within governance, each stakeholder has a specific goal and communicates in a horizontal relationship through a process of autonomous consultation and coordination to pursue a common goal, and communication within this governance increases awareness and understanding of policies, thereby maximizing policy coordination, consensus and adherence [8–10]. That is, through communication, the policy-making process is initiated by the participation of policy-implementing actors to increase their awareness and understanding of the policy and maximize the effectiveness of the policy.

Numerous communication theories deal with communication, and Habermas' communication theory in particular diagnoses the problems that arise during modernization and offers alternatives to society that need to move forward through genuine communication behavior [11]. In other words, Habermas has constructed a theory of communication for the purpose of transitioning to a society in which cooperation between the members of society is possible. Therefore, Habermas' communication theory can be applied to cybersecurity policies, especially in smart cities where citizens participate as major actors. In addition, There are also studies that have used Habermas theory as a framework for analyzing cybersecurity policies, such as those by Bernd Carsten Stahl et al(2012) [12]. Therefore, based on Habermas' theory, it is possible to propose the requirements that the communication structure necessary for communication between the actors and policymakers of smart city cybersecurity policy should be met.

2.2 Requirements of communication structure for smart city cybersecurity policy according to Habermas' communication theory

In regards to the structure and policy contents of smart city cybersecurity policy, the communication theory can be applied as follows. First, we apply the conditions for the situation for the ideal dialogue in the theory of communication. The reason for applying these conditions is the relationship between the stakeholders in the smart cities. Stakeholders in smart cities consist of R&D organizations, companies, governments and municipalities, and citizens who are users.

The relationship between these stakeholders is asymmetrical in the real world. The relationship between the stakeholders is structured as shown in the following table 1
As above, asymmetric relations triggered by political and economic asymmetry are the cause of distortions in communication [13]. The vertical structure of politics and economy, which inevitably exists in reality, directly or indirectly affect communication between stakeholders, leading to repression in communication, which in turn leads to distortion of communication. Without critical review, an asymmetric relationship only ensures the legitimacy and rationality of the upper speaker's remarks, and thus prevents agreement genuine consensus among stakeholders. In addition, repression during the communication process makes it difficult for stakeholders to speak freely, which prevents stakeholders from accepting consensus as a genuine consensus [14].

Habermas presents an ideal speech situation in communication theory as a requirement that prevents communication distortion and achieves a legitimate and rational agreement. The ideal speech situation refers to a conversation in which external constraints like political and economic issues and internal conditions from the communication structure do not interfere with communication [15]. The requirements for the ideal speech situation in Habermas' theory are as follows.

- Ensure equal communication opportunities for participants.
- Giving participants the same opportunity to interpret and explain.
- Ensure the opportunity for substantive speech.
- Granting equal regulatory rights to all participants.

The four requirements have the following meanings in the process of establishing smart city cybersecurity policies. First of all, ensuring equal communication opportunities for participants (requirement 1) means acknowledging that, in reality, stakeholders with vertical relationships are on an equal footing, at least in the policy-making process. This allows all stakeholders to respect each other's arguments and questions and to express their opinions. And giving participants the same opportunity to interpret and explain (requirement 2) means that all stakeholders in the policy-making process are guaranteed the opportunity to explain what concepts or thoughts they have made about their arguments. This excludes the possibility that other stakeholders can predict the claims carelessly. In addition, ensuring practical opportunities for speech (requirement 3) does not symbolically guarantee equal opportunities for

Table 1: Classification of Smart City stakeholders according to the criteria

Level	Capital influence	Political influence	professionalism
High	Government Corporation R&D	Government Corporation R&D	Government Corporation R&D
Low	citizen	citizen	citizen

Table 2: Classification of Smart City stakeholders according to the criteria

Level	Construction of U-City ('~13)	System Linkage ('14~'17)	"Smart City" in earnest ("18~")
Goals	Fostering new growth in convergence Innovation of Construction and Information Telecommunication Industries	Low-cost High-Efficiency Service	Solve Urban Problems Foster Innovation Ecosystem
Information Platform	Vertical Data Integration Closed-type(Silo-type)	Horizontal Data Integration Closed-type+Open-type	Multilateral, Bidirectional Closed-type+Open-type(Expansion)
System	U-City Act 1st U-City Comprehensive Plan	U-City Act 2nd U-City Comprehensive Plan	Smart City Act Smart City Development Strategy
Main Body	Federal Government (MOLIT)	Federal Government (Separately)+ Local Government (Partially)	Federal Government (Collaboration)+ Local Government (Expanded)
Target	New Town (Over 1,650,000m^2)	New Town+Existing Cities (Part)	New Town+Existing Cities (Expanded)
Project	Development of Physical Infrastructure such as Integrated Control Center, Communications Network	Public Integrated Platform and Ensure Compatibility and Standardize	Development of National Pilot Cities Implementation of Various Public Contest Projects

communication but rather means actually granting such opportunities. In other words, it actively allows stakeholders who exist in lower positions, such as citizens, to escape the vertical relationship of reality. Finally, enabling regulatory actions for all participants in the conversation (requirement 4) means excluding privileges generated from unilaterally created norms that can be applied in the process of communication. Although equal opportunities for communication are guaranteed on the premise of equal positions, one stakeholder, like the government, can impose unilateral sanctions on other stakeholders as soon as regulatory actions are allowed only to specific stakeholders. Therefore, satisfying the requirements is to solidify the equal status among stakeholders in the policy-making process.

If a situation that satisfies these four requirements is introduced to making a smart city cybersecurity policies, it is possible to minimize the impact of communication distortion among smart city stakeholders due to the asymmetric social structure, thereby achieving a true consensus on relevant policies. In other words, cybersecurity policies, which are valid agreements accepted by all stakeholders in the smart city through the process, can be effectively implemented and understood by each stakeholder about the content of the policy in the consensus process, so that the effective implementation of the final policy can be achieved.

3 ANALYSIS OF THE COMMUNICATION STRUCTURE WITHIN KOREA'S SMART CITY CYBERSECURITY POLICY

3.1 The current status of policies related to smart cities in Korea

Smart cities in Korea have upgraded smart cities since 2016 after going through the construction stage (2003-2014) and the linkage stage (2014-2017). This is summarized in the following table 2 [16]. One of the smart city policies that has been prominent since 2018 is the National Pilot Smart City Project. The 4th Industrial Revolution Committee announced the National Pilot Smart City Project in January 2018 as one of the Smart City Promotion Strategy parts. The National Pilot Smart City was implemented to freely demonstrate and integrate technologies related to the Fourth Industrial Revolution to sites without development plans. In addition, it aims to create an innovative industry ecosystem that can implement creative business models and present a leading model for future smart cities. Currently, national pilot smart cities are Sejong [17] and Busan [18]. The current paper will focus on cybersecurity in policy documents published by the national pilot smart city.

Table 3: Data Governance of Data Security in Sejong 5-1 Living Area

Field	Details
Data Security	• Personal information and privacy • Establishment of IP protection system • Critical Data Security Classification System
Data Transparency	• Audit data provider's compliance with data distribution and exchange policies • Allow access to data for innovative and economic development and high quality of life
Data Policy	• Free public open data service • Sharing-based data operation. • Responsibility-based confidential data provision • Strict regulation of critical data. • Sharing secret data under strict regulations
Data Operation	• The selection system and authorization of the competent authority. • Supervision and support of competent authorities related to the Urban Data Act.

3.2 Status of cybersecurity policies in the national pilot city

The cybersecurity policy established in Sejong 5-1 Living Area and Busan Eco Delta Smart City, a national pilot smart city, follows. First, the Sejong 5-1 Living Area Implementation Plan stipulates cybersecurity by mentioning data management under the key promotion strategy of operating a data-based city. The policy is summarized as follows(Table 3) [17].

1. Establish a policy to fully inform the data utilization entity of the rights and obligations related to open data.
2. Securing citizens' trust through compliance with personal cybersecurity-related norms and data-related norms.
3. Data security measures (building blockchain strategies, platforms, and data governance systems)

The policies related to cybersecurity mentioned in the Busan Eco Delta City implementation plan are as follows. It aims to build a digital city platform for continuous urban innovation and refers to establishing a cybersecurity platform and a data-sharing platform as detailed tasks. The establishment of a cybersecurity platform focuses on a triple security control system (infrastructure security, field-specific security, and urban security). It is composed of developing and internalizing security guidelines for each smart city field. Establishing a data-sharing platform involves designing and applying data hubs for collection and management methods suitable for data classification and introducing a My Data system. Data subjects directly manage their information. In addition, the Busan Smart City cybersecurity Joint Public-Private TF, which has been organized since 2015, plans to request advice from time to time as necessary.

3.3 Analysis of the communication structure within the cybersecurity policy according to the communication theory

3.3.1 Analysis of Sejong 5-1 Living Area [17]. An analysis of the cybersecurity policy according to the communication theory among the Sejong 5-1 living area implementation plans shows that the communication structure exists to establish the policy but does not satisfy the requirements for an ideal conversation situation. For example, there is content to secure citizens' trust in data management within the data policy. Still, there is no way to gain trust other than to comply with data-related norms and audit data providers' compliance with data distribution and exchange policies. Therefore, it does not directly specify the participation of citizens. However, if you look at the process of building a solution in creating a blockchain platform, another way to secure data, you can check the participation of citizens. The process consists of five steps. There is a possibility that citizens can participate in identifying user tendencies and requirements and establishing opinions from stakeholders in devising user scenarios, the third stage.

Based on this, it is reasonable to say that the Sejong 5-1 living area implementation plans have a communication structure for establishing cybersecurity policies. In other words, there is an opportunity to communicate equally (requirement 1).

However, the data alone cannot guarantee the same opportunity to interpret and explain other requirements (requirements 2, 3, 4). Therefore, it is reasonable to judge that no communication structure satisfies the ideal speech situation mentioned in the communication theory within the cybersecurity policy-making structure mentioned in the Sejong 5-1 living zone implementation plan.

3.3.2 Analysis of Eco Delta City in Busan [18]. When we analyze the cybersecurity policy according to the communication theory among the implementation plans of Eco Delta City in Busan, we can confirm that there is no communication structure for establishing cybersecurity policies. Among Busan Eco Delta City's cybersecurity policies, citizens' participation is a self-information management plan for data subjects by introducing the My Data system in the data-sharing platform construction part. However, these measures only mean that citizens directly participate in the cybersecurity process and do not mean that citizens can directly participate in creating the policy. In addition, the Busan Smart City Cybersecurity Joint Public-Private TF is a cooperative organization for strengthening smart city security and policy proposals consisting of local governments, smart cities, the Internet of Things, big data, and cybersecurity experts. However, there is no proper communication structure in that citizens, the most critical stakeholders, do not participate, providing equal communication opportunities for all stakeholders.

4 A WAY TO REALIZE A COMMUNICATION STRUCTURE FOR SMART CITY CYBERSECURITY POLICIES

4.1 The realization of communication structure requirements for smart city cybersecurity policies

It was confirmed that no communication structure satisfies the ideal speech situation requirements discussed above in the process of making Korea's smart city cybersecurity policy. Actually, it needs to look at the cases of other countries. Still, through this analysis, it can be assumed that the communication structure for smart city cybersecurity policies has not been generally implemented. However, the establishment of a smart city cybersecurity policy in which citizens participate on the premise of a communication structure according to Habermas' communication theory can ensure the understanding and active participation of citizens who implement the policy. Therefore, if a cybersecurity policy-making system with such a communication structure can be established, cybersecurity can be efficiently and effectively performed, one of the most essential parts of smart cities. It is necessary to think about how those requirements can be realized in the real world. First of all, the current paper will look at how each requirement can be implemented in a real smart city cybersecurity policymaking.

First, requirement 1 should take into account the practical problems and consider the implementation measures. This is because it is impossible to completely guarantee the equal status of all stakeholders, ignoring the political and economic upper and lower structures. Therefore, it is necessary to consider ways to create an environment in which they can recognize that they are equal beings with equal opportunities for communication and act accordingly. It is essential to specify these contents in the norms that control the policy-making process. However, more realistically, the process of recognizing that each other is in an equal position because they are essential to making policies is placed at the beginning of the policy-making process, or all speech in the policy-making process of stakeholders is recorded.

Second, the implementation of Requirement 2 requires ensuring that each stakeholder has sufficient time and opportunity to interpret or explain their opinions. This opportunity needs to be further guaranteed to citizens among stakeholders. For example, R&D organizations, companies, and governments have their expertise in cybersecurity. Still, citizens will not be guaranteed this opportunity because it is difficult to be recognized for their expertise. Therefore, the requirements can be implemented by establishing guidelines for at least what should be mentioned when expressing the opinions of each stakeholder within the communication process for policymaking. It is necessary to present sufficient examples of interpretation or explanation for citizens in the guidelines.

Third, the best way to implement Requirement 3 is more straightforward than the previous implementation method of other requirements. It makes it mandatory for each stakeholder to make remarks on opinions in the process of making smart city cybersecurity policies. These measures force all stakeholders to present their opinions at least once in all policy-making procedures, which can be the most straightforward way to ensure that all stakeholders deliver their opinions.

Finally, the method for implementing requirement 4 is as simple as requirement 3. Implementing Requirement 4 is to determine the norms that can be applied to them during the policy-making process in all stakeholders participating. However, there is no way to prevent regulatory actions that specific stakeholders make based on vertical relationships in reality. Therefore, to prevent this, it is necessary to prepare in advance a way that other stakeholders can object to issues unilaterally decided by a specific stakeholder or a method of sanctions.

4.2 Proposal of a framework for making a smart city cybersecurity policy

This paper proposes a framework for making a smart city cybersecurity policy to implement the abovementioned requirements. It is a cybersecurity policy-making meeting based on an intentional conflict of opinions. This meeting is based on the progress of Living Lab, which is currently being used in smart cities to discover services. The basic process of Living Lab(Table 4) consists of the action plan stage (Ideation), the implementation design stage (User Research), and the construction and operation stage (User Test). This process can also make cybersecurity policies of smart cities in each region [19]. Each step will follow if the corresponding process is substituted into the policy establishment process.

In each process of the policy-making procedure, the process of communicating the current situation and developments in accordance with the relevant process should be an essential element. In other words, it is not crucial to hold a meeting in this framework, but the stakeholders' relationship within the meeting is essential. Therefore, it should be organized so that one stakeholder plays a leading role in each procedure meeting and the other stakeholders with opposite opinions(Figure 1). The stakeholder who plays the leading role refers to the person who can play the top position for the goals of each stage. It is intentional to create a conflict of opinions by making them make presentations that have no choice but to present their views. However, the citizens mentioned here presuppose citizens with the average ability who have completed

Table 4: Explanation of the process for making a smart city cybersecurity policy using the Living Lab procedure and major actors in the process

Process	Leading actor in the process	description
Ideation	citizens	The stage of presenting policy goal points
Research	experts, and companies	Steps to come up with measures to make policy goals
User Test	smart city managers, and practitioners	The prepared plan's application and evaluation, and remuneration stages

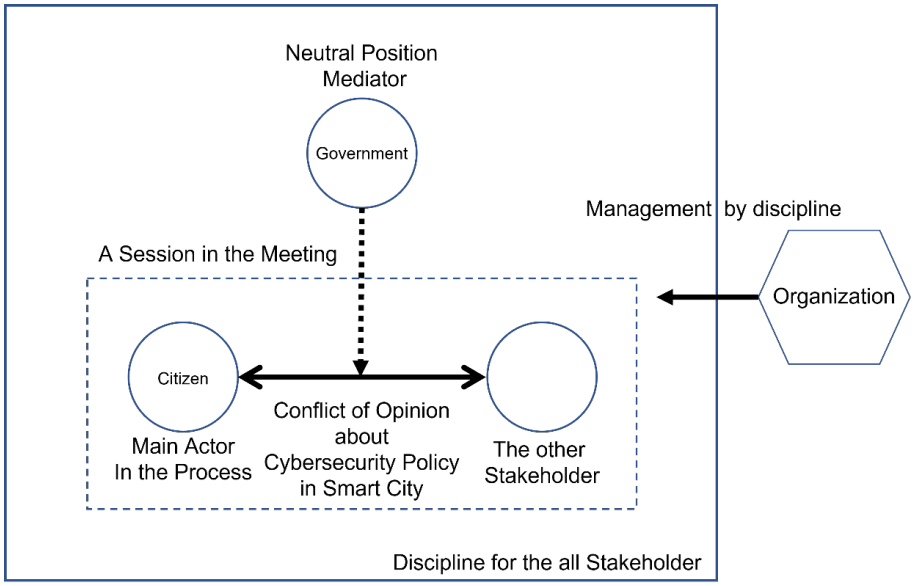


Figure 1: Framework for making a smart city cybersecurity policy in the Ideation process.

the primary education each society provides. This is because the citizens mentioned within the framework collect the opinions of many citizens and represent citizens whose ideas have been agreed upon. Of course, it would be ideal if it could reflect all the opinions of individual citizens. However, everyone's range of opinions may have too broad, and there may be opinions that are not rational. Therefore, citizens in the framework presented in this paper will be premised as citizens representing the agreed opinions through a separate procedure to gather the opinions of the local residents of the smart city.

Citizens must be assigned to one side of the opinion in which the intentional conflict of opinion occurs. Through this intentional conflict of views, the phenomenon of citizens' sympathy that may occur is excluded, and all stakeholders are forced to speak practically. However, there is a possibility that conflicts of opinion will not be resolved in this process. To prevent this, the government, a stakeholder, and policy expert who can play the most neutral role, should participate in the meeting in a neutral position. It is also to ensure that the highest-ranking government in power does not significantly impact its opinions on policy. In other words, this meeting framework allows stakeholders to stand in opposite positions, forcing them to be recognized as equal roles. It also places stakeholders in a position where they must speak on the subject to have no choice but to speak. Therefore, through this, requirements 1 and 3 are achieved.

For resolving conflicts of opinion, each stakeholder undergoes a sufficient explanation for their opinion, so that requirement 2 can be satisfied through the relevant meeting. However, in order to sufficiently satisfy Requirement 2, the meetings should not be planned one time at each stage but held several times for a certain period, whether online or offline(Figure 2). This gives citizens time to prepare and receive help to prepare and claim their opinions that have been refuted. And through this, all stakeholders can sufficiently exchange their ideas.

Finally, Requirement 4 can be implemented by including stakeholders by determining the contents of matters related to overall meeting management and creating an organization within the meeting that manages the general schedule of the meeting. For example, regarding the management of the meeting body, they intend to make a discipline with contents such as preventing all stakeholders, including citizens, from participating in future meetings for members who did not properly participate in the process during each session. Making these rules ensures that any member of the meeting body complies with them. Since anyone who does not adhere to the discipline will be disadvantaged by the content, indirectly specifying the right of all stakeholders to regulate. In addition, creating a schedule management organization within a meeting body

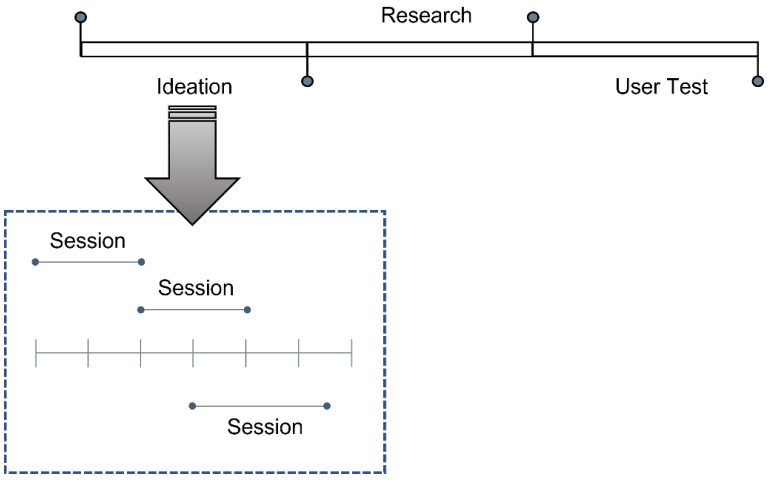


Figure 2: Process in Framework for making a smart city cybersecurity policy.

has a management organization that checks whether it complies with the rules to be effective.

5 CONCLUSION

The communication structure of Korea's smart city cybersecurity policy discussed above has a structure in which true communication cannot be achieved in that it cannot guarantee the participation of citizens. According to Habermas ' communication theory, the formulation of a smart city cybersecurity policy in which citizens participate in a communication structure can ensure the understanding and active participation of citizens who implement the policy. Therefore, if a cybersecurity policy-making system with a communication structure can be established, cybersecurity, one of the critical parts of smart cities, can be efficiently and effectively performed. For this reason, the proposed smart city cybersecurity policy establishment framework will be a way to present sufficient opportunities for the exchange of opinions to stakeholders as design intentional conflicts of opinion.

However, this study only deals with the communication structure within making a smart city cybersecurity policy. For making an efficient and effective smart city cybersecurity policy, additional research is needed on the attitudes each stakeholder must have and the factors that the created cybersecurity policy must have in making the cybersecurity policy. Therefore, research on this will continue in the future.

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Conceptual challenges of researching Artificial Intelligence in public administrations

Definitional challenges and varying dimensions on the meaning of Ai

Colin van Noordt
Ragnar Nurkse Department of Innovation and Governance Tallinn University of Technology
Tallinn, Estonia coliva@ttu.ee

ABSTRACT

Research has been advancing on the development and deployment of Artificial Intelligence (AI) in public administrations. However, there is limited consensus and agreement on what is considered Artificial Intelligence, as different understandings and approaches in research and practice exist. This paper explores and compares the varying ways AI has been described and understood in previous Information Systems and eGovernment research. Following, a survey amongst Belgium civil servants is analysed to assess what they associate with the term Artificial Intelligence. The findings show that many civil servants tend to associate AI with being able to conduct intelligent tasks, have certain capabilities or are specific applications they are familiar with. Specific algorithms or learning methods, often included in research papers, are not associated with the term AI. These results show that researchers and policymakers may have opposite or even paradoxical views on what is or is not AI, which could have significant consequences for researching the adoption of AI in government, as well as comparing different research findings. In this respect, the paper proposes to use an integrative lens to study AI in government, by including different dimensions and understandings.

CCS CONCEPTS

• **CONCEPTS**; • **Artificial Intelligence**; • **Public Sector Innovation,**; • **Technology adoption**;

KEYWORDS

Artificial Intelligence, Public administration, Perceptions, Civil Servants, Machine Learning

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1 INTRODUCTION

Artificial Intelligence (AI) has grasped the attention of many people across the world. Many governments have been writing specific AI-strategies, conferences on AI are held frequently and new articles are being written in rapid succession [1]. All in all, there is a general understanding that Artificial Intelligence is going to transform our societies and that governments should do everything to harness its full potential [2]. Time will tell whether these transformative predictions will be correct, as often the transformative potential of new technologies does not live up to its expectations [3]. In fact, it is not the first time we are discussing the potential and challenges of AI in the public sector as older research articles show us [4, 5].

However, despite this immense hype and efforts to be the best in Artificial Intelligence, there is very limited clarity of what is exactly meant by the term, with different audiences using the term in different ways [6]. This lack of a clear terminology for AI has led to a variety of critical remarks, stating that people only refer to software as Artificial Intelligence when there is funding to be held -otherwise, it would just be said to be statistics [7]. This is not to say that there are no articles or reports present which describe definitions of AI, in fact, the opposite is true. There are incredibly large volumes of publications on Artificial Intelligence, especially in recent years [1]. Despite the great number of publications, the term remains unclear and contested due to the various backgrounds and interests using these terms with many reports referring to AI as forms of 'intelligent machines', 'machine learning' or similar terms [6, 8–11].

Many of these new applications, systems or applications are considered AI as they can conduct intelligent tasks [9]. Existing studies already highlight that there are many, varying forms of technologies and applications considered to be AI, which may not be alike [12–14]. What is the most fundamental for research on AI in the government, however, is that civil servants themselves may use different terms and concepts to understand and describe Artificial Intelligence. Researchers who are researching the next algorithm to extract patterns in large data sets will use the term AI in very different ways (usually regarded as data science) than policymakers would refer to it [15, 16]. Now that there has been increased interest in researching AI in government, one of the more fundamental research gaps relates to the empirical examples and insights into how AI can create public value [17, 18]. With such strong research needs for additional empirical works, ensuring consistency and generalizations of what is and is not AI in government within the scope of the study is crucial in advancing knowledge. As Krafft et al., 2019 already indicate, many governmental documents do include policy recommendations on AI, but do not define their

understanding of the term, raising concerns about what exactly policymakers attempt to govern. Already, as a result, discussions on the impacts and consequences remain to be general, more focused on ethics or the development of fair AI and large efforts are required for any form of systematic and comparative studies; especially cross-domains [19, 20]. Furthermore, it is likely that in the coming years, more and more governments will use some form of AI to improve their practices [21], further emphasizing the need to create a common baseline of definitional convergence to understand and explain what and how AI develops in the government, and whether this is desirable [22].

To highlight how different civil servants define and understand AI, this research is built on two steps. Firstly, an exploration of the different understandings and definitions of Artificial Intelligence as discussed in existing literature are introduced and discussed, illustrating their main differences and similarities, and, in doing so, providing a fresh and new perspective on the topic [23]. Secondly, a survey has been conducted among Belgium civil servants, asking them what they understand with the term "Artificial Intelligence" in an open-response format. Using a deductive coding technique, an overview with different understandings of AI is introduced to assist further research on AI, as well as to highlight a challenge of how civil servants perceive AI could significantly influence research on the adoption of this technology. As such, the article concludes with a discussion and concluding remarks on the potential research and policy implications of the different perceptions in policy and research.

2 CHALLENGES OF THE TERM "ARTIFICIAL INTELLIGENCE"

Despite the historical works on AI, there is still no commonly accepted definition and many studies consequently do not provide a clear definition of AI. If a definition is given, already as many as 28 different definitions were identified [24]. In that respect, research could describe AI in many different ways. Some papers aim to highlight the difference between the AI as a SuperIntelligence, General Intelligence or Narrow Intelligence, to avoid potential confusion on these different types. Discussions on *AI as a Superintelligence* often refer to futuristic robots which are far more intelligent than humans [25]. This type of AI belongs in the realm of science fiction – although the potential futuristic perspective of how AI could look like has been at the basis for some ethical discussions on how to 'control' AI even if such a moment comes to pass [26]. Like this type of Superintelligence, research could also discuss *Artificial General Intelligence*. Unlike the Superintelligent variant, this type of AI refers to robots (or other systems) which are just as intelligent as humans. This type of AI is commonly capable of learning and transferring its previous thought knowledge into new domains [27, 28]. More relevant for current research on the adoption and the type of AI applications belongs to the *Artificial Narrow Intelligence* or 'weak' AI understanding. This is often understood as machine intelligence that is equal or (slightly) superior to human intelligence – but only for a specific task, predictive, reactive and based on rules [29–31].

Within this field of current or Narrow AI, papers often describe *AI as the learning methods or techniques* used to make the AI systems 'as AI'. At the moment, machine learning is the most popular form used as the learning method in AI, or considered as a subset thereof [24]. What makes machine learning distinct from 'traditional AI' is that machine learning algorithms learn by 'themselves' on (very) large datasets. The field of machine learning, however, consists of many different approaches and specific analytical techniques. Often, a distinction is made between supervised machine learning, unsupervised machine learning and reinforcement learning. In supervised learning, labelled training data is used in order to predict new cases based on the existing information whereas in unsupervised learning insights from the data without a clear output are derived [32]. In the reinforcement learning approach, an AI system learns how to do a task well by giving a "reward" based on the output of the task [31]. Within these broad approaches, a massive amount of different analytical techniques belong to this realm. For instance, the following terms have been used by Sousa et al., 2019 to measure the progress of AI in public sector research, such as: *case-based reasoning (CBR); cognitive mapping fuzzy logic (FL), machine learning (ML), artificial neural networks (ANN) genetic algorithms (GA), multi-agent systems (MAS) and natural language processing (NLP),* amongst many others [33]. These methods are often included in the keywords of larger comparisons such as the OECD [34] or described in the proposed AI regulation from the European Commission as AI techniques or approaches.

Commonly, the use of these AI learning techniques aims to enable an *AI system to gain an ability in order to conduct specific tasks.* These abilities, or capabilities as others also mention, are what define for some whether we classify something as AI or not [35]. These capabilities or abilities gained from the learning techniques described earlier allow the AI to conduct tasks considered to require intelligence or for the AI to behave rationally [22], or to think and learn [36]. Consequently, it is not so much the question of how AI learns – but what it is possible to do following the learning– and whether it does so successfully. These abilities include, but are not limited to, perceiving, reasoning, learning, interacting, problem-solving, decision-making or being creative [24].

Related, but not entirely similar, are some publications which refer to AI as specific applications which are consequently used by public administrations and considered AI [37]. Often, these are special IT, software or hardware which are used to improve government's processes or decisions. It has been argued that approaching AI as a tangible technology such as is more preferred for research and regulatory purposes as it is more concrete [38]. Currently, applications mentioned as such include voice assistants, facial recognition software, recommendation software, chatbots, and robotic process automation among others [13, 30].

Lastly, some tend to refer to *Artificial Intelligence as the general academic field* – not specific to any kind of applications, but rather the full study domain as it has started since the 1950s [39]. Despite the status as an emerging technology, the study of AI already started in the 1950s with various researchers such as Gregory Powell, Mike Donavan and Alan Turing publishing works on intelligent machines [25, 35]. Not much later in 1956, the term Artificial Intelligence was first brought up during the Dartmouth Summer Research Project on Artificial Intelligence, often seen as the 'starting moment' of the study of AI.

Table 1: Varying perspectives of AI, author's own elaboration

Understanding of AI	Explanation	As seen in:
AI as Superintelligence	A futuristic machine or computer which (far) surpasses human intelligence	[13, 25, 26]
AI as General Intelligence	A futuristic machine or computer which displays equal human-like intelligence in a variety of domains	[31, 40]
AI as Narrow Intelligence	Current artificial intelligence in which systems display human-like intelligence in one specific function	[41, 42]
AI methods/techniques	Techniques and methods that allow the analysis of large volumes of data to develop AI such as case-based reasoning, cognitive mapping, fuzzy logic, machine learning, multi-agent systems, rule-based systems amongst many others. These may fall under supervised, unsupervised and reinforcement learning methods	[14, 27, 32, 43–45]
AI as human-like cognitive capability	Ability of machines to carry out tasks which require human capabilities, by displaying human-like behaviour, to behave rationally, the ability to solve hard problems	[22, 35, 46, 47]
AI as applications	A special form of IT systems, applications or software that are capable of performing tasks that normally need human intelligence	[12, 13, 30, 38]
AI as a science	The general study and science behind the pursuit of making machines or computers intelligent	[5, 39, 48]

An overview of these different understandings, which at times can overlap, can be found in Table 1 below.

As can be seen by this overview, the term of Artificial Intelligence is highly fluid and changing – even over time, depending on the latest state of the development [49].

3 METHODOLOGY

To assess how civil servants perceive Artificial Intelligence, this research uses data from a survey conducted amongst Belgium public administrations in April and May 2021, as part of the Belgium AI4GOV programme. The AI4Belgium community is an ecosystem of researchers, policymakers, civil servants, and citizens interested in advancing AI within Belgium, and has a strong research interest and examines the current use of AI in Belgium and is actively putting policy in place to boost the uptake of AI in society. As such, there is a strong need to identify what is considered AI by civil servants themselves, as they would play a key future role in examining the current level of uptake and impact of this technology. The survey also included various questions to the respondents regarding the current level of use of AI in their organisation, and which perceived drivers and barriers are influencing the use of their organisation. However, one of the crucial elements of the survey was to gain a comprehend of how civil servants, with varying backgrounds, perceive the term "Artificial Intelligence". This question was stated: "*What is according to you Artificial Intelligence (AI)? Please provide a short answer.*". Respondents were given the opportunity to provide a short, open answer as a response.

A web survey was chosen to gain answers on how civil servants from the survey, as the aim was to gain as many civil servants participating, in a relatively short time. While a survey may not lead to the same amount of detailed understanding and conceptualisation of AI as one may obtain in an interview or in a focus group due to the limited opportunities to express their thoughts, a survey is an excellent research methodology to many people in a short amount of time, and to this extent, a great research method to research general perceptions to AI [50]. Naturally, one of the key requirements of a survey design is to obtain a representative sample of respondents. To do so, various distribution channels were chosen to target a diverse number of civil servants as possible, ranging from local, regional, and federal levels of government, and also civil servants who may have limited formal education in Artificial Intelligence. Firstly, all the members of the AI4GOV network were requested to respond to the survey by email. Secondly, the survey has been distributed within the internal communication networks of the Belgium government, to also target the various public organisations which may not be active members of the AI4Belgium network. Lastly, the survey has been shared on social media and in the newsletter of the Belgium Digital Government Administration (BOSA) and AI4Belgium.

Since the Belgium public administrations have different working languages (mostly Dutch and French), the survey has been translated to Dutch and French, giving respondents the option to answer in English, Dutch or French, depending on the respondent's preference, in order to obtain a higher response rate. The full survey was proof tested and reiterated various times to make the questions relatively easy and quick (within 15 minutes) to answer, common characteristics of mail-based surveys [51].

The question was answered by different 134 respondents, from the municipal, regional, and federal levels of the Belgium government – although most of the respondents were from the Belgium

Federal government. Following a review of the answers, 18 questions were either blank or duplication from another answer, which were consequently removed. This left 116 answers on what the respondents found to be "Artificial Intelligence". As the answers were provided in both Dutch and French, they were both translated to English using DeepL machine translation. Following this translation, the answers were deductively coded and analysed using MaxQDA software based on the categories identified in Table 1 except for the Narrow Intelligence, as the techniques and applications categories overlapped strongly with this category since they described current techniques and applications considered AI and should be better-understood vis a vis General or Superintelligence, rather than a category by itself. As each of the answers could be coded one, or multiple times, the final number of codes was 159 out of the 134 answers, meaning that there were several answers which referred to one or more of the categories identified below.

4 FINDINGS

4.1 Artificial Intelligence as a future Superintelligence or General Intelligence

Despite that some academic literature strongly focuses on the futuristic general or even superintelligence as Artificial Intelligence, only one of all the answers retrieved was coded as such. This respondent criticized the use of the term Artificial Intelligence as part of the survey, as according to him, it did not exist. Rather, the respondent preferred that the term "Super Robots" would be used instead. Unfortunately, it is not entirely clear why the respondent found the use of the term AI so problematic, nor is it completely straightforward if "Super Robots" would be in the scope of the futuristic AI or the current robotic applications that are already being used. The answer "*Super robots are capable of doing things much better than humans but none of them are capable of doing anything they were not designed to do*" does, on the one hand, gives the reference to superintelligence, as they are better than humans, but at the same time, seems to refer to existing applications due to the incapability of doing actions they are not designed for.

However, in any case, this suggests that for most civil servants, AI is not associated with futuristic technology. General and superintelligent AI doesn't exist now and is likely to not make its appearance for many decades (or even centuries), although some reports and authors do refer to AI as the futuristic possibility of superintelligence [26]. For the respondents, however, this is not the case, and questions regarding the use of AI thus refer to more practical experiences of technologies they now consider AI, rather than this potential futuristic technology. At the same time, there are discussions regarding the ethics of AI and the academic debate on the AI alignment problem tend to discuss this form of AI. These discussions within the academic community may refer to totally different iterations of AI with other challenges and governance difficulties [31] – and this may not fully align or even cause confusion as civil servants have a different perception of what is AI technology [20, 52].

4.2 Artificial Intelligence as a learning technique:

A substantial part of the respondents responded to the question about what they consider to be Artificial Intelligence a variety of answers linked algorithms, methods and techniques to learn systems and to possible mimic human intelligence. These answers (29 out the 159 coded answers) referred to this theme. Often, this included answers such as "*A set of algorithms capable of solving problems by connecting various sources of information and drawing conclusions from varied or incomplete information*" or "*Machine and deep learning tools that allow learning from an algorithmic point of view from input data, or iterative learning loops, to provide a result as close as possible to the expert's expectations.*".

These answers could be well interpreted as understanding AI as the algorithms or techniques dominant in the development of AI systems. This, as such, thus focuses on the *creation and design* of technological tools which can conduct intelligent tasks. Traditionally, the field of AI has always been about the creation of intelligent machines and finding the appropriate techniques, methods and algorithms to do so [25]. This art and science of creating intelligent machines are therefore referred to as AI [53], which is in line with an answer which mentioned the "*training of computers to perform intelligent actions by themselves.*".

In this perspective, the *methods or tools* during the creation are leading in explaining AI such as Machine Learning, Deep Learning, Bayesian methods, Conventional Neural Networks and more, changing over time [14]. In general, discussions within this perspective will focus mostly on the methods used to create the AI such as the various algorithms or approaches used to create higher-performing models [43].

One consequence here for research on the adoption of AI is the assumption that AI thus is used when an organization is utilizing these (one or more) analytical techniques on their data. The understanding AI as a learning technique is highly dynamic – as in the past other techniques were considered AI. Especially AI research up to 1980s, Symbolic AI research was the leading method for creating intelligent applications (Stone et al., 2016) – but may not be considered as such anymore.

Some of the respondents referred to these algorithms as *'intelligent algorithms*', which branch a variety of different backgrounds together, including mathematics, logic, computer science, cognitive science and neuroscience. In some cases, specific algorithmic techniques (considered to be AI) were mentioned in the answers of the respondents, such as machine learning, deep learning or neural networks, but more advanced jargon or specific statistical techniques, such as Bayesian methods, conventional neural networks amongst others, were not mentioned once. This is, however, in rather sharp contrast with some of the measurements currently in use to track "AI", as highlighted earlier.

4.3 Artificial Intelligence as an ability:

Most of the respondents answered various types of abilities and capabilities that are linked to the term "Artificial Intelligence". Following the coding process, 59 of the 159 codes are considered to describe some form of ability, the highest number of coded groups. In contrast with the previous set of answers, these respondents

do not refer to the algorithms or techniques used in the development of the systems, but rather what AI can – or should - do. A consensus on the different abilities of AI was not found amongst the respondents, as many highlighted different actions that they consider AI to do, although several were mentioned a couple of times. These include, amongst others:

- Performing tasks are previously done by humans or imitating human intelligence
- Learning new things, learning from experience, and improving itself
- Conducting tasks autonomously or without human interference
- Capable of automating repetitive tasks
- Find connections, recognise patterns (in data), derive trends, create or predict

If computers, systems, or other forms of ICT are thus capable of portraying one of the following abilities, the more likely it is that they are considered Artificial Intelligence. In this perspective, the *ability to conduct intelligent tasks* determines whether we regard technology as Artificial Intelligence [54]. These unique capabilities are often enabled by the AI learning methods combined with the relevant data [43]. Most AI now tend to be able to do the tasks such as digital media recognition, pattern recognition, detection of speech and text, clustering and the detection of anomalies in large datasets [55]. Many respondents of the survey also identified more specific abilities other than the ones described above linked with AI, such as *"draw conclusions from data"*, "*capable of solving problems"*, "*detecting certain actions by analysing data"*, "*enabling the exchange of data safely and efficiently", (. . .) "report deviations (large or small) to the product owner or support"* or "*the possibility of having value-added tasks performed automatically"*.

It is possible that thus, solely assessing the AI learning technique is thus insufficient to identify AI, but its abilities and what tasks they perform should be regarded as the leading factor. It may be very well possible that some AI learning techniques are used – but that alone is not sufficient to regard something as "AI". In particular, the answers showed a strong tendency that Artificial Intelligence is either replacing or acting without the supervision of humans. In some way, AI could thus be better understood as 'automation' – which could be done by technologies that are based on techniques other than the learning techniques described before. However, not all – and especially AI used in the public sector – is acting completely autonomous, but often acts as decision support in combination with human expertise [56]. This may thus lead to difficulties in researching the adoption of AI in the public sector since certain applications are not see perceived as AI due to a lack of autonomous decision-making.

Similarly, as several respondents were mentioning that AI is capable of mimicking human intelligence or performing tasks requiring human intelligence, it may lead to challenges in defining if this task truly requires "intelligence" to be completed. There is not a sole answer to what can be considered intelligence. In fact, there seems to be little consensus on whether machines will ever be able to be intelligent at all or whether an AI can be considered "rational" creates further difficulties regarding which exact abilities should be included [38]. Indeed, one respondent even mentioned that AI is to "*have non-intelligent machines do intelligent tasks"*.

4.4 Artificial Intelligence as an application:

Many of the respondents also described a variety of systems, programmes or applications that they considered to be Artificial Intelligence. In this sense, 53 out of the 159 answers to the question were coded to be considered part of this theme of answers. The type of applications referred to be Artificial Intelligence varied greatly, but are often referred to as either programmes or computer systems, that are capable of adapting or learning to their own needs. Respondents would mention specific applications, such as "*A prediction tool created by humans to assist them in their prediction tasks based on input data"* or "*A system that answers your questions from a computerized system such as a chat box"* are examples of such answers given by the respondents.

Here, applications are considered differently from the learning techniques or algorithms that were described before. Instead, it focuses on the technological artefacts which are referred to as Artificial Intelligence [46]. These are the 'final products' such as applications, ICT-systems, interfaces or innovations in which AI capabilities are embedded and with whom users interact with [13]. These applications are services, products or information systems which enable – autonomously or in combination with people – the AI to provide services, insights or make decisions. Hence, respondents sometimes mentioned this integration of (machine learning) algorithms other times of software and hardware as AI, such as "*technology based on algorithms to enable machines/computers to analyse data, calculate, decide" "(. . .) is software that you can use not only to perform repetitive tasks, but that can quickly learn new tasks (. . .)"* or "*a function you can assign to a program, app, game, machine etc. to create or predict systematic things"*. To a certain extent, some of the applications already identified by Wirtz et al., 2019 were also mentioned by some of the respondents. For instance, answers mentioned a system that automatically recognises a system through a recognition matrix, facial recognition, a system for preventing diseases, robots, and virtual assistants or chatbots.

Commonly these applications combine other software and functions in combination with the insights of the AI learning methods, creating a blurry field of how much the system is actual "AI" [57]. Furthermore, there are so many different types of applications that could be considered "AI" that it broadens the scope of the number of applications perhaps too wide. Indeed, one of the answers given highlighted this issue: "*Very broad: the word suggestions on my mobile phone, Google Home, a chatbot (. . .).*".

Each of these applications functions very differently, and one may only wonder if agreement can be found whether each of these specific applications is considered "AI" by all – and if so, whether the effects as discussed in the existing literature and policy discourse will apply to each of them. Even with chatbots, while the application and purpose may be the same, research has already highlighted the variety of complexity and functionalities each of these chatbots may have, leaving one to wonder if all chatbots are truly AI or not. The same accounts for the use of robotic process automation, which is considered to be AI by some [58] and not by others due to the lack of 'cognitive' decision-making [27].

4.5 Artificial Intelligence as a science:

There were 4 answers out of the 159 coded referring to the overall branch of the science of Artificial Intelligence, a small minority. One of these answers, for instance, mentioned that Artificial Intelligence is "*A branch of computer science covering many different techniques that rely on data and learning to mimic human intelligence*" whereas another highlighted the *"set of theories and techniques for developing complex computer programs (. . .)"* which derive from the academic discipline. One of the respondents referred to the goal and progress-oriented research focus of the field of AI, as he responded: "*Working towards the most autonomous technology possible based on self-learning algorithms*", highlighting the alignment of the goal-oriented field of study.

However, in general, based on the responses, many civil servants do not often refer to the overall academic discipline or the science of Artificial Intelligence when asked what they mean by AI. Similarly, to the associations given with Superintelligence and General Intelligence, most of the associations that the respondents have with AI are practical – related to applications, capabilities, and the applications. One may find these the results or the output of the science of AI – rather than the academic field itself.

4.6 Other:

Lastly, there were 13 answers coded in the residual category of "Other", as these answers did not fit in any of the other categories identified above. Some of these answers referred to what AI enables for society, such as "*A way to save time and jobs"* or *"A necessity"*. These residual answers show that despite the broad and diverse meanings and understandings that already exist in the literature, civil servants may still have a different association with the term. Future research could dive more deeper into other, less usual associations that civil servants may have with AI.

5 IMPLICATIONS FOR RESEARCH AND PRACTICE

As the responses show, the term Artificial Intelligence indeed has many different concepts and understandings among Belgium civil servants, and, consequently, when asked whether these civil servants are using AI could lead to a plethora of different answers and examples. However, based on the answers given, there are some main dimensions of categories with which to understand how policymakers may associate the term AI with. In this respect, this may either be AI as specific learning techniques, AI as an ability, AI as a specific application or a futuristic form of AI, or a mixture between them, as these dimensions support and even expand upon one another. Each of these concepts also follows the different stages of the adoption; from development & design to the application and implementation of AI, with each phase having different requirements or study perspectives as a result [32].

More fundamentally is that, when researching the use of AI by civil servants, for instance, is that merely using general definitions of AI may thus be insufficient to account for all the different ways this term is used. Thus, it could be more fruitful to be more specific in the research and aim to differentiate between the different types of AI – whichever is the aim of the researcher – as to assist respondents in associating the requested 'kind' of AI. This is even more crucial due to the apparent gap already in some surveys on 'general' AI usage and more specific applications, as can be seen in the latest European Commission survey on the uptake of AI in businesses [59]. A somewhat paradoxical finding of this survey was that a significant number of businesses reported that they are using AI already (45%), but when asked about specific applications, such as sentiment analysis or Chatbots, the percentage was much significantly lower, sometimes ranging in less than 5%, making the reader wonder if specific applications of AI are so rarely used, how come organisation report such a high uptake of AI?

Furthermore, similar difficulties could be identified if one would research the adoption of machine learning or other statistical techniques within public organisations. It is, indeed, very possible that organisations are using these statistical approaches within their organisation – logistic regressions, Bayesian methods or other quantitative analysis tools are commonly used within private and public organisations. However, just merely using these statistical approaches may not necessarily lead to the development of an AI application or active use of the output of such models. As such, the uptake of AI learning methods may thus be higher than AI applications, as there may be various challenges from moving to the development of models using AI learning methods to practically using applications built on those. This dilemma can already be seen in various measurements based on tracking the 'progress' of AI. Most of these track the use of various machine learning terms or methods in scientific papers. This, however, says very little about what is the result of these models, how these models are consequently finalised and whether they are in active use in (public) organisations. It seems by some existing research that the uptake of the final applications seems much lower and more problematic indeed. For the research on the uptake of AI, one should also keep in mind that many of the 'successful' pilots of AI usage in government discontinue or are not used anymore after a while. In such a scenario, indeed, the learning methods of AI have been used in a government context, but real adoption and integration of the applications did not happen [56].

The same accounts for the potential reverse definition difficulties of these dimensions. If, for instance, a civil servant is asked about their organisation's use of AI applications, it may be possible that a response consisting of software, machines or other applications is given – but these may not necessarily be (fully) based on the learning methods considered AI by others. These applications may still be able to do tasks successfully or considered novel enough to appear like it is AI but may lead to disagreements to which extent it can be seen as AI by all. An example of such disagreements are recent articles highlighting that a large portion of "AI" start-ups may sell software or applications they sell as AI, but in fact, are not based on AI learning methods, leading to sharp criticism as not being 'truly AI'[1]. Future research could focus more deeply on the professional and/or academic backgrounds of the respondents, as this could shed a light on how some identify Artificial Intelligence more closely with the learning methods, applications and/or other identified categories of this paper.

[1] See e.g. "About 40% of Europe's "AI companies" don't use any AI at all, MIT Technology Review: https://www.technologyreview.com/2019/03/05/65990/about-40-of-europes-ai-companies-dont-actually-use-any-ai-at-all/

These limitations could significantly affect nuanced discussions on the uptake, effects and governance of the different facets involved with AI, as there are indeed many different challenges which require more research to understand the consequences of AI on society [60]. In this respect, much can for instance be learned from previous unclear concepts used in eGovernment research, such as Smart Cities. This has also led to various critical reflections on the term, as a recent publication on smart cities highlights as well [61]. Researchers, as well as policymakers, can have completely different understandings of what is considered a smart city, as well as how it should function [62]. What may be a potential solution for this issue is to conduct research with a more integrated view of AI, which aims to combine the different dimensions discussed in this paper. It may thus be extremely worthwhile in research to describe a specific AI system with its ability, as well as which AI learning methods were used. Such an integrated approach also fits the definition as proposed by the High-Level Expert Group on AI by the European Commission, as well as the OECD.

With this paper, the research, as well as the policy community, may be better equipped with additional insights on how different groups perceive AI differently – and the need to ensure comparability of the findings. This is not only crucial for improving the generalization of research findings beyond individual case studies, surveys or other studies, but also in ensuring that any negative consequences following the use of any AI system do not lead to unnecessary restrictions on the many other times of technology referred to as AI, which do other tasks and are developed differently. Future research may further explore why these different perceptions differ between civil servants, and to which extent professional backgrounds, familiarity with AI as well as how civil servants work with AI in their job influence how they perceive what is to be considered AI, and what is not. Furthermore, there is also room to explore differences in understanding of other concepts related to AI such as bias, AI governance, manipulation or exploration of various unethical forms of AI uses in a follow-up study.

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A Conversational Agent for Argument-driven E-participation

Andrés Segura-Tinoco
Escuela Politécnica Superior,
Universidad Autónoma de Madrid
Madrid, Spain
andres.segurat@uam.es

Andrés Holgado-Sánchez
Escuela Politécnica Superior,
Universidad Autónoma de Madrid
Madrid, Spain
andres.holgado@estudiante.uam.es

Iván Cantador
Escuela Politécnica Superior,
Universidad Autónoma de Madrid
Madrid, Spain
ivan.cantador@uam.es

María E. Cortés-Cediel
Facultad de Ciencias Políticas y
Sociología,
Universidad Complutense de Madrid
Madrid, Spain
mcorte04@ucm.es

Manuel Pedro
Rodríguez-Bolívar
manuelp@ugr.es
Facultad de Ciencias Económicas y
Empresariales,
Universidad de Granada
Granada, Spain

ABSTRACT

The majority of current e-participation tools are based on online web forums where citizens make proposals and provide comments and opinions, forming large conversation threads. Motivated by the huge popularity of instant messaging applications and the impressive, recent advances in natural language processing and artificial intelligence, in this paper we propose and investigate the use of conversational agents or chatbots as a new form of citizen-to-government communication. Specifically, we present and evaluate a novel chatbot that assists a user on the overwhelming task of exploring the citizen-generated content of Decide Madrid, a forum-based e-participatory budgeting platform. Among other things, the proposed chatbot is capable of automatically extracting, categorizing and summarizing the arguments underlying the citizen proposals and debates in the platform. Through a user study, we show promising results about the potential benefits of the chatbot in terms of several citizen participation, decision making and public value criteria.

CCS CONCEPTS

• **Applied computing** → **E-government**; • **Computing methodologies** → **Discourse, dialogue and pragmatics**; • **Human-centered computing** → **Natural language interfaces**; **User studies**.

KEYWORDS

e-government, participatory budgeting, chatbots, natural language processing, argument mining

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1 INTRODUCTION

Open Government represents a paradigm of public management that aims to facilitate the cooperation of citizens in the design and innovation of public services, and to strengthen the transparency and accountability of the public administration [19]. It has been proposed as a tool for collaborative governance that, from a perspective that empowers the citizens, has progressively promoted the use of technology as a means of interaction [16]. In fact, in recent years, the expansion of social media, the appearance of disruptive technologies –e.g., augmented and virtual reality, blockchain, and conversational agents–, and the consolidation of significant advances in the massive use of (open) data and artificial intelligence are supporting even more this type of governance [10].

Particularly, citizen participation has been strongly influenced by new information and communication technologies, transforming the online participation and the democratization of the internet into major pillars of Open Government initiatives [23]. In this context, e-participation –understood as the computer-assisted support to citizen collaboration– has originated novel consultation and deliberation processes conducted through modern technologies, particularly web technologies.

The research literature on e-participation has mainly focused on the social consequences of using online platforms, rather than on the impact the platforms features have on the participation mechanisms and outcomes [17]. Hence, most research has been conducted with platforms based on traditional web forums, which have been the dominant type of tool used in e-participation. In the last years, nonetheless, attention has shifted to social media, especially social networks –e.g., Facebook and Twitter– [9, 30], and recently to instant messaging tools, such as Telegram and WhatsApp [4, 13].

Conventional web forums promote interaction over the production and reuse of collective knowledge. They offer smooth, large-scale interaction, but in general provide very limited or no functionalities for content organization, filtering and analysis [17]. This makes the moderation and processing of debate results (e.g., to create opinion summary reports) challenging and sometimes overwhelming. Furthermore, the forum content is structured by *time*, so it may be dispersed and redundant. Without additional mechanisms, such as reputation (rating) functionalities, it might be very difficult and time-consuming for users to find high quality contributions. Citizens would like to be able to process and understand the debates on certain topics in order to have global views of existing problems and proposed solutions, but forums do not usually have functionalities to support critical thinking and argumentation. As a consequence, contributions are often not guided by evidences, and thus limit the creation of informed and constructive debates [24].

Computer-supported argumentation visualization (CSAV) tools have been proposed to overcome the above shortcomings by providing structured deliberation support for e-participation [6, 7, 12, 17, 22, 25]. Specifically, these tools guide the deliberation around underlying arguments. They organize citizen-generated content by *topic* rather than by *time*, and represent a debate as a graph or network consisting of alternative positions on issues, as well as arguments in favor and against discussed ideas. Debates are then summarized as interactive maps displaying positions, arguments and links connecting them.

CSAV [18] thus favors knowledge representation over conversational interaction. It enables critical thinking and evidence-based reasoning, since it forces users to make explicit the rationale behind their claims. Besides, it fosters the deliberation on controversial issues as users can represent their points of view in coherent structures. However, CSAV also entails some disadvantages [17]. First, it may require users to undergo an intensive training to become proficient with the considered argument and debate models, and may involve higher coordination in terms of moderation and supervision of the argumentative maps. Second, it limits the social interaction and consequently may decrease the users' engagement. Third, large argumentation maps may hinder the exploration and understanding of the debates, especially in small electronic devices, such as mobile phones.

Aiming to exploit the benefits and mitigate the drawbacks of both forums and argumentation tools, in this paper we seek to develop a hybrid approach in which forum-based debates are enriched with argumentative information. In particular, we make use of natural language processing (NLP) and argument mining methods to automatically extract the arguments –together with their constituents and relationships– provided in the citizens' proposals and comments. Hence, instead of requiring users to explicitly express their ideas and opinions as formal argument maps, they freely manifest them as natural language texts.

The proposed approach could have the potential of promoting a higher citizen involvement in public decisions because no technical language and knowledge are necessary to be used in their comments, providing easily understandable arguments in favor and/or against some proposals for public policies. This way, some debates on generally well-known topics could be opened to the opinions of a higher number of citizens, enriching the debate and analysis of the issues they deal with.

Moreover, motivated by the huge use of instant messaging applications, and the little existing research on the potential of such applications for e-participation, the approach proposed in this research is evaluated through a conversational agent or chatbot integrated in the Telegram system[1]. In recent years, this type of artificial intelligence agents has been considered for a variety of government-to-citizen scenarios, such as providing automatic attendance on public services [1, 2, 14, 21], easing the access to open government data [11, 27], and supporting citizen consultation [3]. Differently to previous work, this research is framed in a citizen-to-government scenario. We thus envision chatbots as future assistants and even moderators in e-participation processes conducted in online forums, web platforms, and instant messaging applications. In this sense, to the best of our knowledge, incorporating argumentative capabilities to chatbots for exploring user-generated content also represents a novel research contribution.

In brief, this paper presents first steps towards the full implementation of an e-participation chatbot. Leaving as future work the chatbot interaction to moderate participation, we focus on the chatbot capabilities for topic- and argument-driven exploration of citizen-generated content. Specifically, we report an implementation and evaluation of a prototype chatbot for Decide Madrid[2], the e-participatory budgeting platform of Madrid (Spain), in which residents post, comment and vote ideas and initiatives to improve public services and address existing problems in the city. As an additional differential aspect of our work, the conducted evaluation consists of a user study where both objective and subjective metrics were measured, going beyond the traditional usability and usefulness criteria considered in the literature [11] by assessing the benefits of the proposed argument-driven approach in terms of engagement, persuasiveness, and public values such as transparency and fairness.

The remainder of the paper is organized as follows. Section 2 surveys existing research work on computational argumentation and conversational agents for e-participation. Section 3 presents the proposed argument mining framework, which is composed of an argumentation model and an argument extraction method. Section 4 introduces the developed conversational agent that allows users to access citizen proposals and debates through both topic- and argument-based information exploration mechanisms. Next, Sections 5 and 6 describe the conducted evaluation and discuss the achieved results, respectively. Lastly, Section 7 ends with some conclusions and future research lines.

2 RELATED WORK

We performed a systematic review of the literature on e-participation focused on the use of computational argumentation and conversational agents, since they represent the main topics of interest in our work. For such purpose, we launched formal search queries on the Web of Science[3] and Scopus[4] digital libraries, which index the major journals and conferences in all

[1] Telegram instant messaging, https://telegram.org
[2] Decide Madrid e-participatory budgeting platform, https://decide.madrid.es
[3] Web of Science digital library, https://www.webofscience.com
[4] Scopus digital library, https://www.scopus.com

research fields. Specifically, for computational argumentation in e-participation, we considered a query that retrieves those papers whose title, keywords or abstract contain the regular expression[5] (‘‘e-part*’’ OR ‘‘*participat*’’) AND (‘‘argument*’’). For conversational agents in e-participation, we considered an analogous query, but using the regular expression (‘‘e-part*’’ OR ‘‘*participat*’’) AND (‘‘conversational’’ OR ‘‘dialog*’’ OR ‘‘chatbot*’’ OR ‘‘chatterbot*’’ OR ‘‘*assistan*’’). In the next subsections, we describe the relevant papers obtained from the queries.

2.1 Computational Argumentation in E-participation

With respect to the use of argumentation theories and models in e-participation, the majority of the surveyed work is focused on the development of **computer-supported argumentation visualization** (CSAV) approaches[6]. Instead of unstructured debating, by adding posts of plain text to form conversation threads as done in online forums, collaborative CSAV tools only allow contributions as structured, well-defined elements, such as *issues*, *positions* and *arguments* [25]. Debates are then represented as argument maps, which are visualizations of networks or graphs (generally trees) relating the above elements around a given topic or document. The nodes of a map represent argument constituents (e.g., *claims*, *premises* and *evidences*) and its edges express argumentative relationships (e.g., *support* and *attack*) [7]. A map supports the work of stakeholders by enabling them to manage and navigate through arguments. In this sense, collaborative CSAV tools are aimed to foster a participative process in which the collective effort is put forward in the creation of shared argument maps [17].

Motivated by the information overload problem, in 2009 Loukis et al. [22] proposed the use of CSAV to enhance e-participation. Using the Compendium[7] tool, they conducted a pilot user survey where 27 people showed moderately positive opinions about the ease of use and usefulness of the proposed argument chart-based visualization, in the context of a debate surrounding a cohabitation law. Contemporaneously with that study, Cartwright and Atkinson [12] investigated the above idea, presenting Parmenides, an e-participation prototype system that uses argument schemes to structure and analyze proposals for political action. The authors stated that the system was evaluated positively by students in a user study. However, they did not report details about the conducted experiment.

It is in 2012 when Benn and Macintosh [6, 7] presented PolicyCommons, a fully operational platform to facilitate online deliberation of public policies. In addition to issue-centered argument maps, common in CSAV tools, PolicyCommons provides a diagram that uses color-coded rectangular blocks to depict the issues within a debate. The size and color of each block reflects the discussion level and topic of the corresponding issue. The authors claimed that the issue map allows addressing the readability and scalability problems. However, they did not report an evaluation of these aspects.

Also in 2012, Panopoulou et al. [25] presented WAVE, a web-based CSAV platform developed to facilitate the understanding and debating of the European legislation. Integrated with the DebateGraph[8] tool, WAVE allows creating and exploring argument maps, as well as sharing and rating ideas. The authors reported a user study where 319 participants used the platform for discussing about the environment and climate change. Through a questionnaire aimed to evaluate the platform's ease of use, its facilities to make the discussed topic and underlying debates understandable, and its impact on user participation and engagement, the authors concluded that the platform was in general perceived as valuable and engaging, but generated frustration to some users due to the argument map visualization logic. About 33% of the participants –who mostly were young, educated and computer-literate people– had difficulties to read ideas and navigate through them, especially when the map was too crowded. Also, participants were confused by the lack of a forum-like participation structure.

More recently, in 2018, aimed to empirically measure the impact of the adoption of a collaborative CSAV tool in online political debate with real users, Iandoli et al. [17] reported a user study where a traditional online forum and a collaborative argumentation e-platform were compared. In the study, 95 participants were split into deliberation groups to discuss online reforms of an existing electoral law, using either a conventional forum or a CSAV tool. By analyzing several objective metrics and subjective questionnaire responses related to activity levels, system usability, and quality of collaboration, the authors showed that in the forum, users produced more ideas and activity, and perceived a better quality of the collaboration process, whereas in the CSAV tool, users exchanged more arguments and viewed and rated more posts from others.

Differently to the previous surveyed researches on CSAV, in 2015 Bench-Capon et al. [5] proposed to use computational argumentation –and more specifically, **argument mining**– to elicit justifications of a public policy, and supply critiques for a given proposal and justification. Specifically, they presented an argumentation scheme and a semantic structure for practical reasoning. The scheme considers several policy elements, such as *circumstances*, *goals*, *actions*, *consequences* and *promoted values*. The semantic model is composed of encoded rules that instantiate the scheme on a given domain, and can be interpreted for reasoning arguments, e.g., by logic programming engines. The approach received initial positive user feedback about its capability to support participatory democracy, but requiring a considerable investment of time and expertise for encoding the domain model.

Analyzing the state of the art, we can observe that providing argumentation-supported functionalities in e-participation platforms is generally perceived as valuable by users since they achieve a better understanding of existing proposals and debates, and are capable of getting a better formed opinion and consequently making better decisions. By contrast, as concluded in some of the reported

[5]The asterisk * in the regular expressions means zero or more characters. Hence, for instance, the expression ‘‘argument*’’ is satisfied by the terms *argument*, *arguments*, *argumentation* and *argumentative*, among others.

[6]See [6] for a survey of general-purpose CSAV frameworks.

[7]Compendium - mapping and management of ideas and arguments, http://compendium.open.ac.uk

[8]DebateGraph network of thought visualization and sharing tool, https://debategraph.org

studies, although relevant, the dominant argument map-based visualization makes it difficult to manage and explore the argumentation information.

We thus advocate for maintaining a forum content structure, but enriching it with argument-based information. Attempting to exploit the benefits and mitigate the drawbacks of both forums and CSAV tools, we propose a hybrid approach where users post ideas and comments in free text, and the system automatically extracts and relates the underlying structured arguments. The system then makes use of generated argumentative structures to organize and present the textual content, and allows users to perform an argument-driven information exploration. In this context, as we shall present in subsequent sections, our system manages both topic-centered [6, 7] and issue-centered [17, 25] argument browsing. The system, on the other hand, is built upon a novel, rich argument model with fine-grained argument relationships (e.g., *cause*, *consequence*, *comparison*, *exemplification*) that go beyond the traditional *support-attack* argumentative schema considered in the literature on CSAV for e-participation [17, 25].

2.2 Conversational Agents in E-participation

In the last few years, conversational agents –and more specifically chatbots– are increasingly being considered for a variety of **government-to-citizen (G2C)** applications, such as providing automatic attendance on public services [1, 2, 14, 21], easing the access to open government data [11, 27], and supporting citizen consultation [3].

E-participation –focused on the computer-assisted support to collaborative citizen initiatives– entails other applications for chatbots. Although the idea of incorporating a conversational agent into an e-participation tool was proposed in 2006 by Boden et al. [8], it is in 2019 when the research literature begins to report on the potential of chatbots as facilitators of citizen participation [26, 29], i.e., as **citizen-to-government (C2G)** communication channels.

From a number of interviews with experts, Tavanapour et al. [29] created a list of meta-requirements (e.g., providing answers to topic-related questions, explaining conditions for idea submission) and consequent design principles (e.g., providing the capacity to summarize project-related information, handling the phases of the idea generation process) that an e-participation chatbot should have. Taking these requirements and principles into account, they developed a chatbot aimed to assist users with the idea generation task. Among other aspects, the authors highlighted the benefit of using the chatbot to create citizen proposals in a structured and consistent form, an issue that was positively appreciated in a user study (N=32) and may serve as a good starting point for public decision makers to evaluate elaborated proposals. In a related work, Petriv et al. [26] also conducted expert interviews (N=12) with the goal of identifying concerns, limitations and enablers that may affect on the design of chatbots for the public sector. Among others, limited accessibility and lack of technical user skills were stated as major limitations, and positive perception of innovation and provision of public values were considered as principal enablers.

More recently, research work has been published that reports implementations and evaluations of chatbots in e-participation scenarios. Chohan et al. [28] investigated the use of chatbots as a communication interface in citizen science projects that involve citizens and experts in the development of scientific projects and in the use of scientific knowledge to address societal problems. Analyzing the questions given in a user survey (N=13), the authors confirmed that a chatbot can promote participants' motivation, cooperation and engagement within a project. Assuming the need for higher usability and knowledge integration, the authors claimed that chatbots are also beneficial for continuous development, testing and deployment, since they do not rely on complex visual interfaces which may delay research projects and require particular maintenance.

Finally, Haqbeen et al. [15] presented D-Agree, a text-only discussion-processing and decision support platform that aims to harness the wisdom of the crowd for obtaining innovative suggestions that may help policymakers in the development of strategic city plans. The platform is centered around a chatbot that facilitates people to reach agreements during the urban planning processes. More specifically, the chatbot is introduced into online conversations to interact with citizens, moderating discussions by posting facilitated messages and replying to user posts, and encouraging reaching a consensus by mediating and providing arguments given in the posts. In this context, the chatbot asks participants to provide supporting or attacking arguments for posted opinions. An NLP (argument mining) engine is used to automatically classify sentences of a discussion as *issues*, *ideas*, *pros* and *cons*, as well as to extract relationships between sentences. The authors reported a large user study (N=733) analyzing objective activity metrics which evidence the benefits of using the chatbot facilitator to increase participation, promote argued discussion, and achieve higher consensus, allowing the collection of more reliable opinions and the increase of transparency and legitimacy of decision and policy making processes.

As it can be observed in the surveyed literature, conversational agents have been recognized as powerful tools for C2G e-participation applications, but their research is in its infancy. They have been only proposed as discussion facilitators, and have been mainly evaluated in terms of user participation and engagement levels. Based on these pillars, our research proposes a chatbot that aims to support the exploration of citizen-generated content in e-participation platforms, and is evaluated through various metrics, including measures of public value creation. Moreover, similarly to the D-Agree system [15], our chatbot makes use of argument mining methods to extract and visualize argumentative information underlying the citizens' proposals and debates. This information is used to guide the users' navigation, and could be exploited in the discussion process as well. The argument mining framework of the chatbot is presented next.

3 ARGUMENT MINING FRAMEWORK

In this section, we present our framework to automatically identify arguments in textual content, together with their constituents and relationships. The framework is built upon a generic argumentation model that is based on a rich taxonomy of argument types (Subsection 3.1), and consists of an argument extraction method that makes use of natural language processing techniques (Subsection 3.2). For a given text, the framework generates structured information about the extracted arguments (Subsection 3.3).

Table 1: Types and subtypes of argument relations, with examples of argument linkers for English and Spanish.

Type	Subtype	Intent	English linkers		Spanish linkers	
			no.	*examples*	*no.*	*examples*
Cause	*Condition*	qualifier	30	if [ever/so], in case of/that	33	si [alguna vez/es asÃ], en caso de/que
	Reason	support	16	because [of], due to, since	16	porque, ya que, debido a [que], pues
			46		**49**	
Clarification	*Conclusion*	support	18	to conclude, in/as conclusion	21	para concluir, en/como conclusiÃ³n
	Exemplification	support	8	for [example/instance], as an example [of]	12	por ejemplo, como ejemplo [de]
	Restatement	support	6	in other words, that is [to say]	26	en otras palabras, es decir, esto es
	Summary	support	12	summarizing, summing up, to sum up	7	resumiendo, concluyendo, para acabar
			44		**66**	
Consequence	*Explanation*	support	6	actually, in [actual] fact, indeed	6	realmente, de hecho, en realidad
	Goal	support	19	for, to, in order to, aimed/aiming to	15	para, por, con el fin de
	Result	support	21	therefore, thus, hence, then, so [that]	40	por [lo] tanto, por consiguiente/ende
			46		**61**	
Contrast	*Alternative*	support/attack	21	on the other hand, in another case	26	por otra parte, por otro lado, en otro caso
	Comparison	support/attack	7	while, whereas, compared [to/with]	17	mientras [que], comparado con
	Concession	attack	16	although, [even] though, despite [that]	28	aunque, aÃºn/incluso [si/asÃ], a pesar de
	Opposition	attack	22	but, however, nonetheless, albeit	31	pero, sin embargo, no obstante
			66		**102**	
Elaboration	*Addition*	support	15	also, besides, as well, too, moreover	17	tambiÃ©n, ademÃ¡s/aparte [de], [lo que] es mÃ¡s
	Precision	support	11	in particular, particularly, especially	13	en particular, particularmente, especialmente
	Similarity	support	8	similarly/analogously [to], like, likewise	10	similarmente/anÃ¡logamente [a], como, al igual que
			34		**40**	
		Total	**236**		**318**	

3.1 Argumentation Model

In the Argument Mining research field [20], most of the existing computational methods and tools to design, extract and share arguments consider *premises* and *claims* as the principal **argumentative units**, and *support* and *attack* (rebuttal) as the possible **argument relations**. Our argument mining framework is built upon this argumentation model, but extends it by including purpose-based types of the above relations. More specifically, we propose a taxonomy with the following argument relation types:

- *Cause*: linking an argument that reflects the *reason* or *condition* for another argument.
- *Clarification*: introducing a *conclusion*, *exemplification*, *restatement* or *summary* of an argument.
- *Consequence*: evidencing an *explanation*, *goal* or *result* of a previous argument.
- *Contrast*: attacking arguments, distinguishing between giving *alternatives*, doing *comparisons*, making *concessions*, and providing *oppositions*.
- *Elaboration*: introducing an argument that provides details about another one, entailing *addition*, *precision* or *similarity* issues about the target argument.

These types of argument relations are automatically identified by an extraction method that makes use of natural language processing techniques. As it will be explained in the next section, the method consists of finding certain *argumentative patterns* within the syntactic trees of sentences, and the patters are defined around argument *linkers* or connectors, i.e., set of words that link premises and claims of arguments. Table 1 shows examples of English and Spanish linkers for each type and subtype of our argument relation taxonomy. The taxonomy and full lists of linkers are publicly available online[9] .

3.2 Argument Extraction Method

We propose a heuristic method aimed to automatically identify and extract arguments from textual content, which is evaluated on citizen proposals and comments from the Decide Madrid e-participatory platform. The method searches for certain argumentative patterns in the syntactic trees of input sentences. Such patterns are defined by manual inspection of syntactic phrase structures that have one of the considered linkers (Subsection 3.1) and more frequently appear in a large corpus (from Decide Madrid).

The method follows a simple but effective **algorithm** to address the three basic tasks of argument mining [20], namely *argument detection*, *argument constituent identification* (i.e., *claims* and *premises* related through an argument *linker*), and *argument relation recognition* using the proposed taxonomy (Subsection 3.1). The algorithm is shown in Algorithm 1. It consists of two consecutive phases, where the outputs of the first phase serve as inputs for the second phase. These phases are *identifying arguments* and *extracting argument constituents and relations*.

3.2.1 Identifying arguments. In this phase, the source text –i.e., a citizen's proposal or comment– is first split into sentences, where arguments are searched (isolatedly in this stage of our research). Next, the syntactic tree of each sentence is obtained by using the Stanford CoreNLP library[10]. Through a breadth first search (BFS), each node of the tree is visited checking the presence or absence of a linker. If the text of a node starts with one of the considered argument linkers, a syntactic structure is constructed by concatenating the phrasal categories of the neighbor nodes of the linker node (including it) according to the language reading order, which is from left to right (in English and Spanish). Once the syntactic structure is constructed, it is compared with each of the valid, manually defined argumentative patterns (Table 2). In case of matching, the argument of the corresponding phrase is extracted –in the next phase– and stored in a temporary structure along with the tree

[9] Argument taxonomy and linkers, https://github.com/argrecsys

[10] Stanford CoreNLP library, https://stanfordnlp.github.io/CoreNLP

Algorithm 1 Argument extraction method

```
Require: text, linkerList and syntacticPatternList
  argumentList ← createList()
  sentences ← splitSentences(text)                    ▷ NLP task
  for each sentence s ∈ sentences do
    tree ← obtainSyntacticTree(s)                     ▷ NLP task
    r ← getRoot(tree)
    Q ← createQueue()
    enqueue(Q, r)
    while Q is not empty do                           ▷ Breadth first search
      u ← dequeue(Q)
      uText ← getNodeText(tree, u)
      if uText ∈ linkerList then
        pattern ← null
        nodes ← getNodesAtLevel(tree, u)
        for each node v ∈ nodes do
          phrasalCategory ← getPhrasalCategory(v)
          pattern ← concat(pattern, phrasalCategory)
        end for
        if pattern ∈ syntacticPatternList then
          claim ← getTextFromNodesOnLeft(tree, u)
          premise ← getTextFromNodesOnRight(tree, u)
          linker ← getLinker(linkerList, uText)
          level ← getNodeDepthLevel(u)
          argument ← createArgument(premise, linker,
claim, level, pattern)
          argumentList ←
addArgument(argumentList, argument)
        end if
      end if
      children ← getChildren(tree, u)
      for each node v ∈ children do
        enqueue(Q, v)
      end for
    end while
  end for
  return argumentList
```

level (depth) where the argument is found. In general, the closer to the tree root an argument is found, the more relevant it is within the sentence.

3.2.2 Extracting argument constituents and relations. Once one of the aforementioned syntactic patterns is matched, the phrase is split into a claim and a premise according to and connected through the linker. The extraction of the claim is performed by concatenating (from left to right) the text of all the sibling nodes before the linker node. The extraction of the premise is performed in the same way, but with the sibling nodes after the linker node. The created argument structure is finally stored into a JSON[11] data object whose format is explained next.

[11] JavaScript Object Notation (JSON), https://www.json.org

3.3 Argumentative Structures

As just mentioned, the extracted arguments are stored in **JSON data objects** for their later use and exploitation. Hence, for the citizen proposal "Allowing pets in public transport"[12], our method automatically identifies and extracts an argument composed of the claim "We are almost forced to use public transport in the city" and the premise "but pets are not allowed in EMT", which attacks the claim of the argument that supports the proposal (major claim). Figure 1 shows in JSON format a complete argument structure extracted from the above citizen proposal. It contains i) the identifier of the proposal, ii) the sentence where the argument was found, iii) the argument constituents, connector and relation type, subtype and intent, iv) the sentence nouns, verbs, named entities and main verb, and v) its syntactic tree.

The extraction of arguments from textual content enables the possibility of finding **argumentative threads** associated to the proposal and its comments. These structures can be interpreted as summaries of conversations aimed at debating certain ideas in favor or against the proposal or some of its aspects. To this end, the proposal description along with the comments –having extracted arguments– can be represented and analyzed as a directed graph where argumentative threads can be found using the longest path algorithm. As an illustrative example, Figure 2 shows an argumentative thread (4 levels deep) extracted from the description and comments of a Decide Madrid proposal[13] related to the need of a massive tree planting in Madrid.

4 CONVERSATIONAL AGENT

In this section, we present the developed chatbot, which is shown in Figure 3 by means of three screenshots with examples of real user interactions. Next, we describe the chatbot supported conversation intents (Subsection 4.1) and its high-level architecture (Subsection 4.2).

4.1 Conversation Intents

In modern conversational agents and chatbots, such as those developed through technologies like Google Dialogflow[14], IBM Watson[15], and Microsoft LUIS[16], a conversation is usually composed of **intents** that represent different user information needs (purposes or goals). An intent can be independent of the rest of intents, or should only be considered after addressing another particular intent.

During a conversation, an intent is triggered when the user produces an utterance that satisfies a particular sentence pattern, which has been defined in advance in the chatbot NLP modeling process. Appropriate responses (i.e., natural language messages and menus for interaction) are generated for each utterance and intent.

A possible feature of a chatbot is the storing of log records with the user's actions, queries and feedback, along with associated timestamps and annotations. This functionality was included in

[12] Proposal 5717 in Decide Madrid, https://decide.madrid.es/proposals/5717-permitir-mascotas-en-transporte-publico
[13] Proposal 20389 in Decide Madrid, https://decide.madrid.es/proposals/20389-arborizacion-masiva-en-madrid
[14] Google Dialogflow, https://cloud.google.com/dialogflow
[15] IBM Watson, https://www.ibm.com/watson
[16] Microsoft LUIS, https://www.luis.ai

Table 2: List of the syntactic patterns associated to valid argumentative structures. The patterns are composed of logical combinations of phrasal categories. The phrasal categories are: [conj] = Conjunction, [conj_LNK] = Conjunction that continues with a linker, [grup.verb] = Verb group, [neg] = Negation, [PUNCT] = Punctuation mark, [S] = Clause, [S_LNK] = Clause starting with a linker, [sn] = Noun phrase, [sp] = Prepositional phrase, and [sp_LNK] = Prepositional phrase starting with a linker.

[grup.verb]-[sn]-[S_LNK]*	[sn]-[neg]-[grup.verb]-[S_LNK]*	[sn]-[neg]-[grup.verb]-[sn]-[sp_LNK]*
[neg]-[grup.verb]-[sn]-[S_LNK]*	[sn]-[grup.verb]-[sp_LNK]*	[sp]-[grup.verb]-[sn]-[S_LNK]*
[grup.verb]-[sn]-[sp_LNK]*	[sn]-[neg]-[grup.verb]-[sp_LNK]*	[sp]-[neg]-[grup.verb]-[sn]-[S_LNK]*
[neg]-[grup.verb]-[sn]-[sp_LNK]*	[sn]-[grup.verb]-[sn]-[S_LNK]*	[sp]-[grup.verb]-[sn]-[sp_LNK]*
[S]-[conj_LNK]-[S]*	[sn]-[neg]-[grup.verb]-[sn]-[S_LNK]*	[sp]-[neg]-[grup.verb]-[sn]-[sp_LNK]*
[S]-[conj]-[S_LNK]-[S]*	[sn]-[grup.verb]-[sn]-[sp_LNK]*	[S]-[PUNCT]-[S_LNK]*
[sn]-[grup.verb]-[S_LNK]*		

Figure 1: Example in JSON format of an argument extracted from a citizen proposal about allowing pets in Madrid public transport. EMT stands for "Empresa Municipal de Transportes de Madrid" (i.e., Madrid Regional Transport Company).


```
{
   "5717-1-1": {
      "proposalID": 5717,
      "majorClaim": {
         "entities": "[]",
         "text": "Allowing pets in public transport",
         "nouns": "[pets, transport]"
      },
      "sentence": "We are almost forced to use public transport in the city but pets are not allowed in EMT",
      "claim": {
         "entities": "[]",
         "text": "We are almost forced to use public transport in the city",
         "nouns": "[use, transport, city]"
      },
      "linker": {
         "value": "but",
         "intent": "attack",
         "type": "CONTRAST",
         "subType": "OPPOSITION"
      },
      "premise": {
         "entities": "[EMT]",
         "text": "pets are not allowed in EMT",
         "nouns": "[pets]"
      },
      "mainVerb": "forced",
      "pattern": {
         "value": "[S]-[conj_LNK]-[S]-[PUNCT]",
         "level": 1
      },
      "syntacticTree": "(sentence
                           (S (sn (PRP We)) (group.verb (VBP are) ... ))
                           (conj but)
                           (S (sn (NNS pets)) (group.verb (VBP are) (RB not) ... ))
                           (PUNCT .))"
   }
}
```


our chatbot to measure various performance metrics during the experiments (Section 5).

Figure 4 shows a diagram with the conversation intents handled by our chatbot. In the following, we describe the most relevant ones, and provide some of their input (triggering) sentence patterns and output results and implications.

- *Welcome.* This intent is triggered automatically at the beginning of a conversation and also by greeting the chatbot. In it, the chatbot welcomes and offers its help to the user.

Figure 2: Argumentative thread extracted from a citizen proposal. C, L and P stand for claim, linker and premise, respectively.

```
> Root argument [depth level 0]:
  MC: Massive tree planting in Madrid.

  - Argument reply [depth level 1]:
    C: Planting trees native to the Madrid region.
    L: {linker: 'to', intent: 'support', type: 'CONSEQUENCE', subType: 'GOAL'}
    P: Improve air quality, maintain a natural lifestyle and improve urban aesthetics with living beings.

    - Argument reply [depth level 2]:
      C: The first thing they should do is to stop cutting down healthy trees.
      L: {linker: 'as', intent: 'support', type: 'CAUSE', subType: 'REASON'}
      P: They are doing in Manzanares neighborhood.

    - Argument reply [depth level 2]:
      C: More than 230 trees in 3 weeks with the excuse that they are very dangerous and will fall on us.
      L: {linker: 'but', intent: 'attack', type: 'CONTRAST', subType: 'OPPOSITION'}
      P: When they started cutting down, only 4 of the 230 were hollow inside.

    - Argument reply [depth level 2]:
      C: Then they talk to us about contamination.
      L: {linker: 'but', intent: 'attack', type: 'CONTRAST', subType: 'OPPOSITION'}
      P: It is a lie, an incongruity and a nonsense.

      - Argument reply [depth level 3]:
        C: If only the trees they cut down were replaced by younger ones.
        L: {linker: 'but', intent: 'attack', type: 'CONTRAST', subType: 'OPPOSITION'}
        P: That is not the case.

        - Argument reply [depth level 4]:
          C: When an old tree falls on people it is a catastrophe.
          L: {linker: 'but', intent: 'attack', type: 'CONTRAST', subType: 'OPPOSITION'}
          P: We know that for years the care of the trees has not been controlled.
```

- *Help*. In this intent, the chatbot provides an exhaustive description of its functionalities. It is triggered when the user introduces sentences like "I need some advice," "Can you help me?" or simply "Help." The help documentation is distributed through several themes, accessible by buttons, and associated to the entities retrievable by the chatbot, namely proposals, comments and arguments.
- *Categories*. This intent is aimed to iteratively show the list of available proposal categories. It is triggered with sentences like "Categories" and "What categories are available?"
- *Topics*. This intent is aimed to iteratively show the list of available proposal topics, each of them belonging to certain category. It is triggered with sentences like "Topics" and "Topics of the category urbanism."
- *Proposals*. This intent allows the user to search for citizen proposals. It is triggered when the user writes sentences like "Proposals" or "Proposals of the category mobility", or even "Proposals of the category mobility, topic taxis in the district of Latina and neighborhood of Aluche." The latter utterance example contains all available options for filtering requested proposals: *by category*, *by topic*, *by district* and *by neighborhood*. These filters do not have to be specified all at once, as the chatbot will ask the user for them iteratively (see left screenshot in Figure 3). In any case, the retrieved proposals can be sorted in three different ways: *by date*, *by number of votes* and *by controversy* (as computed in [10]).
- *Details of a proposal*. Once a list of proposals is presented by the chatbot, a numerical identifier is shown for each proposal. With an identifier, the user can ask for the data associated to the corresponding proposal, which appeared shortened in proposal lists. Examples of sentences that trigger this intent are: "Proposal with id 7" and "Details of proposal 891." The data presented for a proposal include its title, summary (used as the *major claim* for possible arguments), and number of votes (see middle screenshot in Figure 3). The chatbot also provides some buttons that allow the user to access more comments and arguments of the proposal, and give several types of feedback: *vote the proposal*, *make a comment*, and *create a new proposal*.
- *Comments*. This intent can be triggered at any time when sentences like "Show comments of proposal with id 7234" are introduced. Also, if a proposal search was recently executed, utterances like "Comments from last proposals" are recognized. The intent allows exploring iteratively all the comments of a given proposal or list of proposals. Since comments are not only issued against proposals, but against

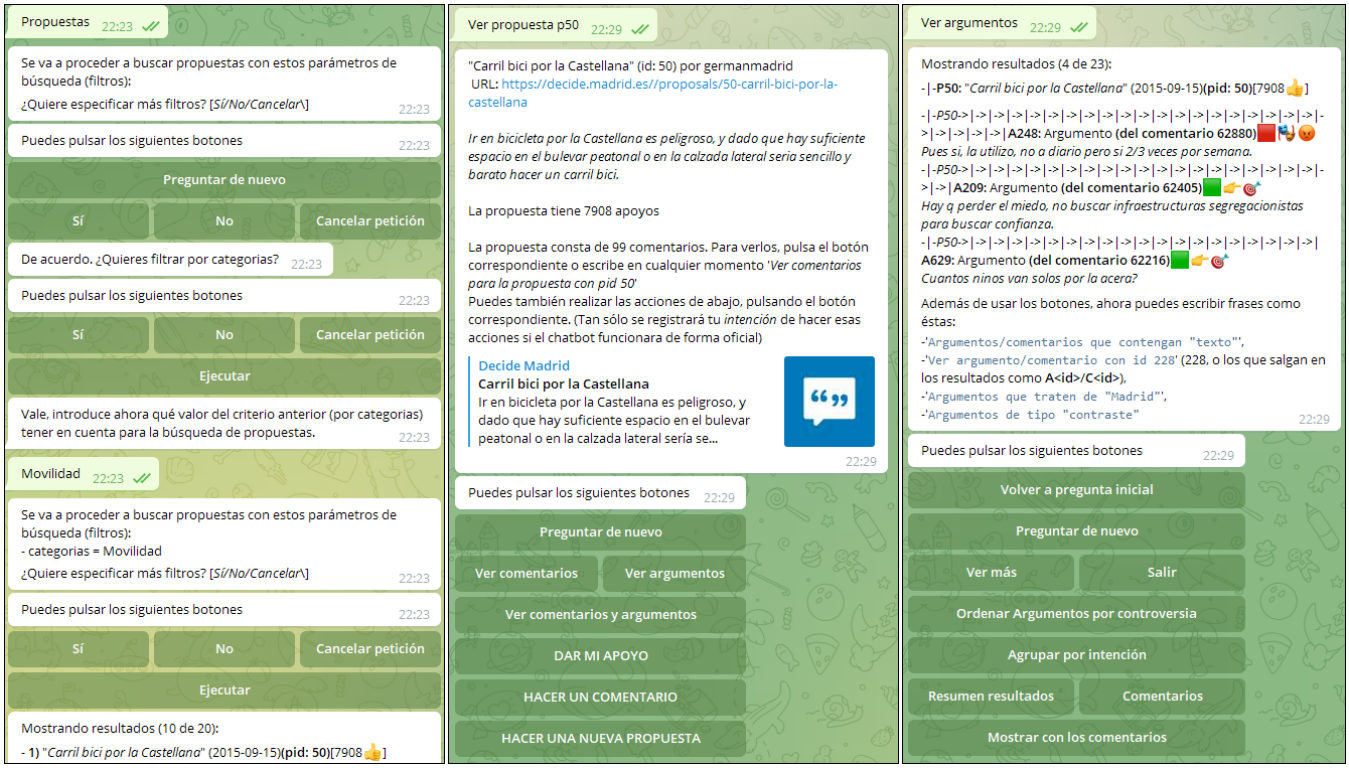


Figure 3: Three screenshots of human conversations with the chatbot. From left to right, they show a filtering process of proposals, details of a given proposal, and a set of categorized arguments existing in a proposal's comments. In the latter case, the intent, type and subtype of each argument are depicted through representative emojis.

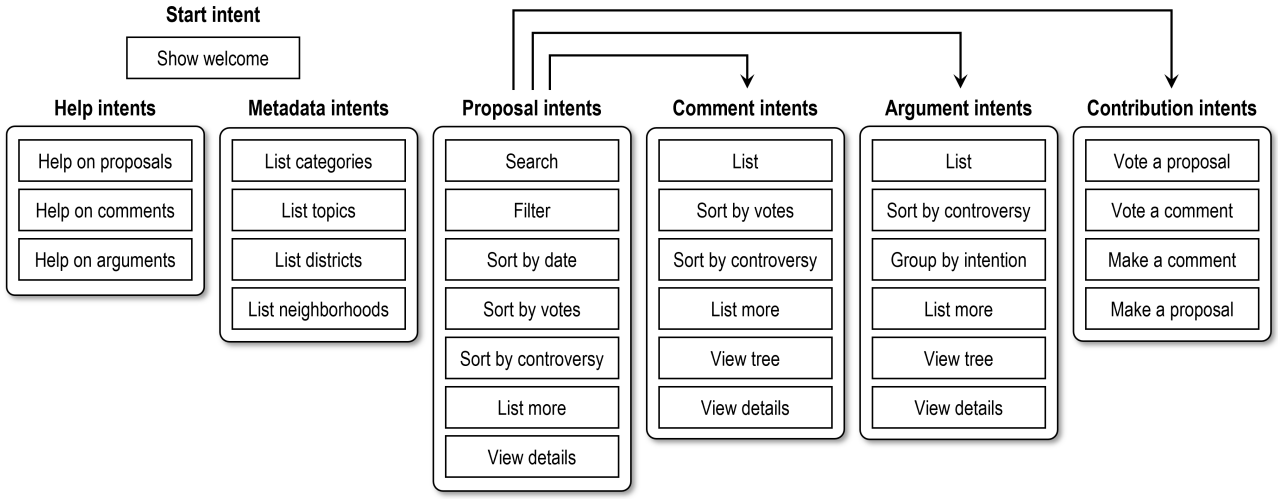


Figure 4: Conversation intents of the chatbot.

other comments, the chatbot also allows exploring the underlying *tree* of comments (debate). A simplification of this structure is provided to the user if she chooses to see summary of results, like "most commented proposal/comment" and "number of debate threads" in the tree. The intent can also be accessed through buttons in the *view details* response.

- *Arguments.* This intent offers analogous functionalities to the *Comments* intent, but applied to arguments extracted

from proposal comments (see right screenshot in Figure 3). In this case, an additional type of utterance is allowed, which is *group arguments by intent* (topic and subtopic). As for comments, either the tree or statistics of arguments of a proposal can be visualized, by pressing the corresponding buttons provided by the chatbot.

4.2 Architecture

Figure 5 shows the **high-level architecture** of the developed chatbot, which is built upon the Google Dialogflow framework. This framework enables relatively easy and fast implementations of conversational agents by processing user utterances in natural language, managing modeled human-machine conversations, handling the connection to external services and data sources, and integrating the communication with commercial instant messaging and social networking applications, such as Google Assistant, Facebook Messenger, WhatsApp, Telegram and Skype. Our chatbot was integrated with the Heroku cloud computing platform for accessing internal PostgreSQL databases, and with the Telegram application for communicating with the user.

The figure depicts the main modules of the chatbot and enumerates the steps of the data flows between the modules. As just mentioned, Telegram is used as the user interface to communicate with the chatbot (step 1 in the figure). However, thanks to the Dialogflow framework, the chatbot could be easily adapted to be used in other applications. In addition to manage the transmission of input and output messages with Telegram (step 2), a Dialogflow agent is capable of several natural language processing tasks, such as automatic recognition of entities (e.g., names of people and places, dates, numbers) in input sentences, matching user utterances with previously defined conversation intents, and managing the flow of conversations, i.e., triggering of events associated to intents and transitions between intents. The definition of intents is done through the online platform of Dialogflow and involves, among other things, the provision of examples of sentences and their corresponding entities. By means of deep learning methods, the agent is capable of recognizing patterns in (new) equivalent input sentences.

When a conversation intent is triggered during a conversation, the Dialogflow agent calls a remote web service which is in charge of executing certain logic of the system. This is done through the Heroku webhook fulfillment server (step 3). The services access the chatbot databases, which are in a remote server and gather the citizen proposals and comments from Decide Madrid, the automatically extracted arguments, and the logs recording the users' activity on the chatbot. The data access is controlled by an ad hoc manager (step 4). The databases are also accessed offline by the argument mining framework (step 5), which, as explained in Section 3, makes use of the CoreNLP library for detecting arguments in text, identifying argument constituents (i.e., claim, link, premise), and categorizing argument relations.

5 EXPERIMENTS

In this section, we present the empirical experiment performed to evaluate the developed chatbot. We briefly describe the case study considered for the experiment (Section 5.1), the addressed research goals and hypotheses (Section 5.2), the used evaluation methodology (Section 5.3) and metrics (Section 5.4), and the participants of the experiment (Section 5.5).

5.1 Case Study

We have implemented and evaluated our chatbot with publicly available citizen-generated content from the **Decide Madrid**[17] **e-platform**. This platform is an ad-hoc website used by the City Council of Madrid (Spain) as part of its participatory budgeting initiative since September 2015. Through the tool, residents of Madrid can post proposals to address issues and problems in the city, and comment and vote others' proposals. On a yearly basis, those citizen proposals that receive certain number of votes are technically and economically assessed, and eventually are funded and implemented by the city government. The budget allocated to these proposals was 50 million euro in 2021.

Similarly to [10], the selection of Decide Madrid as a representative e-participation tool was motivated by two reasons. First, participatory budgeting (PB) is among the most widely used citizen participation methods worldwide. From a total of over 1,900 citizen participation cases reported in Participedia.net, around 600 cases correspond to PB initiatives[18]. Also, according to the Participatory Budgeting Project[19], more than 7,000 cities around the world have implemented PB processes. Second, Decide Madrid follows a standard structure and architecture of electronic PB tools (e.g., Stanford Participatory Budgeting[20] and EU Open Budgets[21]), where web pages held proposals descriptions and metadata, as well as debates and supports on proposals. In fact, Decide Madrid is implemented upon the CONSUL[22] open-source framework, which as far of January 2022 has been utilized by 135 institutions of 35 countries supporting 90 million citizens.

More specifically, we instantiated our chatbot with the Decide Madrid open dataset previously used and publicly provided in [10]. The dataset contains information about 21,744 citizen proposals –automatically classified into 30 categories and 325 topics, geolocated in 21 city districts (and many of them in 129 city neighborhoods), and annotated with controversy scores–, and 62,838 comments –automatically processed with the argument mining framework presented in Section 3. To narrow the scope of the user study, we limited the use of the chatbot to a subset of 80 proposals and their associated 5,633 comments. We provide the dataset and the source code of the argument mining framework and chatbot in https://github.com/argrecsys.

5.2 Research Goal and Hypotheses

In addition to **evaluating to what extent a conversational agent or chatbot can be an appropriate tool in an e-participation context**, we also aimed to assess the **benefits of using argument-driven information exploration in e-participation** with respect to a traditional topic keyword-based

[17] Decide Madrid e-participatory budgeting platform, https://decide.madrid.es
[18] Participatory budgeting cases in Participedia.net, https://participedia.net/search?selectedCategory=case&query=%20budgeting
[19] Participatory Budgeting Project, https://www.participatorybudgeting.org
[20] Stanford Participatory Budgeting, https://pbstanford.org
[21] EU Open Budgets, https://openbudgets.eu
[22] CONSUL open-source citizen participation framework, https://consulproject.org

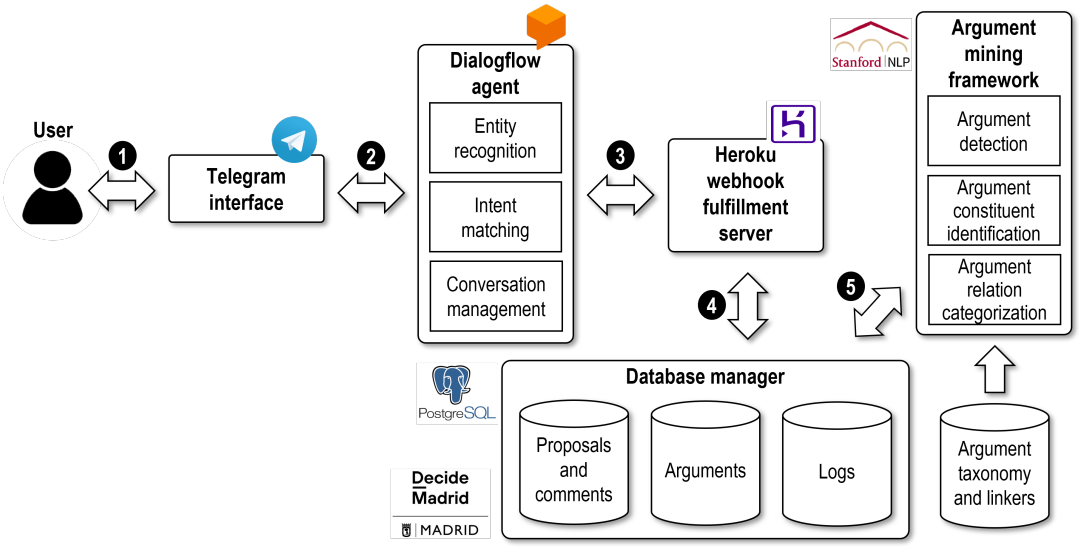


Figure 5: Architecture of the chatbot.

navigation. For such purpose, in the study, participants were randomly and uniformly split into two groups: a ***control group*** whose members only used the topic-driven (i.e., non argument-driven) browsing commands of our chatbot, and an ***experimental group*** whose members also used the chatbot argument-driven browsing commands.

More specifically, inspired by previous work (e.g., [11]), in our study we stated the following research hypotheses associated to potential citizen participation- and public value-related benefits:

- **H1 (usability)**: The users of the argument-driven chatbot achieve a better understanding of the citizen proposals and their pros and cons.
- **H2 (usefulness)**: The users of the argument-driven chatbot perceive the system as more valuable for getting well-formed opinions and making better decisions in the participatory process.
- **H3 (persuasiveness)**: The users of the argument-driven chatbot are more willing to rethink their initial points of view, or to make own proposals and comments.
- **H4 (transparency)**: The users of the argument-driven chatbot feel that using the system are more able to explore a representative sample of citizen proposals and debates.
- **H5 (fairness)**: The users of the argument-driven chatbot feel that the system is inclusive and provides access to heterogeneous ideas and comments, even those that are related to controversial issues, or affect to minority or discriminated groups.
- **H6 (satisfaction)**: The users of the argument-driven chatbot are more satisfied with the information search and exploration functionalities of the system.
- **H7 (engagement)**: The users of the argument-driven chatbot perform more activities, such as access and support to citizen ideas and comments.

To validate these hypotheses, we analyzed a number of objective and subjective metrics measured during the study, as explained in Sections 5.3 and 5.4. Similarly to past research on e-participation chatbots (Section 2.2), in addition to the above benefits and metrics, we also took several metrics into account for measuring the perceived **ease of use**, **effectiveness** and **efficiency** of the chatbot.

5.3 Evaluation Methodology

The design of our user study was done considering evaluations of chatbots for the public sector reported in the research literature [2, 11, 26]. In our case, to make the study as realistic as possible, it was conducted in an **uncontrolled setting** where, without external supervision, participants freely tested the chatbot via Telegram during a period of one week. They used their own Telegram accounts and mobile devices, having similar computing capabilities and internet connection conditions. All their interactions with the chatbot were monitored and recorded anonymized in a database.

Differently to previous empirical experiments where participants focused on a single law [17, 22] or political issue [25], in our study, the users were allowed to explore all the citizen proposals and comments of the chatbot database, with no particular task requested. The users in the *experimental group* also had access to the arguments automatically extracted from the proposals descriptions and debates.

Participants were recruited forming a heterogeneous set of people with different demographic attributes (i.e., age and gender), educational backgrounds, and knowledge levels about chatbots and citizen participation. Before using the chatbot, participants filled a consent form where they provided the above personal data. They also received a few instructions concerning the use of the chatbot and the help documentation available in the chatbot. Finally, after testing the chatbot, participants filled a questionnaire aimed to capture their opinions about the potential user participation- and public value-related benefits of the chatbot presented in Section 5.2.

Both objective interaction records and subjective opinions were considered as metrics to evaluate the chatbot, as explained in the next section.

5.4 Evaluation Metrics

Similarly to [11, 17], we conducted both offline and online experimentation. With respect to the **offline evaluation**, all user interactions with the chatbot were recorded as time stamped logs in a database. After the one-week testing phase, the logs were used to measure a variety of metrics related to the users' activity and engagement on the chatbot. Some of these metrics were *usage time*, *number of browsed (lists of) proposals/comments/arguments*, *number of provided votes/comments*, and *number of manifested intentions to create new proposals*.

Regarding the **online evaluation**, at the end of the testing phase, participants filled a questionnaire aimed to measure the system performance, citizen participation, and public value criteria presented in Section 5.2. The questionnaire was composed of thirty three items on a 5-point Likert scale –from strongly disagree (1) to strongly agree (5)–, which are shown in Table 3. In addition to items used in [17, 25], which were constructed on the basis of several theories and studies, as a novel contribution, some of our items attempted to capture the perceived understanding of the citizen proposals and underlying debates, and the perceived utility of the system to support personal decision making.

In addition to these items, the questionnaire also had three open questions where participants were asked to express benefits and/or best features of the chatbot, its drawbacks and/or worst features, and the pros and cons of the chatbot with respect to a traditional web forum.

5.5 Participants

A total of 32 people participated in our study. In particular, they were 22 male and 10 female of ages ranging 18-29 years old (12), 30-39 years old (9), 40-49 years old (5), 50-59 years old (4), and more than 59 years old (2), with different education levels: secondary education (3), vocational education (1), Bachelor's degree (20), Master's degree (6), and Doctoral degree (2). Those with Higher Education levels had studied Sciences (3), Social Sciences (10), Arts and Humanities (4), and Engineering (11) careers. Finally, participants had relatively low levels of knowledge/expertise on chatbots –null knowledge and expertise (5), null expertise (5), low expertise (20), and medium expertise (2)– and on citizen participation –null (7), low (16) and medium (9). Previously to the study, 21 participants did not know Decide Madrid, 6 participants were aware but had not used the platform, and only 5 had visited it.

6 RESULTS

In this section, we report and analyze the results of the offline and online evaluations introduced in Section 5. We remind that participants were randomly and uniformly split into two groups: a *control group* that utilized the chatbot without the argument-driven functionalities enabled, and an *experimental group* that utilized a full instantiation of the chatbot. In both groups, participants were allowed to freely utilize the chatbot within a period of one week. Broadly speaking, we hypothesized that users of the experimental group would use the chatbot to a greater extent, and would make more positive opinions about the chatbot.

Table 4 shows some statistics about the **activity on the chatbot** performed by participants from each group and recorded in the logs database. As it can be seen, our hypotheses were satisfied. Although there was no significant difference on the average number of sessions[23] per user between groups (2.8 in both cases), the sessions of the experimental group were longer than the sessions of the control group. Specifically, there was an increase of 45.6% on the average session duration (from 16.0 to 23.3 minutes).

This does not seem to be due to a higher difficulty of use of the full chatbot if we take the number of actions into account. As it can be seen in the table, there was an increase of 14.3% (from 56.8 to 64.9) on the average number of actions per user, and an increase of 23.5% (from 1.7 to 2.1) on the average number of feedback provision actions per user, i.e., expressing intention for creating a new vote, comment or proposal. This result also evidences **higher user persuasiveness and engagement** in the experimental group. Moreover, the average number of actions related to the exploration of arguments (7.4) is meaningful; people in that group preferred to inspect the argument trees rather than the comment threads. We thus claim first insights about the fact that checking the arguments given by citizens entails an increase of participation and involvement.

Figure 6 shows a summary of the 5-scale scores given by participants in the **opinion questionnaire** about the ten chatbot evaluation criteria presented in Section 5.2; specifically, it shows the averages of score medians in each evaluation criterion. Three of these criteria are related with the system performance in terms of ease of use, effectiveness and efficiency, whereas the remaining seven are related with citizen participation and public value benefits: usability, usefulness, persuasiveness, transparency, fairness, satisfaction and engagement. Each criterion was measured through a set of items in the questionnaire (see Table 3). Due to lack of space, the figure only shows the average values of the items' score medians in each set, rather than the median values of each item.

As it can be observed, there were not significant differences between the control and experimental groups with respect to the perception of ease of use and efficiency of the chatbot. Participants found the chatbot **moderately easy to use** (giving average median scores of 3.9 and 4.1 in control and experimental groups, respectively) and **highly efficient** (5.0 in both groups). Regarding effectiveness, the members of the experimental group found the responses given by the chatbot as more accurate (3.5 vs. 4.0). This may be due to a perceived value of the provided argumentative information.

More important differences were obtained in the three levels of potential utility of the chatbot: **usability** for exploring the citizen-generated content, **usefulness** for finding out and understanding existing citizens' opinions, and **persuasiveness** for promoting citizen participation. For the three evaluation criteria, the participants of the experimental group expressed higher scores: 4.3 vs. 4.8, 4.0 vs. 4.5, and 3.8 vs. 4.7, respectively.

[23]The sessions of a particular user were established by sorting and grouping her log records so that consecutive timestamps differ in at most 15 minutes. Thus, two consecutive logs with timestamps differing in more than 15 minutes were considered as belonging to two different sessions. Only a few cases close to 15 minutes occurred, and no significant result differences were shown by considering other time threshold.

Table 3: Items of the developed questionnaire to evaluate the proposed online metrics.

Criterion	Questionnaire item
Ease of use	I1: The chatbot is easy to use
	I2: The interaction with the chatbot does not require a lot of mental effort
	I3: The help documentation of the chatbot is easy to understand
	I4: The help documentation of the chatbot is complete
	I5: The help documentation of the chatbot is valuable
Effectiveness	I6: The chatbot understands the user's questions and commands
	I7: The chatbot gives correct responses to the user's requests
Efficiency	I8: The chatbot is ready to interact soon after invocation
	I9: The chatbot provides responses quickly
Usability	I10: The chatbot allows exploring the citizen proposals about certain topic
	I11: The chatbot allows exploring the content of a citizen proposal
	I12: The chatbot allows exploring the pros and cons of a citizen proposal
Usefulness	I13: The chatbot allows finding out the city problems and citizens' concerns
	I14: The chatbot allows understanding others' ideas and opinions about citizen proposals
	I15: The chatbot allows getting well-formed opinions and making better decisions in the participatory process
Persuasiveness	I16: The chatbot promotes rethinking initial opinions about citizen proposals
	I17: The chatbot promotes commenting on citizen proposals
	I18: The chatbot promotes making own proposals for the city
Transparency	I19: The chatbot allows exploring a representative sample of citizen proposals
	I20: The chatbot allows exploring a representative sample of citizen comments and opinions in the citizen debates
Fairness	I21: The chatbot allows exploring an unbiased sample of citizen proposals
	I22: The chatbot allows exploring an unbiased sample of citizen comments (opinions) in the debates
	I23: The chatbot allows getting informed about controversial issues in the city
	I24: The chatbot allows getting informed about city issues affecting to minority or discriminated groups
Satisfaction	I25: I am satisfied with the functionalities provided by the chatbot
	I26: I am satisfied with the interaction (communication) offered by the chatbot
	I27: I am satisfied with the current version of the chatbot
Engagement	I28: I liked using the chatbot as a citizen participation tool
	I29: I enjoyed using the chatbot
	I30: I would use the chatbot again
	I31: I would recommend the chatbot to other people
	I32: I am going to enter into the Decide Madrid platform
	I33: I am going to search for information about (electronic) citizen participation initiatives

Table 4: Statistics about participants' activity on the chatbot without and with arguments.

	control group	experimental group
avg. number of sessions per user	2.8	2.8
avg. duration of session (in minutes)	16.0	23.3
avg. number of actions per user	56.8	64.9
ask for help	13.5	10.8
list categories/topics/districts/neighborhoods	6.4	7.2
filter proposals	8.0	15.6
sort proposals	2.7	2.1
explore proposals	11.3	9.8
explore comments	7.6	6.7
explore arguments	-	7.4
provide feedback (new vote/comment/proposal)	1.7	2.1

A similar trend is observed on the perceived levels of **transparency** and **fairness**. In these cases, the argument-driven instantiation of the chatbot achieved the highest score differences with respect to the non-argumentative version: 4.0 vs. 4.8, and 3.9 vs. 4.8, respectively. According to these and the previous results, we can claim that having argument browsing functionalities plays a relevant role to promote citizen participation and public values.

Finally, **satisfaction** and **engagement** were equally and positively evaluated in the two versions of the chatbot. However, they obtained more moderate score values in comparison to other evaluation criteria. In the open responses to the questionnaire, participants expressed some limitations and weaknesses of the chatbot for which higher satisfaction scores would not be given. We next briefly present the most frequent positive and negative opinions reflected in the questionnaire.

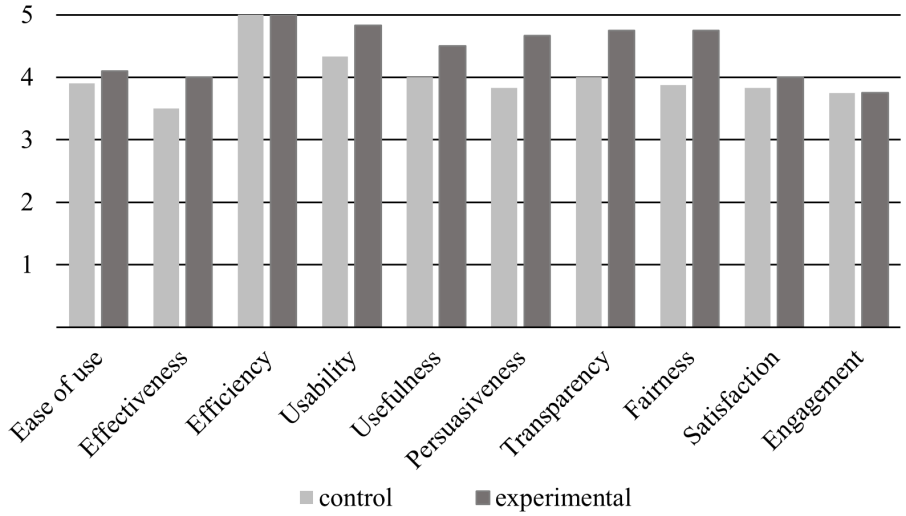


Figure 6: Average of score medians given by participants in the questionnaire items grouped by evaluation criterion, for the chatbot without/with argument-driven information exploration.

Among the chatbot features positively evaluated by participants, two stand out: its efficiency and its summarization capability. Users appreciated the fast way to ask for and obtain information through the chatbot, and the direct and compact presentation of such information. Participants also highlighted the transparency and lack of bias on the information presented by the chatbot, since they could check arguments in favor and against proposals in a structured way, and organize comments and arguments by controversy. In general, users stated that the chatbot was easy to use once its commands were learned. To achieve this, they appreciated the detailed and clear help documentation provided by the chatbot.

The errors and complications occurred when input user utterances were not understood by the chatbot represent the principal and more generalized complaint of participants, who expressed the need for more flexibility on the chatbot commands; in particular, they requested support for a less strict syntax. On the opposite communication direction, some participants also missed a more "natural" conversation, i.e., a more colloquial language by the chatbot. Finally, as more specific (technical) issues, there were suggestions to make a more fluent transition between browsed proposals and to facilitate the reading of proposals with large descriptions.

Comparing the chatbot with a traditional web forum, some participants found the chatbot as a better system to search for information, since it offers a direct and fast access to concise content. Two participants also found the chatbot as more accessible due to its adaptation to mobile devices. By contrast, some users stated that the chatbot entails more effort (actions) to navigate through the conversation threads and difficulties to contribute to existing debates.

7 CONCLUSIONS

In this paper, we have empirically investigated two promising research lines in e-participation: the use of conversational agents or chatbots as citizen-to-government communication channels, and the exploitation of argument mining techniques to automatically extract and present argumentative information from citizen-generated content.

Specifically, through a user study (N=32) we have evaluated a prototype chatbot that enables a rich, interactive exploration of citizen proposals and debates existing in a real e-participatory budgeting platform. Among other functionalities, the chatbot allows a user to access structured and linked arguments given in favor and against the platform proposals.

The results achieved in our experiments represent first insights about the benefits of the proposed solution in terms of various citizen participation and public value criteria. In addition to facilitating a better search and exploration of the content, pros and cons of proposals about certain topic, the chatbot also helps on finding out and understanding city problems and citizens' concerns, and consequently on getting well-formed opinions for making better decisions in participatory processes. In addition, the provision of argumentative information entails a greater user perception of transparency and fairness.

The results, on the other hand, have evidenced limitations and weaknesses of the chatbot that have to be addressed in the future. First, there is the need for providing more flexibility on the natural language formulation of user utterances, as well as more colloquial language in the conversation responses from the chatbot. Second, there are suggestions for improving the visualization of large texts and the navigation from one to another proposal.

Apart from these issues, we envision the opportunity of extending the chatbot in several directions. We could incorporate personalized recommendation mechanisms to proactively present relevant content to the user, thus mitigating the information overload problem. We could also develop richer data structures, analysis and visualizations for facilitating decision making. Moreover, we could implement functionalities oriented to citizen collaboration; to the best of our knowledge, the addition of comments into the

debates and the creation of new proposals are challenging tasks that have not been addressed by chatbots yet. Finally, we could investigate the integration of the chatbot with external data sources, such as open government data collections and news items, which may be used to complement citizen proposals and verify associated arguments.

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A Systems View of Enterprise Data Governance for Artificial Intelligence Applications in Government

Luis F. Luna-Reyes
lluna-reyes@albany.edu
University at Albany
Albany, NY, USA

Teresa M. Harrison
tharrison@albany.edu
University at Albany
Albany, NY, USA

ABSTRACT

The government "enterprise" involves a complex set of organizations with a multitude of goals and values, serving an equally diverse group of constituents. Because of this complexity, governing Artificial Intelligence (AI) applications as well as the necessary data infrastructure to support them has proven to be a difficult task that –according to experts– requires a systems perspective in its design and implementation. In this management paper, we take a conceptual approach to respond to this call from experts by providing working definitions of both enterprise data governance and a systems approach to management. Using these working definitions and the use case of AI-driven statistical profiling, we propose a pluralistic view of systems approaches for the design and governance of AI applications in government.

CCS CONCEPTS

• **Applied computing** → **Enterprise data management**; **IT governance**.

KEYWORDS

artificial intelligence, data governance, systems approaches to management, statistical profiling

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1 INTRODUCTION

Governments around the world have adopted Artificial Intelligence (AI) applications given their potential to improve government operations, policy and decision making, as well as citizen services [18, 52]. Examples of such applications can be seen in many domains of government activity, and range from the very visible smart chatbots that help citizens to navigate government portals and find relevant information and services to the much less visible applications of AI that help governments to make decisions on a variety of issues such as assessing eligibility for services (e.g. social security benefits, employment services, or parole), resource allocation (e.g. policing, inspections, auditing) or managing repetitive tasks (e.g. classifying email) [52].

Data has been identified as a fundamental asset to build AI applications in any domain [10, 26, 47]. Unfortunately, data is also one of the major sources of uncertainty for AI applications because of several technical, managerial and contextual issues [18], including problems related to data gathering, curation and distribution [35], issues associated with data fragmentation and storage [17], and policies and practices for data management [17, 18, 26]. As a result of these problems and issues, data governance constitutes a key success factor for AI applications and requires an enterprise view of data management and data architecture [26, 30].

However, national, state and local governments are complex organizations composed of multiple relatively independent agencies that typically have disparate missions, goals and values. In addition, government policies and management practices need to respond to a set of stakeholders that also represent a complex set of contextualized perspectives, values and interests that are frequently in conflict [48]. Historically, each agency has focused on the development of their own data management practices and information technology capabilities [35], creating an environment where promoting enterprise-wide data governance is a challenging task. Given these complexities, researchers have called for a systems view of data management and governance [18, 30].

In this management paper –conceptual in nature– we respond to this call and adopt a systems perspective to provide a set of principles, concepts and tools that have the potential to deal with the complexity of building an enterprise data architecture for AI in Government. We begin by considering what is meant by "enterprise data governance" and by acknowledging the characteristics of administrative organizations and the nature of AI that make it challenging to achieve. We then proceed by laying out systems views and concepts as they relate to the governance of complex systems [5, 7, 24, 33, 39]. The chapter continues with a closer look at the characteristics of and experiences with one AI use case, statistical profiling in public employment services. We then use this case to illustrate how a pluralistic systems approach may prove valuable to public administrators in dealing with the complexity proper of AI applications to government and data governance. Although there is potential value from all systems approaches, a pluralistic systems view that involves tools, methods and approaches to facilitate conversations and sensemaking are more suitable to address the

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problems of AI ethics and data governance. We conclude the chapter with a brief summary and next steps in our research.

2 WHAT IS ENTERPRISE DATA GOVERNANCE?

Corporations have long appreciated the benefits of an "enterprise" approach to data management, which is focused on creating unified views of data and data infrastructure across an organization [11]. But a focus on data, rather than technology, is a relatively new perspective within the broad scope of information technology management in government organizations. Such a perspective, upon which successful AI applications of any kind depend, foregrounds quantity and quality of data as well as all related operations including data stewardship, data governance, data standards, data quality management, data architecture, and security. Achieving the goals of an enterprise approach encompasses the possibility of substantial organizational change.

By "enterprise data governance" we refer to a model of information system management in organizations that seeks to "manage heterogeneous data sources, validate the quality of data, devise a common data model by integrating information, build analytical and presentation layers, and manage end-to-end metadata in the analytical and presentation layers" [46]. In such management systems, the objective is to create an "integrated enterprise-wide data environment" that "ensures consistency of information with a 'single version of truth'" [46]. In the corporation, the enterprise system has been viewed as a way of replacing previously disparate and often idiosyncratic information systems in an effort to share information across multitudes of business functions, such as sales, manufacturing, suppliers, and accounting and across hierarchical levels [42]. As Davenport [12] suggested, an enterprise system can be "viewed as an opportunity to take a fresh look at the company's strategy and organization." In making decisions about type, definition, form, structure, quantity, quality, and flow of information as well as where and how to standardize, changes inevitably need to be made in how organizational units conduct work, from job design, work sequencing, and training to the possibility of organizational restructuring [36].

2.1 Enterprise Data Governance Challenges for AI

Successful AI application development depends on characteristics of the data in several ways. First, AI depends upon the availability, usability, fitness for task, and integrity of the data itself. AI applications cannot proceed beyond pre-processing without datasets that exist in sufficient quantity and quality to enable developers to apply AI's computational strategies. Further, the greatest value obtained in using AI often comes from integrating volumes of data from multiple sources, a task that brings its own set of challenges. Government must marshal and deploy the required data in order to pursue AI benefits.

In one respect, government would seem to be up to the task since agencies create very large data resources while carrying out their missions. However, at the same time, critics have charged that government agencies do not typically possess data resources that are appropriately curated [38]. Government data is scattered in registers among agencies that are siloed, making it difficult to determine what registers exist and identify which data are contained in which register. "This means there is little transparency on whether a specific data point is available somewhere in the government, whether it is available in multiple registers, or where the most current data can be found" [17].

Further, there are few unified technical formats and shared semantic meanings for data registers so that similar data sets may be incapable of being used by other agencies, much less being shared [52], defying technical interoperability. Compounding these issues, lack of legal interoperability suggests that it is often unclear what data can be legally shared, accessed, exchanged or combined between agencies [17, 18]. Such conditions may be difficult to overcome due to insufficient expertise. Lane [35] observed that "The [US] federal government does not have the in-house expertise (gathering, prepared, cleaned, explored, cleaned, visualized, and protected against a range of new privacy challenges) to translate new data sources into information." Historically, agencies have tended to focus on data practices that support their own missions, which makes sharing data resources a challenging task. Lack of data sharing, collaboration among government agencies, interoperability, and shared data governance are familiar and recurrent problems in the literature of e-government (e.g., [43]).

Although recent trends show that governments are working on more centralized structures for managing their information resources (e.g., the US Department of State has just announced the creation of an enterprise system of data governance [41], integrating data management across boundaries is very much a challenge [52]. However, even assuming that technically adequate datasets can be obtained, successful government AI applications must conform to democratic values, and often legal requirements, for outcomes consistent with fairness, privacy, and transparency. Unfortunately, more serious and fundamental data issues arise as a function of interdependencies between datasets for training and learned models and AI's current computational strategies. The challenges of achieving outcomes consistent with democratic values have fueled substantial interest in ensuring that AI can be trustworthy and ethically sound.

The inherent cultural and politically situatedness of datasets, means that data and its attributes reflect the societies from which they are collected. Numerous scholars have noted that when data are taken from their original sites of production and used to enable AI products in other domains, the outcomes can distort, stigmatize, and discriminate (e.g., [9, 14, 20, 34]). This suggests that significant care must be taken in re-purposing data collected for government's mission-related purposes to achieve AI-fueled objectives.

However, this situatedness also means that bias is an inherent characteristic of datasets. Pointing to training datasets at the core of most machine learning systems, Crawford [10] argues that the "origins of the underlying data in a system can be incredibly significant and [..] there are no standardized practices to note where all this data came from or how it was acquired – let alone what biases or classificatory politics these datasets contain that will influence all the systems that come to rely on them" (p. 103). Even attempts to remove classificatory information of gender, race, or religion can fail since other characteristics co-varying with them can introduce

potential sources of bias. So far, efforts aimed at ensuring that algorithms produce legally equitable results, such as "fair machine learning," have not produced guarantees, although some strategies may be better than others under given circumstances [8]. Given this situation, algorithms used in government profiling and service targeting are susceptible to the possibility of reducing citizen equality in order to achieve efficiencies (e.g., [27]).

Safeguarding privacy poses another significant challenge. Beyond the dangers of data breaches and the sometimes faulty assurances of anonymization, another recurrent issue is the danger of inferred identity that can occur as a consequence of AI computational strategies. Identity inference can take place when learned models are reverse engineered, when models are over-fitted, and, as requirements for transparency increase, producing more publicly available models [32, 54].

The challenges above are now widely acknowledged and generate considerable discourse over technical solutions that might ameliorate their worst manifestations. But technical solutions may not be sufficient by themselves, and they will not by themselves address historically entrenched patterns of behavior and rigid bureaucratic structures that must change in ways commensurate for obtaining appropriate data for incorporation in AI and finding ways to work ethically with the difficulties presented by AI. As Crawford [10] has observed, decisions need to be made by individuals that can assess the impact of AI systems interacting with social processes: "Making these choices about which information feeds AI systems to produce new classifications is a powerful moment of decision making: but who gets to choose and on what basis? The problem for computer science is that justice in AI systems will never be something that can be coded or computed. It requires a shift from assessing systems beyond optimization metrics and statistical parity and an understanding of where the frameworks of mathematics and engineering are causing the problems. This also means understanding how AI systems interact with data, workers, the environment, and the individuals whose lives will be affected by its use and deciding where AI should not be used."

We argue that an enterprise data governance approach in organizing systems for AI development is required to enable public administrators to be sensitized to the interdependencies between the AI strategies contemplated, the nature of the data currently available or newly created, and policy implications of the use cases under consideration. Dawes [13] has argued that the future "infrastructure for digital government requires an extended view of enterprise that goes far beyond a single organization to encompass all the parts of a government as an interconnected whole operating in a complex social and economic environment" (p. 258). This vision of the future is one that includes the theme of public-private-civic sector relationships that are focused on "sharing responsibilities and exchanging information among networks of diverse organizations in ways that generate public value and satisfy public requirements for fairness, accountability, and competence" [13].

3 SYSTEMS APPROACHES TO MANAGEMENT

Current research calls for a systems approach to respond to the challenges described in the previous section. Nonetheless –as we introduce in this section– many different system approaches exist. In this section, we introduce a pluralistic view to systems approaches. We start by describing the diversity of systems approaches in management, and we continue by providing one potentially useful way of applying these approaches to the complex problem of enterprise data governance.

3.1 Hard vs. Soft vs. Emancipatory Systems Approaches

Systems approaches emerged in the first half of the 20th century as a reaction against the traditional scientific method, which was criticized for using a reductionist approach to develop and test theories of the world, through developing and testing hypotheses. According to critics, although highly effective in advancing our understanding of causality in the world, the approach was less effective in helping us to understand complex behaviors of biological and social systems [29]. Ludwig Von Bertalanffy and Norbert Wiener were important pioneers of the systems approach in the areas of biology and engineering respectively. The major contribution of Von Bertalanffy was the premise that most complex systems share characteristics and organizing principles that can be modeled mathematically [51]; Wiener introduced the concepts of purposeful systems, communication and control in social and organizational systems [53].

These seminal works have inspired the development of what Jackson calls Applied Systems Thinking [28, 29]. Applied Systems Thinking is a set of systems approaches that –according to Jackson's premise– constitute a toolset of methods that can be used in tackling different types of management problems or used in different contexts. Figure 1 introduces what Jackson calls a System of Systems Methodologies [28], which constitutes a map to the toolset. In this map, Jackson maps systems approaches to types of problems (or contexts), using a 2X3 grid of types of problems based on their levels of complexity of the problem and conflict among participants.

Complexity of problems is defined on the basis of the number of elements or components within the problem. Repairing an oven or a bicycle or managing a small NGO or business may be examples of simple problems. Developing advanced information systems such as AI applications in government organizations is most likely a complex problem involving –as described above– the integration of diverse sources of data as well as the involvement of a diverse group of stakeholders and policy makers. Conflict, on the other hand, is measured as the level of agreement on the system's purposes among problem owners and problem participants. When all actors in the problem situation agree on the goals unanimously, Jackson classifies the problem as Unitary; when there is diversity of perspectives about the goal that can be harmonized, Pluralistic; and when power imbalances make consensus impossible, Coercive. We believe that actors and stakeholders in the development of AI applications in government are at least a pluralistic group of actors, although some of the AI research suggests that there are multiple situations where we face a coercive situation of perpetuation of power [21, 22].

The framework in Figure 1 is not only useful as a map of systems approaches, but it can also be used as a way of describing main categories of systems approaches: (1) system approaches to improve goal seeking and viability, (2) system approaches to exploring and

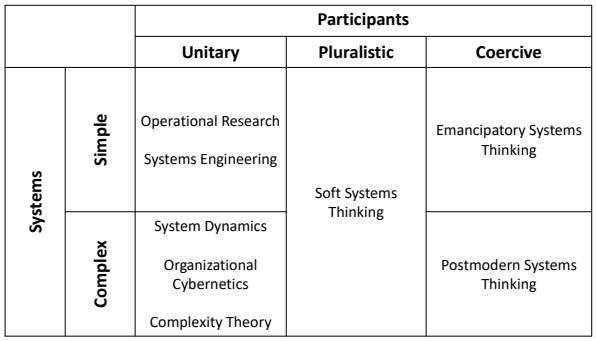


Figure 1: A System of System Methodologies (Adapted from [28]).

clarifying goals among stakeholders and (3) system approaches to ensure fairness and promote diversity [29].

The first type of system approaches –those interested in improving goal seeking– are located in the first column in Figure 1. Common applications of operational research and systems engineering used a variety of mathematical modeling tools to optimize organizational outputs and improve efficiencies in the use of resources. Similarly, system dynamics and complexity theory apply mathematical models to the understanding of complex system behaviors. Finally, approaches such as organizational cybernetics define key functions necessary for an effective organization [33]. In general, this family of system approaches share the assumption that system behavior is the result of the interaction of an identifiable set of components within the system. In this way, all these approaches provide practical methods to identify those components and model their interactions.

The second type of systems approaches emerged as a reaction of main criticisms to the first type. Systems thinkers like Peter Checkland pointed out a major problem with what he referred to as Hard Systems Thinking [6]: it is uncommon that social and organizational actors are in full agreement about main goals and ways of measuring them. In addition, he also recognized the difficulties of identifying crisp components within the system and modeling their relationships as objective reality. As a result, he developed the Soft Systems Methodology, founded in the principle of dialogue and learning among actors in order to learn about the problem and potential solutions. Many other "soft" systems thinking approaches have been developed, and many of the traditionally "hard" approaches have developed participatory modeling techniques, involving stakeholders in the exploration of the problem and the solutions [29, 50].

Soft system approaches' main criticism lies in the fact that all of them assume that it is always possible to reach agreement about goals among problem stakeholders [28], giving birth to the last type of systems approaches. In this last type of approach, conflict and power imbalances are openly recognized, promoting the need for an active search for fairness and diversity from a pluralistic perspective. In the next section of the paper we will briefly describe some basic characteristics of this emancipatory and pluralistic approach.

3.2 A Pluralistic view of Systems Intervention

The pluralistic systems intervention that we propose in this section of the paper is based on the postmodern system approaches [49], which promotes pluralism and diversity in the nature of the client, the use of methods, the modes of representation employed and the facilitation process [29]. Being plural in terms of the nature of the client means not only to ensure the widest possible range of viewpoints in the discussion of the problem, but also acknowledging that consensus may be impossible, and thus accepting that satisfying solutions can be adopted with the consent of participants. Pluralism in methods consists of using all possible systems approaches not only for different aspects of the intervention, but using different methods to approach the same task using different lenses. In addition, the selection of methods should be based on the nature of the problem, but also from the preferences of facilitators and stakeholders. Pluralism in terms of the representations used involves the use of a mix of verbal (stories and narratives), visual (diagrams and pictures) and kinesthetic (sociodrama) representations. Finally, being pluralistic in terms of the facilitation process involves flexibility to adapt to the situation, challenging the process and results when appropriate, keeping sense of purpose and reflecting on fairness and equitable participation.

A systems view of this nature will take advantage of many of the soft systems approaches to facilitate dialogue and extended participation. Moreover, such participative approaches may be used together with any of the hard approaches that have been traditionally less inclusive. One hard view that we find potentially useful to organize plural discussions about data governance for artificial intelligence is Complex Systems Governance (CSG) [5, 33]. CSG incorporates principles and concepts from organizational cybernetics to think about the main components and functions of governance [5]. According to Calida and their colleagues [5], a governance concept for complex systems should examine the governed system (structure and activities), the governing system (controller, provides regulatory capacity), a meta-governance system (main functions and principles of governance), and the contextual environment. From a pluralistic view, all these components and functions need to be negotiated and developed from diverse perspectives as described in the previous paragraph.

4 USE CASE: AI DRIVEN STATISTICAL PROFILING

We do not yet know in what contexts and how extensively AI has been deployed for analysis and decision making in government. However, in the US, some of the most widely known use cases include: the determination of welfare payments and fraud detection [23], potential fraud detection in financial transactions by the Securities Exchange Commission, facial recognition systems and traveler risk profiling by the US Customs and Border Control; and determining candidates for adjudication hearings by the Social Security Administration[19].

It is also worth noting that profiling systems are often used in government services where assessing eligibility is a common task (see, e.g. [21]). In Europe and elsewhere governments have used AI in labor contexts to profile those registered in public employment agencies in order to make service-related decisions; current research

has examined AI systems used in Austria, Australia, Belgium, Portugal and Netherlands. We draw on this research in illustrating the goals of profiling, the kinds of data that is used and the nature of the algorithms deployed, the stakeholders affected, and some significant risks and challenges of these applications. In what follows below, our aim is to illustrate the ways in which a systems approach to enterprise data governance in AI-driven decision making could produce organizational systems that minimize uncertainty, better balance benefits with risks, and do so within frameworks of democratic values.

4.1 Profiling Jobseekers and its Goals

According to Büchi et al. [4], profiling can be defined as the "systematic and purposeful recording and classification of data related to individuals." Automated algorithmic profiling and large quantities of diverse data have made it possible to create profiles from singular and diverse data sources that are used to create predictive models that guide decision making. In labor contexts, governments have adopted AI based statistical profiling to predict how job seekers will fare in the job market [16] and often use that information to "target" the level or types of services provided for individuals based upon the assigned category.

In Austria, for example, AI profiling is used to classify unemployed individuals into three categories: those with high chances of finding employment in half a year, those with mediocre chances of finding employment, and those who are not likely to find employment in the next 2 years [1]; services are provided largely to those in the middle category on the grounds that members of the first category have less need and members of the third category are unlikely to make the best use of services. According to researchers, "High investments in these two groups are not deemed cost-effective" [1].

Upon providing data, Portuguese clients of the public employment service are given a score classifying the risk of that individual becoming long-term unemployed as high, medium or low [56]. However, decisions about which interventions to provide that might assist the client are left to the discretion of counselors who create for each client a personal employment plan that may draw upon a variety of intervention possibilities.

Typically, employment services offered by governments are under-resourced and over subscribed. Profiling in this domain is frequently motivated by a desire to reduce the costs of providing unemployment services or to better allocate scarce resources. Fiscal austerity is the primary driver for the Austrian system; at one time it was anticipated that more individuals might be served with the AI system, but now the AI system is used to enable budget cuts [1].

Often those most in need of services are from vulnerable or marginalized populations [56]. AI systems are often thought to be neutral or objective thus bearing the possibility of ensuring that those predicted to become long-term unemployed are treated similarly by the agency, in contrast to caseworkers whose personal proclivities may lead to normative choices such as prioritizing young versus old job seekers [16].

4.2 Data and Algorithms

For many profiling services, data is obtained from the client upon initial registration in the public employment system or upon meeting with a caseworker. The data typically consists of standard demographics, such as age, gender, education level, nationality/origin, as well as professional background information, and periods of unemployment. In Austria and Belgium, no information specifically related to the profiling algorithm or its improvement is collected; information used for the algorithm is re-purposed from other uses. In Austria and Portugal, information about the registrant is also provided by other government offices such as social security services [1, 56]. The Belgian system collects no additional information from other government offices, however, the system monitors the activity of job seekers such as clicks on job vacancies or updates of their online CV [16]. Poland's system, which was dismantled in 2019, was similar to those of these other countries in many respects, however, further data was collected during a computer-based interview with questions seemingly open-ended, but answers were recorded by selecting from a list of possibilities [40].

Diverse types of machine learning approaches are used to produce models based on the data that are trained to produce the scores by which job seekers are classified. In Portugal, the approach is logistic regression; the model is an equation based upon input data that produces a number that is interpreted as a risk score for becoming long-term unemployed. The algorithm is applied only upon the beginning of a new registration, posing a threat to model validity, since the risk score remains unchanged even if, with a low risk score, a registrant continues to be unemployed [56]. Researchers noted that the system, as of their writing, has not been updated. By contrast, the Belgian system uses a random forest model, viewed as flexible because it can be easily retrained as more data or explanatory variables are obtained. Regularly retraining the model under changing economic conditions also serves to improve the accuracy of the profiling model [16].

4.3 Stakeholders

There is remarkably little research information available about the stakeholders in algorithmic profiling systems in the countries we have reviewed, of which we could name: the registrants to such systems, the agency employees that work with registrants (caseworkers), the individuals who have designed and/or operated the system, and policymakers. In the case of Poland's dismantled system, it was noted that registrants had no rights to information about how the system established their profiling scores and no right to contest the decision received [40]. There are no other references to rights of job seekers in the research articles we consulted.

Although there are some exceptions, the EU prohibits entirely automated profile decision-making for individuals; however, in countries such as Austria and Portugal, caseworkers can overrule the judgment of the algorithm [31, 56], thus inserting "humans-in-the-loop," and maintaining the legality of the AI approach. Research has therefore been focused on caseworkers' attitudes toward the system as well as whether, and in what ways, caseworkers exercise this discretion. Among the findings, we learn that caseworkers very seldom alter the algorithmic score, in part because they do not have time in their interviews with clients to find a basis for

an alternative score. Even though they do not always trust the products of the algorithms, they also do not understand how the scores are produced, due to the opacity with which the system is managed. And even if they did wish to exercise discretion, they do not necessarily understand the reasons given in the system that can be used to justify overriding the system score. Thus, in the majority of cases, it is far easier for the caseworkers to accept the algorithm's score.

4.4 Risks and Challenges

Laws protecting citizens' rights. In the US, administrative law is committed to values of fairness, transparency, and accountability, issues upon which AI systems of all kinds will be judged and potentially challenged in court. In the US and Europe, it is illegal to include variables in AI systems such as gender, age, and ethnicity into models because of their discriminatory potential [16], a condition with further consequences we discuss below. Indeed, the inability of Poland's system to create a non-discriminatory system and the failure to fully appreciate the importance of legal guidelines regarding data appears to have been responsible for the decision by Poland's Constitutional Court that the profiling system was a breach of the Polish constitution; the system was subsequently scrapped [40]. As indicated above, fully automated AI profiling systems are prohibited in EU countries, which means that significant attention must be devoted to the efficacy of human involvement in and understanding of AI systems for decision making related to job seeker profiling [16, 40].

Algorithmic discrimination. Critics charge that the use of algorithms to construct profiles introduces choices reflecting social values into the system, producing conditions in which individuals may be mis- classified and potentially reinforcing patterns of discrimination in society. For example, in the Austrian system, attributes such as disability and women with care responsibilities are inscribed into the system through the data they are based on and the way the data is processed, making it more likely that such individuals are classified into the riskiest group [1]. Further women in technical occupations and women with migration backgrounds along with other marginalized groups receive lower scores on certain indexes of value [15]. Noting that the process of algorithm construction involves normative decisions such as defining outcome variables, constructing decision rules and setting category cut-off points, some recommend that a continuous dialogue needs to take place between data analysts, policy makers and caseworkers [16].

Accuracy-equity trade-off. Although it is illegal to include certain demographic variables such as gender and ethnicity into algorithmic models, these variables are often correlated with other predictors in the model, such as proxies for local labor market conditions, that can identify minorities [16]. Although work-arounds have been suggested, the result of using them is a decrease in accuracy. Thus statistical profiling and selection rules "inevitably entail statistical discrimination" while other options tend to reduce the accuracy of the model producing greater numbers of misclassifications [16] which may unfairly limit the resources available to job seekers.

5 TOWARDS A SYSTEMS APPROACH TO AI DRIVEN STATISTICAL PROFILING

In this section of the paper, we discuss both process and design choices that may be introduced by a pluralistic systems approach to enterprise governance during the development of an AI statistical profiling system.

5.1 Stakeholders from a pluralistic perspective

Given the inherent cultural and politically situatedness of datasets, uncovering the meanings of data itself as well as interpreting the patterns that AI algorithms may uncover require the involvement of many different stakeholders that participate in the production and collection of data. In this way, a pluralistic systems approach to statistical profiling systems would require extensive and careful thinking about who are those stakeholders, and how they should be involved in the process. Stakeholders in the system would include not only the caseworkers serving the clients looking for jobs, but also the providers of the services that support the job seeking and placement process. Clients looking for employment and potential employers would be two other important stakeholder groups. Involvement of all those different stakeholders is important because they are producing the important data through their actions in the system, and their knowledge is key to make proper interpretation of the patterns in the data, as well as identifying when those patterns are only artifacts of problems of data quality [25]. Those patterns represent the activities and idiosyncrasies of system participants. Systems approaches include plenty of tools for stakeholder analysis; a very widely known one in public management is John Bryson's approach to identify stakeholders that matter [3].

5.2 Contesting system goals

Stakeholders in this system have many different goals, and saving resources in helping citizens to find a job is only one of them. Other potentially important goals in the system are the following: (1) Employers within the community most likely want to get the best possible employees, (2) employees most likely are looking for a job that suits their needs and provides them with a sense of fulfillment, (3) service providers in this system may have the goal of providing the most relevant skills to their clients, and helping them to be successful in job placement, as well as (4) representatives of other government entities that contribute data to the modeling, and thus need to be consulted regarding the characteristics and scope of that data. Even from the perspective of cost savings, previous research suggests that job placement efficiency constitutes only one component of the problem, and that savings in this part of the system may backfire by increasing client recidivism [55]. This same research suggests then that investments in supporting clients after job placement is a more effective way of reducing costs in the system when compared with investments in increasing the efficiency in job placement. Incorporating all these perspectives in defining goals of the system requires the use of both a diverse set of system representations and a diverse and flexible set of facilitation techniques. Soft system approaches provide many tools to be used in the process, many of them successfully used already in developing public policy [2, 44, 45, 50].

5.3 Governing data and algorithms

Complex System Governance (CSG), as described in previous sections, is a systems approach that has been used successfully in developing governance of complex systems [5, 33] as those that are necessary for the development of AI applications for statistical profiling systems in government. The approach may be useful not only as a tool to identify the main components of the governed system (data, algorithms, goals, people, etc.), but also in identifying the meta-functions that produce control, communication, coordination and integration of the system. From the pluralistic perspective, these definitions need to be continuously audited and redesigned to ensure system viability and sustainability over time. Design principles that may be perceived as important at first may prove to have no effect in reaching the goals of the system. For example, current regulations forbid the use of demographics as data inputs for AI profiling algorithms. Nonetheless, and given that race and gender are correlated with many other data elements associated with an individual, current research suggests that incorporating those data elements in a transparent way may be a way of reducing bias and promoting fairness [32]. Once more, the use of soft systems approaches may be useful in the definition of components and processes for data governance. Some of these approaches are already in early stages of experimentation, showing promising results [37].

6 CONCLUSION

In this management paper, we have described some of the main challenges of data governance for the development of fair and transparent AI applications in government. To tackle those challenges, we sketch a potential approach based on a pluralistic view of systems approaches to management. The use of AI poses entirely new risks and challenges which, in order to avoid or minimize, will require substantial reorganization of the historical practices and structures of numerous government entities as well as public-private partnerships. Trustworthy AI will certainly not be achieved overnight and may instead require experimenting with incremental enterprise changes and frequent assessment of their impacts. Future research and government practice should incorporate general ideas of pluralistic systems approaches to enterprise data governance in more specific designs to be tested in the development of AI systems.

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Designing for Responsibility

Antonia Sattlegger
Delft University of Technology
a.s.sattlegger@tudelft.nl

Nitesh Bharosa
Delft University of Technology
n.bharosa@tudelft.nl

Jeroen van den Hoven
Delft University of Technology
m.j.vandenhoven@tudelft.nl

ABSTRACT

Governments are increasingly using sophisticated self-learning algorithms to automate and standardize decision-making on a large scale. However, despite aspirations for predictive data and more efficient decision-making, the introduction of artificial intelligence (AI) also gives rise to risks and creates a potential for harm. The attribution of responsibility to individuals for the harm caused by these novel socio-technical decision-making systems is epistemically and normatively challenging. The conditions necessary for individuals to be adequately held responsible – moral agency, freedom, control, and knowledge, can be undermined by the introduction of algorithmic decision-making. Thereby responsibility gaps are created where seemingly no one is sufficiently responsible for the system's outcome. We turn this challenge to adequately attribute responsibility into a design challenge to design for these responsibility conditions. Drawing on philosophical responsibility literature, we develop a conceptual framework to scrutinize the task responsibilities of actors involved in the (re-)design and application of algorithmic decision-making systems. This framework is applied to an empirical case study involving AI in automated governmental decision-making. We find that the framework enables the critical assessment of a socio-technical system's design for responsibility and provides valuable insights to prevent future harm. The article addresses the current academic and empirical lack of philosophical insights to understand and design for responsibilities in novel algorithmic ICT systems.

KEYWORDS

AI, Digital Government, Algorithmic Decision-Making, Task Responsibility

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1 INTRODUCTION

Governments are increasingly emphasizing the potential of artificial intelligence (AI) in the public sector [1]. AI promises more efficient, data-driven, and evidence-based public administration [2]. AI is applied across different public domains, including the automation of decision-making and service provision in areas critical to the well-being of vulnerable citizens, such as welfare services, healthcare provision, or policing [3–5]. Beyond the promise of more efficient, data-driven, and evidence-based public administration, there is a darker side to the application of AI in the public sector [4]. The application of AI in the 'digital welfare state' is particularly concerned. In his report on digital welfare states and human rights, UN Special Rapporteur Philip Alston [6] argues that governments increasingly use "predictive analytics to foresee risk, automate decision-making, and remove discretion from human decision-makers" [6] in their obsession with "fraud, cost savings, sanctions, and market-driven definitions of efficiency" [6]. This digital transformation "disproportionally targets the poorest and most marginalized in society" [6].

This dark side of AI was illustrated strikingly in the Dutch childcare benefits scandal. The scandal surrounding a nationwide applied algorithmic fraud indication system has emphasized AI systems' potential risks and harms in administrative decision-making. One may argue that the Dutch childcare benefits scandal was the first case in which a government fell over the irresponsible application of AI. A nationwide applied self-learning algorithmic risk classification system was applied for the automated screening and predictive assessment of childcare benefits applications on a greater scale. Eventually, it was found that the self-learning algorithmic system assessed applications for childcare benefits based on several dozen indicators, including the distance between the residence and the childcare facility, as well as discriminatory indicators, such as income and citizenship [7]. The discriminatory and erroneous assessment led to stigmatizing and unfounded fraud investigations. Families were unjustly forced to pay back tens of thousands of euros over minute errors, such as missing signatures, with no means of redress. Children were removed from their homes. Families and livelihoods were ruined. Consequently, 71% of the public say their trust in the political system was negatively impacted [8].

The Dutch childcare benefits scandal illustrates the risks of applying AI in government decision-making. One of the core challenges is to define who is responsible for the harm caused and, perhaps even more important, how to prevent harm in the future. The use of algorithms in socio-technical decision-making systems requires us to rethink the allocation of responsibilities and the conditions that need to be fulfilled for individuals to take these responsibilities. We argue that the application of AI in governmental decision-making may challenge the adequate individual attribution of responsibility for the outcomes of such systems. Philosophers generally distinguish three conditions necessary for the adequate attribution of responsibility to individuals. Firstly, the individual must be able understand the moral significance of her actions and act accordingly. Secondly, the individual must be able to act freely and without coercion. Thirdly, the individual must possess sufficient knowledge to be aware of the consequences of one's actions. However, these



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conditions can be undermined for both designers and operators due to the properties of AI systems. AI is understood as autonomous, interactive, and adaptive technology that is capable to carry-out tasks which require human-like intelligence [36]. Several design properties of AI in socio-technical decision-making systems challenge the attribution of moral responsibility [37]. Firstly, it's learning capabilities enable the system to evolve in the interaction with its environment, making it unpredictable over time. Secondly, AI systems are often designed as black boxes. Opaque AI decision-making processes may be difficult to explain and predict for both designers and users of the system. Thirdly, AI may be designed with varying degrees of autonomous decision-making capabilities, further challenging meaningful human control over the system. Lastly, many stakeholders are involved in and affected by the (re-)design, development, and application of AI systems. These stakeholders may have different capacities and preferences in the interaction with the system [37]. The involvement of 'many hands' [27] challenges the attribution of responsibility to individual actors.

We turn this challenge to adequately attribute responsibility into a design challenge. Rather than looking back and attributing responsibility after the fact, we argue that these responsibility conditions need to guide the design of socio-technical decision-making systems applying AI to prevent future harm. Our main research questions are threefold:

First, which responsibilities should be attributed to relevant individuals when applying AI in governmental decision-making? Second, which conditions need to be satisfied for the adequate attribution of these responsibilities? How do we design for these conditions?

This paper proceeds as follows: Section two discusses the research method. Section three presents the conceptual framework for moral responsibility and the respective conditions to attribute individual moral responsibility fairly and effectively. Section four presents the case study analysis. Lastly, we will discuss how the research of past harm can contribute to preventing future harm. We shall propose theoretical insights and practical recommendations for the responsible design and application of AI decision-making systems in the public sector.

2 METHODOLOGY

We first develop a conceptual framework on moral responsibility that we apply in a single case study. The case of the algorithmic risk classification model was chosen as a suitable case [9] based on the following criteria. First, the application of the algorithmic model was found to have contributed to significant harm to those deemed to be fraudulent in the application for childcare benefits. Eventually, the government coalition and prime minister stepped down over the unfolding scandal. Second, there is much data available on the case. Due to the public interest, detailed documentation about the algorithmic model's design, use, and impact have been publicized. The case has been thoroughly reviewed and evaluated by national and international government and independent, non-governmental organizations. The data collection was a systematic search for governmental reports, independent inquiries, and subsequent snowballing technique. The empirical analysis was based on document analysis of government reports and non-governmental inquiries into the child benefits scandal. The documents were analyzed using deductive coding within the NVivo software [9]. The conceptual framework developed below served as the coding book.

3 CONCEPTUAL FRAMEWORK

In this section, we define the key concepts of this research, which include (1) AI in public sector decision-making and (2) the philosophical foundation of moral responsibility. Subsequentially, we develop a conceptual framework by drawing on the notions of what has been called "task-responsibility" [21] and "meta-task responsibility" [23] in connection with the necessary conditions that need to be in place for individuals to be held responsible.

3.1 Artificial Intelligence in the Public Sector

As the number of studies on AI in the public sector is growing [e.g. 5, 10], we are steadily beginning to see the benefits and dangers more clearly. In the absence of generally accepted and unequivocal terminology, it is essential to clarify the application of these terms and their underlying assumptions. Algorithmic systems may carry out tasks that require intelligent, human-like behavior. The transformative difference that AI makes in the public sector is not merely the digitalization of traditional administrative decision-making procedures but a new quality of predictive analytics and autonomous decision-making. It is essential to consider the application of algorithms as part of a broader socio-technical system. Isolated technical or legal solutions to the responsible design of artifacts, such as explainable, transparent, or responsible AI, have largely neglected this embedding – an optimism Stilgoe [11] refers to as "technical solutionism". Kitchin [12] emphasizes that "algorithms need to be understood as relational, contingent, contextual in nature, framed within the wider context of their socio-technical assemblage. From this perspective, 'algorithm' is one element in a broader apparatus which means it can never be understood as a technical, objective, impartial form of knowledge or mode of operation." [12]. Selbst et al. [13] problematize the lack of considering AI as part of broader socio-technical systems in current (computer science) discussions on just and fairness-aware learning algorithms. A failure to understand the interactions between the technical systems and social worlds leads to two different traps: the framing trap – a "failure to model the entire system over which a social criterion, such as fairness, will be enforced" [13], and the formalism trap – a "failure to account for the full meaning of social concepts such as fairness, which can be procedural, contextual, and contestable, and cannot be resolved through mathematical formalisms" [13]. The authors [13] argue that, for one, "technical designers can mitigate the traps through a refocusing of design in terms of process rather than solutions" (p. 59) and for another, must "include social actors rather than purely technical ones." [13]. This research addresses these traps and focuses on algorithmic decision-making systems as socio-technical systems.

3.2 Individual Moral Responsibility

Moral Responsibility is not a single, unitary, and generic concept [14], but a polysemous term that admits a variety of meanings, usages, and degrees. A variety of different taxonomies of moral responsibility have been developed to illustrate the scope of moral

responsibility [see earliest 15; or more recent 14, 16, 17]. In the philosophical literature being morally responsible is often understood to imply, among other things, that "the person is an appropriate candidate for reactive attitudes" [18]. These reactive attitudes encompass a spectrum of feelings directed at a responsible agent for her action or contribution to an outcome. They can be positive reactions, feelings, and attitudes, such as praise, gratitude, or respect, or negative reactions such as blame and resentment [18, 19].

This backward-looking notion of moral responsibility has dominated much of the traditional philosophical literature. In this sense, moral responsibility has been primarily understood as backward-looking responsibilities and referring to past actions to enable the normative evaluation, such as consequential blame or praise (responsibility as blameworthiness) and possible retribution (responsibility as liability) [20]. Another backward-looking notion of responsibility that has been prevalent in public administration studies is responsibility-as-accountability. An accountable agent has a responsibility to provide an account of her actions and why she is not blameworthy for a state-of-affairs. While these backward-looking responsibilities can have a behavioral effect in stimulating desirable or discouraging undesirable actions, the actors are made responsible for past outcomes. These responsibilities are attributed ex-post to individuals based on their contribution to the harm that has already taken place. However, we are interested in the prevention of harm through the ex-ante design for responsibility. Thus, we focus on forward-looking responsibilities which prescribe responsibility to individuals for future state-of-affairs [16]. Two kinds of forward-looking notions of responsibility can be distinguished: Firstly, responsibility-as-virtue attributes responsibility to a person rather than a state of affairs. A responsible agent is characterized by the willingness to take responsibility and acts in due care for others. Secondly, responsibility-as-obligation implies that one has the (moral) obligation to see to it that a certain state-of-affairs is brought about. Goodin [22] formulated this obligation as follows: "i ought to see to it that φ." [22]. This formulation specifies that the obligation does not refer to specific actions on behalf of the responsible actor, such as "i does or refrains from doing α" [22] but bringing about a desirable state-of-affairs. Likewise, it is insufficient that the desired state-of-affairs (φ) occurs, the core of the obligation lies in 'seeing to it'. The obligation – "ought to" – can stem from multiple sources, such as legal, cultural, or normative assumptions. We can think of 'ought' as having an index or subscript 'ought, following Dutch criminal law,' 'ought, following our contract,' 'ought, following the declaration of human rights, 'ought, according to the moral point of view'. It is important to emphasize the source of the responsibility as a moral obligation rather than the descriptive task attribution. Van de Poel [16] illustrates this with a striking example: "Whereas it might be said that Eichmann had the task (responsibility) that the Jews were effectively transported to the concentration camps, it does not follow that he had a (moral) obligation to see to it that they were effectively transported. In fact, because the transport was part of an immoral plan, aiming at the extinction of the Jews, he might even have had a moral obligation to see to it that they were not effectively transported." [16]. Responsibility-as-obligation is particularly relevant regarding the design for responsibility. This notion of responsibility enables the fine-grained organization of responsibility by ex-ante specifying abstract desirable state-of-affairs into concrete individual obligations. This specification is difficult in complex and uncertain innovation processes in which new normative requirements may arise throughout the process, especially when these responsibilities are attributed externally [17]. However, it is precisely for this difficulty that responsibility(as-obligation) needs to be part of the design process, rather than ex-post when individuals refuse to take responsibility for harm that has already occurred.

Goodin's [22] conceptualization of responsibility-as-obligation into task-responsibilities enables this specification. He further specifies the obligation 'to see to it that' into "activities of a self-supervisory nature" [22]. These "require minimally: that i satisfy himself that there is some process (mechanism or activity) at work whereby X will be brought about; that i check from time to time to make sure that that process is still at work and is performing as expected; and that i take steps as necessary to alter or replace processes that no longer seem likely to bring about X.". The different types of responsibility-as-obligation can be deduced. They are summarized in Table 1.

Van den Hoven [23] applies Goodin's [22] concept of task-responsibility to elucidate the responsibilities of designers and users of decision support systems in the public sector. Van den Hoven [24] has referred to such environments as artificial epistemic niches. As decision-makers, the civil servant can become 'narrowly embedded' in these digital government systems because the system presents itself as a black box to the end-user. The operator is epistemically dependent upon the system because he has to defer to it for the justification of his actionable beliefs, he lacks the independent epistemic resources to contest the output of the system because he is dependent on the knowledge the system produces and the logic it uses and is not able to scrutinize processes during run time. This is applied to complex rule-based systems, but it applies a fortiori to AI systems. The operator cannot put forward "system independent reasons" for her beliefs or for reasons to overrule or disagree with the system [23]. The operator cannot morally justify deviating from the system at the moment of decision-making. This argumentation pointing to the moral consequences of epistemic dependence and narrowly embedded end-users is very relevant to understanding the moral predicament of operators and screen-level bureaucrats in the age of ubiquitous AI applications in public administration. In order to take their task-responsibilities, civil servants as end-users of the decision support systems "(. . .) ought to endorse (or act upon) the output of Information Systems they are epistemically dependent upon, and with which they know they will be working under conditions of narrow embeddedness, only after an inquiry of acceptability of the system, the cost of which is proportional to the cost that could reasonably be expected if what is endorsed and acted upon should prove in any sense to be inadequate." (p. 106). To morally empower the civil servant in the use of AI systems, designers "ought to allow users to work with systems in such a way as not to make it impossible for them to live up to their obligations as users." (p. 106). They have thus a meta-task responsibility to design "the system or epistemic artifact (. . .) in such a way as to allow the user to work with it, while retaining his status as a morally autonomous person, who can take his responsibility." (p. 106). If a task-responsibility of agent A for X is an obligation to see to it that X is carried out, then there is a meta-task responsibility associated

Table 1: Task responsibilities – Which task-responsibilities can be attributed to individuals based on their obligations?

Task responsibilities – Which task-responsibilities can be attributed to individuals based on their obligations?	
Task responsibility	Task responsibility implies the obligation to see to it that X is brough about [22].
Negative task responsibility	Negative task responsibility regarding X implies the obligation to see to it that no harm is done in seeing to it that X is brought about [22].
Self-monitoring responsibility	Self-monitoring responsibility implies that A ought to "satisfy himself that there is some process (mechanism or activity) at work whereby X will be brought about; that A check, from time to time, to make sure that that process is still at work and is performing as expected; and that A take steps as necessary to alter or replace processes that no longer seem likely to bring about X." [22].
Supervisory responsibility	Supervisory responsibility implies that A ought "to see to it that others act or refrain from acting in a certain way" [22].
Meta-task responsibility	"A has an obligation to see to it that (1) conditions are such that it is possible to see to it that X is brought about, (2) conditions (moral agency, knowledge, freedom, capacity) are such that it is possible to see to it that no harm is done in seeing to it that X is brought about." (. . .) while retaining her status as a morally autonomous person, who can take moral responsibility [23].

with it: relevant others and A himself have an obligation to see to it that A can see to it that X is done. If A has a task-responsibility to make the correct payments on Friday, then A – and relevant others – have on obligation to see to it before Friday (as far as this is possible) that A can do what A has to do on Friday, and they have an obligation to refrain from doing such things that prevent A from doing so (p. 106). Meta-task responsibility plays an essential role in effectively distributing (task-) responsibilities across the multi-actor design and usage of complex algorithmic decision-making systems. Building on Goodin's [22] expressions of task-responsibility, Van den Hoven [23] defines meta-task responsibility as follows: "A has an obligation to see to it that (1) conditions are such that it is possible to see to it that X is brought about, (2) conditions are such that it is possible to see to it that no harm is done in seeing to it that X is brought about." (p. 108). Table 1 summarizes these task- and meta-task responsibilities.

3.3 Conditions for individual moral responsibility

To adequately ascribe responsibility to a person for an action, certain conditions need to be fulfilled. These responsibility conditions are also described as "fairness criterion of responsibility ascriptions" [24]. These preconditions enable an individual to take responsibility for fulfilling her obligations. What these conditions amount to can be seen by studying generally accepted types of excuses and viable attempts to deny one's responsibility. If there is damage to a precious object, for example, and someone is held responsible for the untoward outcome, we often hear: "I was not the one who caused it", "there is nothing wrong with it", "it was not my intention", "I was forced, I had no choice" or "I did not know what was happening". Excuses target the conditions for responsibility, such as intention, knowledge, capacity to judge, free choice, causal involvement, something that went wrong. In the case of black box AI-based systems, it is evident that many of these excuses are readily available. Plausible deniability of responsibility is almost guaranteed if users are in the dark. Rubel, Castro & Pham [25] emphasize that users and designers of algorithmic decision-making systems, can intentionally obscure their moral responsibility – thus, engaging in agency laundering. According to the authors "using an automated process to make decisions can allow a person to distance herself from morally suspect actions by attributing the decision to the system" [25] and "letting it forestall others from demanding an account for bad outcomes that result" [25], thereby laundering their agency.

There is no universal agreement regarding the formulation of these conditions [26]. Multiple typologies have been developed to distinguish these conditions [see e.g. 18, 19, 20, 27, 28]. Generally, three interrelated conditions are necessary for the fair and effective attribution of moral responsibility can be distilled, as summarized in Table 2

- Moral agency and intentionality – Moral responsibility presupposes a moral agent capable of intentional and purposeful action. She can grasp moral reason and can control her behavior accordingly. An agent's action or inaction stems from a decisional mechanism responsive to moral reason. This mechanism is receptive to (moral) reasons for and against a particular course of action, as well as reactive to those (moral) reasons [18]. This condition is violated if an agent acts under force or the influence of drugs.
- Freedom and control – Interrelated with the condition of moral agency is the condition of free will or control over one's action. A responsible person must be capable of determining and acting according to one's moral reasoning. Free will requires the absence of coercion, force, or other barriers outside the actor's control. The agent must take ownership of one's decisional mechanisms to be able to take moral responsibility. Thus, if one decides to apply an algorithmic system for sensitive decision-making, one cannot blame the algorithmic system for its output as one has taken ownership of the decisional mechanism in the first place. Thus, the agent's action "issues from the agent's own, reason-responsive mechanism." [18]. The meaning and scope of free will continue to be disputed. However, few would dispute that an actor who acts under coercion can be morally responsible for her actions.

Table 2: Responsibility conditions – When is it adequate to attribute responsibility to someone?

Responsibility conditions – When is it adequate to attribute responsibility to someone?	
Moral agency & intentionality	A responsible actor can engage in intentional, purposeful action. She understands the moral significance of her action and can reason accordingly.
Freedom & control	A responsible actor can act freely and without coercion. The actor has control and can take ownership over the decisional reason-responsive mechanisms.
Knowledge	A responsible actor possesses sufficient knowledge to be aware of the consequences and causal contributions of one's action or inaction.

- Knowledge – Knowledge and awareness are essential epistemic conditions for moral responsibility. A responsible actor is aware of the consequences and causal contributions of one's action or inaction. An actor is not excused for ignorance due to negligence. An actor has the normative duty to ensure she knows what she should know or can reasonably be expected to know.

These responsibility conditions enable a systematic assessment of an agent's capacity for being attributed moral responsibility. This does not mean that these actors are entirely excused if these conditions are not fulfilled. An obvious case, for example, is when their ignorance is self-caused since self-caused ignorance (what is called ignorantia affectata) does not excuse. Likewise, epistemic recklessness does not excuse. In what follows, we assume that only human beings can be morally responsible. The conditions of moral agency and freedom are closely interrelated and form inherently human conditions for being responsible and being able to take responsibility. In a backward-looking sense of responsibility, both human agents and non-human agents, such as artificial agents, or even natural events, such as the weather, can be causally responsible for an event, but only human agents can be morally responsible [18]. While the system crash of one's computer can be causally responsible for wiping out weeks' worth of work, we intuitively feel silly to react with emotional resentment or blame towards our computer. In the case of an artificial and non-human agent, such as our computer or an algorithmic model, the conditions necessary for the attribution of moral responsibility do not apply. For this argumentation, we will assume in this work that only human agents can – given these conditions – be moral agents and, thus, be morally responsible. This argumentation extends to collectives of individuals, such as government organizations or administrative units, who cannot be morally responsible. Eventually, those representing the collective are crucially involved in its decision-making and governance may be held morally responsible, not as private individuals but based on their professional function or role, such as public officials [27].

4 CASE STUDY – THE BENEFITS MACHINE: RESPONSIBILITY IN THE ALGORITHMIC SOCIO-TECHNICAL DECISION-MAKING SYSTEM

We apply the concepts of task- and meta-task responsibility discussed above to better understand how the application of the algorithmic risk classification model used by the Dutch Tax Authorities from 2013 until 2019 can cause severe harm and great injustices to Dutch citizens. Thereby, we seek to apply insights to the design for the responsibility of AI-based socio-technical systems to prevent future harm. We will analyze which responsibilities and conditions were attributed to the relevant actors tasked with designing, developing, and applying the algorithmic model. See Table 3 for an overview of the relevant actors.

The application of the algorithmic model must be understood as part of a socio-technical system that is embedded within a broader political and institutional context. Table 4 summarizes the relevant actors.

4.1 Responsibilities in designing the algorithmic risk classification model

The algorithmic model was designed by civil servants and data specialists from the department Allowances, a sub-department with the Dutch tax authorities, subordinate to the Ministry of Finance. The design choices made reflect the task responsibilities the Department was assigned within the government organization and attributed within this hierarchical order.

The Allowances department has the core task responsibility for granting, paying, and recovering childcare benefits. With a strong political priority on the efficient prevention and combat of fraud in the childcare benefits system, civil servants at the Allowances department were to check the applications before payments were made, particularly those without prior residence in the Netherlands. To do so more time and cost-efficiently, the Allowances department was tasked with developing an ICT system that could screen the citizen-clients for fraud automatically at scale. Table 5 (Appendix) summarizes the developer's task responsibilities.

The developers at the Allowances department of the tax authorities acted within a political and institutional environment that prioritized efficient prevention and combatting of fraud over other public values, such as the rule of law, such as "foreseeability, for those affected, precision and scope in the executive's discretion, and respect for human rights" [30] to prevent hardship for citizen-clients. Ministers argued that "the Tax and Customs Administration/Allowances should operate like a machine (. . .). Exceptions would throw a spanner in the works." [31]. These expectations were reflected in the General Act on Means-tested Benefits, the policy the tax authorities were expected to execute. Following this political prioritization, the Tax Authorities were pressured by the Ministry of Social Affairs to finance their enforcement scheme through the repayments and fines by the citizen-clients. Simultaneously, the Tax Authorities and sub-units were faced with significant spending

Table 3: The relevant actors and their roles in the design, development, and application of the algorithmic model

Relevant actors and their roles in the design, development, and application in the algorithmic decision-making system
Design of the algorithmic model
• Civil servants and data specialists from the Allowances department as designers of the algorithmic model
Application of the algorithmic model
• Civil servants as operators of the algorithmic model
• Citizen-clients as objects or targets of the decision-making process

Table 4: The relevant actors and their roles in the political and institutional context

Relevant actors and their roles in the design of the socio-technical decision-making system
Design of the social benefits legislation
• Government and Parliament
Design of the execution of the social benefits legislation
• Ministry of Social Affairs
• Ministry of Finance
Enforcement of the social benefits system
• Tax and Customs Administration

cuts imposed by the Cabinet, putting additional pressure on the streamlining and greater efficiency of the "benefits 'machine'". One may argue that this financial pressure led to an immoral incentive to maximize repayments and undermined the Tax Authorities' decisional reason-response mechanism. Professional discretion and room for free choice were deliberately designed out across all levels and tiers of government. As the former director of Allowances emphasizes, "the current benefits system is very complex (. . .). There is hardly any room for maneuver in administering it." [31]. This political and organizational background sheds light on the corrosion of the responsibility conditions that the system developers faced.

The self-learning algorithmic risk classification model was developed in 2013 by civil servants and data specialists from the department Allowances. A set of weighted risk indicators was selected based on a statistical analysis of historical data. A scorecard was developed based on which all incoming applications were automatically assessed, and a respective fraud risk score was calculated.

The algorithmic model automatically assessed monthly incoming applications for childcare benefits based on several dozen weighted indicators. Indicators related to the childcare center, such as the type of childcare or the distance between childcare center and residence, as well as to the situation of the applicant, such as income, benefit debts, family status, age, and the number of children [32]. Based on the accumulated risk score of all indicators, those applications were selected for subsequent manual scrutiny that were either above a risk score of 0.8 or part of 30-100 applications (depending on capacities) within a month that had the relatively highest risk score below 0.8. Civil servants then manually assessed those high-risk cases and had the power to label them as fraudulent. All other applications were automatically approved.[1]

In doing so, the developers at the Allowances department arguably had a so-called negative task responsibility to develop the

[1] Automated or semi-automated system – The algorithmic decision-making system can be understood as both an automated and semi-automated system. The algorithmic decision-making was fully automated for those that were not perceived to be of high risk by the system. Those with a high-risk score were automatically selected for manual scrutiny, thus, a semi-automated system with human interference. Due to this differentiation, it was not legally necessary to inform the citizen-clients about using an algorithm according to the GDPR.

system without (i) inflicting harm on innocent, non-fraudulent citizen-clients, (ii) placing unproportioned burdens on the end-user, and (iii) imposing additional costs on the administration, but arguably equally without making it impossible for end-users to take and bear moral responsibility for decisions significantly affecting citizens. The developers violated this crucial responsibility. Nationality was deliberately included as a risk indicator in the initial design of the algorithmic model. Not having the Dutch nationality lead to an increase in an applicant's risk score [7]. The algorithmic risk profiles meant that those of non-Dutch nationality or low income were disproportionally selected and, thus, affected by delays in benefits payments and the harsh sanctions that could follow from a manual assessment. Amnesty International [33] has criticized the algorithmic model for enabling intersectional discrimination and human rights abuse. Amnesty International [33] concluded that "the inclusion of nationality as a factor in the risk classification model, in combination with the mapping of certain groups of people whom the tax authorities believed would be more likely to engage in fraudulent or criminal behavior, shows that the tax authorities were motivated by racial prejudice concerning fraud detection. This risk-scoring led to a disproportionate focus on particular groups of people based on their ethnicity and qualified as racial profiling under the international human rights framework." [33]. There was no differentiation within the algorithmic model between different non-Dutch nationalities. However, in an exemplary case, the risk indication of 120 to 150 citizen-clients of Ghanaian nationality led to a subsequent manual investigation of all 6047 citizen-clients with Ghanaian nationality [7]. The model itself dropped the indicator nationality in October 2018 due to its low risk predicting power. It is assumed that publishing information in different languages on the tax authorities' website had led to fewer incorrect applications [7].

The developers had the self-monitoring responsibility to monitor and, if necessary, re-design the self-learning algorithmic decision-making system. This includes the responsibility to design the algorithmic model to allow for continued oversight and an understanding of its internal workings. This responsibility was neglected in the design of the algorithmic model as self-learning. The algorithmic model was a self-learning model that was continuously trained with historical data. The model continuously updated the weighted risk indicators based on the high-risk cases that were manually assessed and either deemed correct or incorrect assessments. Specific indicators were added others dropped throughout the lifespan of the model. This self-learning characteristic meant that the indicators and their weights were designed and re-design throughout the application by the algorithm itself without sufficient human understanding and oversight. This self-learning design meant that a sufficient understanding of the changing algorithm, continuous oversight, and deliberate re-design were lacking. A necessary consequence is that even though specific protected characteristics may (legally) not be collected or added as indicators (such as ethnicity), the algorithm can develop proxy variables (such as postal code), which can correlate strongly with the former. Eventually, those citizen-clients deemed to have the highest risk and subsequently scrutinized lived in an urban area, with an income under 20.000 Euro, were single parents, with multiple children in the household, who asked for many childcare hours, and who lived far from the childcare center [34].

Management had the supervisory responsibility to see to it that the developers saw to it that end-users of the model use the risk score as an indication for manual assessment could see to it that assessment of the applications could be carried out independently. However, there is no indication that the algorithmic model was evaluated and subsequentially re-designed [35].

Core responsibility is the meta-task responsibility of the developers and higher management, according to which they have the obligation to see to it that the end-user can use the algorithmic model responsibly. By designing for the end-user's responsibility conditions, the end-user is empowered to take responsibility for the outcomes of her application of the algorithmic model. Table 6 illustrates the end-users necessary responsibility conditions. These are the conditions and the non-functional requirements that the developers ought to design for.

As elaborated above, three interrelated responsibility conditions that enable civil servants to fulfill their respective task responsibilities can be distinguished. First, moral agency and intentionality, the end-user must work with the system as a morally autonomous person (within the bounds of the professional role) and understand her model-independent actions. Second, freedom & control, the end-user must be free in applying the algorithmic model. Third knowledge, the end-user should understand why and how the algorithmic model arrives at a certain risk indication. These conditions were undermined by the design of the algorithmic model and the way it was embedded in the organization. Firstly, the algorithmic model was autonomous insofar as the end-user is automatically tasked to scrutinize the applicant flagged as high risk by the model. She has no professional discretion or freedom on whether or not to proceed with the assessment. Secondly, the end-user was epistemically dependent on the risk score provided by the algorithmic model. She blindly relies on this information because she cannot scrutinize the processes during run time as the algorithmic model was designed as a black-box model. The end-user was not provided with additional information beyond the accumulated risk score [30]. She did not understand how and why an individual application was flagged with a high-risk status. She was not provided with further knowledge about the input and workings of the algorithmic model. Therefore, the end-user was epistemically dependent on the algorithmic model. Without means to scrutinize the model, she cannot justify her beliefs that an applicant is potentially fraudulent independent of the algorithmic model's output. Her manual judgment of the cases selected by the model can be intentionally or unintentionally impacted by the algorithm's risk indication. These conditions – narrow embeddedness in an artificial epistemic niche and epistemic dependency – result in the epistemic enslavement of the end-user [23]. In such circumstances, Van den Hoven [23] argues that "in order to curb the reduction of intellectual autonomy and relativization of moral responsibility, the user must be permitted to reflect ex-ante upon the epistemic conditions, within the confines of which she knows she will be working." (p. 106). There is no documentation that such ex-ante reflection was enabled either through deliberative processes or inclusive design practices. Instead, there are strong indications that end-users did not understand the workings of the black-box model [33].

4.2 The civil servant's task responsibilities in the application of the algorithmic model

The algorithmic model was designed based on two subsequent task responsibilities. Firstly, civil servants were expected to independently assess the application selected for manual scrutiny by the model. Secondly, the citizen-clients were expected to provide the correct information in their applications.

As the end-user of the algorithmic model, the civil servant has the task responsibility to independently assess those applications that are flagged as high-risk by the algorithmic model. In doing so, she has the negative task responsibility to not inflict harm by falsely accusing innocent citizen-clients or disproportionate burden on those found to have provided incorrect information. She also has a legally defined negative task responsibility not to base her judgment on protected or otherwise discriminatory indicators, such as ethnicity. The room for discretion and potential consequences in deviating from the algorithms risk indication are unknown. However, as she was epistemically dependent on the algorithmic model, there is reason to believe that this discriminatory risk assessment impacted her judgment of the application. Building on Van den Hoven's [23] argumentation, the civil servant also has the self-monitoring responsibility to check the algorithmic model, which automatically assigns applications to her. She has an obligation to raise concerns about the algorithmic model. Table 7 (Appendix) summarizes the civil servant's responsibilities.

We have already outlined how the design of the algorithmic model undermined the civil servant's conditions to fulfill these responsibilities (see Table 6, in the Appendix). However, the civil servant's autonomy in the decision-making process was further undermined by the institutional context in which the algorithmic decision-making process was embedded. As just a small cog in the larger 'benefits machine', civil servants were to follow a "zero-tolerance approach" or "all-or-nothing" approach [34]. Citizen-clients were forced to pay back benefits in full for the past up to five years for minor errors, such as incomplete information or missing signatures. Those citizen-clients who had to repay more than 3.000 Euro were automatically labeled with "deliberate intent or gross negligence" without further verification. These citizen-clients were no more eligible for debt payment plans or payment in installments. While this harm is primarily based on the harsh administrative sanctioning and enforcement policies, which are not the focus of this research, the algorithmic model must be judged as part of a socio-technical decision-making system. While the intention for implementing the algorithmic model was efficient and predictive decision-making at large scale, the algorithmic model has failed to indeed make correct decisions or to contribute to better decision-making procedures. The Dutch government concluded that between 2012 and 2019, 25.000-35.000 individuals were labeled as "deliberate intent or gross negligence" and, thus, had to repay the total amount of the benefits received. However, it was found that 94% percent of those judgments were incorrect.

Civil servants at the Allowances department fulfilled their self-monitoring responsibilities and raised concern about the workings and impact of this decision-making procedure with their management. A manager at the Allowances department noted that he encountered 'resistance' by the civil servants over the harmful impact this procedure has and their perception of being unable to 'do something for those impacted'. The legal advice of the Allowances department concluded that the tax authorities were merely implementing existing laws [34]. The civil servants' concerns were left unresolved.

4.3 The citizen-clients task responsibility in the application of the algorithmic model

This "zero-tolerance approach" placed much responsibility on the shoulders of the individual applicant [31]. Table 8 (Appendix) summarizes these responsibilities. However, the responsibility conditions necessary to take that responsibility were not intentionally designed in, and, in some cases, they were actively undermined, see Table 9

The citizen-client has the task responsibility to submit timely and correct (to the best of his or her knowledge) applications for childcare benefits. However, citizen-clients who were not sufficiently familiar with the Dutch language were not empowered by the administration to understand the applications. After information was published in different languages on the website, the error rate dropped, which subsequently led to dropping non-Dutch nationality as fraud indication [7]. There is an indication that many faults were not with fraudulent intention, but errors made in good faith. The applicant also has the crucial self-monitoring responsibility to satisfy herself that her application for childcare benefits is being processed accordingly. She is responsible for requesting information, challenging, and appealing decisions perceived to be epistemically or morally wrong. However, crucial responsibility conditions are curtailed. Citizen clients were not informed over the processing of their information by an algorithm. The citizen-clients were not provided with sufficient information about why their applications were dismissed or labeled fraudulent. There was no system of redress in place to provide citizen-clients with sufficient channels for challenging the decision. The administrative system to request information or appeal a decision is complex, centralized and citizen-clients received little to no information or support. Especially, those "economically and culturally distant from administrative rules and procedures" [31] found the complaints procedures challenging. As a citizen, one may be attributed a supervisory responsibility to voice wrongdoings and harm through government decision-making. However, many of those unjustly and untruly targeted do not have the socio-economic capacities to organize. The citizen-clients were not further empowered by other government organizations to do so.

Neither the responsibility conditions of the civil servants as end-users of the algorithmic model nor the responsibility conditions of the citizen-clients were deliberately designed for but undermined or compromised in the current socio-technical decision-making system. In retro perspective, we can only argue normatively that the tax authorities, ministries, and policymakers had an obligation to see to it that these responsibility conditions were brought about. The lack of explicitly transparently and continuously designing for responsibility is reflected in the understanding of the algorithm as the core technology, rather than it being part of a broader socio-technical system.

5 DISCUSSION & CONCLUSION

The application of task- and meta-task responsibility with the fine-grained responsibility vocabulary discussed above, and the attention to the responsibility conditions provide a more comprehensive conceptual lens to understand how the absence of explicit designing for responsibility in complex digital socio-technical systems enables harm and injustices in the application of AI in government decision-making. The analysis has enabled us to explore problems and provide answers to the research questions we posed up-front:

Which responsibilities should be allocated when using AI in governmental decision-making?

The five different task-related responsibilities (task responsibility, negative task responsibility, self-monitoring responsibility, supervisory responsibility, and meta-task responsibility) provide an analytical lens to identifying actor's various obligations and duties of a range of actors regarding the design, development, and application of artificial governance in public sector decision making. The task- and meta-task responsibility enable the design for responsibility within and across all levels of granularity. An actor's task responsibility may be developing a single system component or the task responsibility for adopting a legal framework. This approach enables the design for responsibility of socio-technical systems rather than isolated technological artifacts.

Which conditions need to be satisfied for the adequate attribution of these responsibilities?

The analysis has illustrated the relevance of establishing the necessary responsibility conditions – moral agency, freedom, control, and knowledge over one's contribution to the outcome – to be able to take and to be held morally responsible. For the developers, end-users, and citizen-clients, the adequate responsibility conditions to be held sufficiently responsible for (part of) their actions and inactions were not established or undermined. Consequentially, it would be unfair and ineffective to assign moral responsibility to these actors based on their inability to fulfill their task responsibilities and their involuntary contribution to a harmful outcome. If there is consensus that individuals a, b, c should be held morally responsible for X, Y, Z, we should design their artificial epistemic niche so that the conditions for responsibility are satisfied and holding them responsible is fair. Our proposed conceptualization enables a more thorough assessment and the identification of distinct conditions for specific task responsibilities. It must be acknowledged that though these conditions may guide design practices, they remain rather broad. In practice these conditions have to be contextualized and monitored in the continuous (re-)design of AI systems.

How do we design to ensure these conditions?

The retro perspective analysis highlights the importance of designing for responsibility upfront. It was epistemically impossible to attribute these lacking responsibility conditions satisfactorily to another actor's meta-task responsibility in retro-perspective. Despite having argued for an individualist notion of responsibility, we had to resort to attributing task responsibilities vicariously to government organizations and administrative units. This was since there was no design for individual moral responsibility in the first place. Eventually, we cannot satisfactorily distribute the individual moral responsibility for the harm caused by the application of the algorithmic model in the decision-making processes.

These findings further emphasize the importance of designing for responsibility ex-ante. Doing so will require attention not only to the artifact in isolation but as socio-technical systems embedded in a broader political and institutional context. The concept of meta-task responsibility as a corollary of task responsibility highlights the importance of designing for oneself and others' responsibility conditions. This conceptualization enables us to adopt an interconnected and holistic understanding of these responsibilities and, thereby, include AI systems' micro, meso, and macro context. This case shows that not only those immediately involved in the design and application of the algorithmic model bear task and meta-task responsibility. Instead, responsibilities, roles, and tasks are nested in further administrative and political institutions, which shape the preconditions of these actors as moral agents. These institutions, such as here the ministries, parliament, Cabinet, and the prime minister, bear task responsibilities themselves and meta-task responsibilities in ensuring the responsibility conditions of those downstream. This case exemplifies this in the political pressure exerted downwards to prioritize values such as efficiency, and the focus on combating fraud impacted the moral agency of those who implemented these policies.

These insights need to be considered in light of some limitations that reveal directions for further research. First, the case study analysis relies solely on reports provided by the government and non-governmental organizations. This approach made it difficult to distinguish responsibilities between and within different administrative units or the attribution to individuals. These documents are mainly focused on responsibility as accountability, liability, or blame. However, this paper does not intend to serve as an annex to a government inquiry. Instead, it seeks to explore whether and how designing for task responsibility can help understand past wrongdoings and prevent future harms by foregrounding the need for a fine-grained responsibility vocabulary that matches the complexity of the systems it is applied to. In our opinion, this is what is needed for a responsible design of algorithmic decision-making in government. Second, the conceptualization was not indented and, thus, fails to attribute complete backward-looking responsibility for the harm inflicted by the algorithmic model. This analysis shows both the relevance and difficulty of analyzing the socio-technical system rather than individual human or technical components. However, the task and meta-task responsibility conceptualization take the actors' tasks and necessary conditions as a starting point to design for responsibility and prevent future harm. Future research should engage practitioners in the co-creative design for the responsibility of algorithmic decision-making in government. Identifying and including all relevant actors, those operating the systems, and citizen-clients will mainly contribute to this design challenge. Future research should focus on integrating private technology companies as designers and users of AI in the public sector. In this paper we focus on the adequate attribution of responsibility-as-obligation. However, one may argue that the adequate attribution of responsibility is not necessarily effective in stimulating desirable behavior and, thus, preventing harm. Future research should focus on the relationship between adequate or fair and effective attributions of responsibility. Theoretical and conceptual contributions from public accountability studies may contribute to closing this gap.

The use of algorithms in socio-technical decision-making systems requires us to rethink the allocation of responsibilities and the conditions needed to take these responsibilities. The deliberate and inclusive design for responsibility can prevent governments from "stumbling, zombie-like, into a digital welfare dystopia" [6]. Instead, AI can contribute to more responsive, just, and effective social welfare systems if designed for responsibility. In AI and socio-technical systems that will be increasingly introduced in public administration, we cannot hold people responsible if they have not been made responsible, and our design mirrors this. They cannot be held responsible if the epistemic conditions do not support (or even undermine) them in taking moral responsibility. We should not expect to answer questions about who was responsible in AI and Data Government applications in a morally satisfactory way if the context and the applications were not adequately designed.

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APPENDIX

Table 5: Task responsibilities – What are the task responsibilities the developers of the algorithmic model are attributed?

Task responsibilities – What are the task responsibilities the designers of the algorithmic model are attributed?	
Task responsibility	The Allowances department was responsible for the operational task of granting, paying, and recovering childcare allowances. With the political priority being the efficient prevention and combat of fraud in the childcare benefits system, they were to check the applications before payments were made, particularly of those without prior residence in the Netherlands. To do so more time and cost efficiently, they were tasked with developing an ICT system that was able to screen the applicants for fraud automatically and on a large scale.
Negative task responsibility	The developers had the negative task responsibility to do so without inflicting harm on innocent, non-fraudulent applicants, as well as reducing the costs of the ICT system.
Self-monitoring responsibility	The developers had the self-monitoring responsibility to monitor and, if necessary, re-design the self-learning algorithmic decision-making system. This includes the responsibility to design the algorithmic model so that it allows for continued oversight and an understanding of its internal workings.
Supervisory responsibility	The developers had the supervisory responsibility to see to it that the end-users of the model use the risk score as an indication for manual assessment yet are still able to assess the application independently.
Meta-task responsibility	The developers had the obligation to see to it that the end-user can use the algorithmic model responsibly. By designing for the end-user's responsibility conditions, she is empowered to take responsibility for the outcomes of her application of the algorithmic model (see Table 6).

Table 6: The developers meta-task responsibility to design for the end-user's responsibility conditions

Designing for operator's responsibility conditions – When is adequate to attribute responsibility to the operator?		
Designing for moral agency & intentionality	Designing for freedom & control	Designing for knowledge
The operator must be able to work with the system as a morally autonomous person and understand her model-independent actions.	The operator must be (and perceive to be) free in the application of the algorithmic model and possess a professional room for discretion to act accordingly.	The end-user should understand why and how the algorithmic model arrives at a certain risk-indication.
The developers neglected their meta-task responsibilities to design for the operator's responsibility conditions. The design of this algorithmic model makes the operator epistemically dependent upon the model's output. The design of the broader socio-technical decision-making processes further designs out their room for discretion.		

Table 7: Task responsibilities – What are the task responsibilities attributed to the civil servant as an end-user of the algorithmic model?

Task responsibilities – What are the task responsibilities attributed to the civil servant as operator of the algorithmic model?	
Task responsibility	The civil servant has the task-responsibility to assess those applications that are flagged as high-risk by the algorithmic model.
Negative task responsibility	The civil servant has the obligation to independently assess each flagged application. She must do so without inflicting harm or false accusations on innocent applicants, this includes no basing one's decision on protected or otherwise discriminatory indicators, such as ethnicity.
Self-monitoring responsibility	The civil servant has the obligation to check the algorithmic model which automatically assigns cases to her. She also has to see to it that no disproportioned burdens are placed on incorrect or potentially fraudulent applicants through her manual assessment. If she does perceive such harm, she has the obligation to act and raise her concern.
Supervisory responsibility	The civil servant has the supervisory responsibility to see to it that the applicants provide correct and refrain from providing incorrect or fraudulent information.
Meta-task responsibility	As the end-user who is not involved in the design of the algorithmic model or broader decision-making system, the end-user is neither attributed meta-task responsibilities, nor has the power to impact the relevant conditions.

Table 8: Task responsibilities – What are the task responsibilities the applicant (citizen-client) can be attributed?

Task responsibilities – What are the task responsibilities attributed to citizen-client?	
Task responsibility	The citizen-client has the task responsibility to submit a timely and correct (to the best of his or her knowledge) applications for childcare benefits.
Negative task responsibility	In applying for childcare benefits the applicant has an obligation to ensure that a correct application avoids large reclaims.
Self-monitoring responsibility	The citizen-client has the self-monitoring responsibility to satisfy herself that her application for childcare benefits is being processes accordingly. She has the responsibility to request information and challenge wrong or unjust decisions.
Supervisory responsibility	A citizen-client is also a free citizen in a liberal-democratic system and, thus, has the supervisory responsibility to voice unjust treatment and immoral behavior by those elected or appointed to power.
Meta-task responsibility	The citizen-client has the meta-task responsibility to ensure her own responsibility conditions, as it is within her own capabilities.

Table 9: Responsibility conditions of the citizen-clients were not met, making it impossible to attribute responsibility fairly and effectively.

Responsibility conditions of the citizen-client were not met make it impossible to adequately attribute responsibility		
Designing for moral agency & intentionality	Designing for freedom & control	Designing for knowledge
The citizen-client must be able to act intentionally.	The citizen-client must be able to raise her concerns in case she feels unjustly treated.	The citizen-client must understand his responsibilities to provide correct information and must understand the potential consequences or incorrect information.

Mind the Gap: Towards an Understanding of Government Decision-Making based on Artificial Intelligence

David Valle-Cruz
Unidad Académica Profesional Tianguistenco, Universidad Autónoma del Estado de México
davacr@uaemex.mx

Rigoberto García-Contreras
Department of Business, Universidad Autónoma del Estado de México
rgarciac@uaemex.mx

J. Patricia Muñoz-Chávez
Department of Business, Universidad Tecnológica de la Zona Metropolitana del Valle de México
j.chavez@utvam.edu.mx

ABSTRACT

Decision-making has become more critical for organizations in the 21st century. The citizens' countless needs and the emerging problems (internal and external) faced by governments increase the complexity of government decisions worldwide. The research question guiding this attempt is: How is government decision-making grounded on artificial intelligence (AI)? Based on the PRISMA approach and empirical analysis of some international cases are adopted. The authors analyze different organizational and environmental factors, the objectives, benefits, and risks of AI-supported decision-making. The findings show an increasing interest in the research on government decision-making based on AI. Finally, there is the potential of AI to support decision-making for the benefit of citizens and public value generation, collaboratively between governments, industry, and society. Future work will further analyze AI-based decision-making in government in depth.

CCS CONCEPTS

• **Computing methodologies**; • **Philosophical/theoretical foundations of artificial intelligence**; • **Theory of mind**;

KEYWORDS

Artificial Intelligence, Government Decision-Making, Organizational and environmental, Public Sector, Goals, Benefits, Risks

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1 INTRODUCTION

Herbert Simon argued that artificial intelligence (AI) is an empirical science with no apparent reason for a close connection between research aimed at designing intelligent systems and the simulation of human cognition [40]. However, decision-making is a cognitive process, neuralgic in organizations, occasionally limited by the human incapability of recording all information (bounded rationality), but it could be boosted by AI. The existing large amount of data and the emerging problems increase the government decisions complexity throughout the world [9, 23]. A key factor to consider when selecting a decision-making tool is its degree of reliability, as this reduces uncertainty and risk [45].

In decision making, data and timely information have been the backbone of organizations. Cognitive biases lead to poor decision-making, yet. AI has the potential to improve it since AI-based decision-making allows the processing of data, automatically and massively. AI could simplify decision-making in a relevant way, but it may leave humans out of the loop; for this reason, processes that combine AI with people are gaining ground. This phenomenon is just getting started, and more governments are implementing it worldwide, discovering great benefits, but producing ethical problems, discrimination, and unexpected results [30].

AI could be a powerful quantitative technique with qualitative application in organizations. We can find specific ones (e.g. machine learning, expert systems, and multi-agent systems) that may mimic experts' functions, gradually approaching qualitative and creative activities automatically [2, 48]. From a socio-technical view, organizational, environmental, and technological factors interact and influence government decision-making [32]. This approach has been studied in the e-government research; with the rise of AI in the public sector, several scholars have taken up this perspective again [13].

In this regard, decision-making in the public sector must be oriented towards management problems, satisfying citizens' demands, and generating shared public value. However, some uncertainties about the perils, biases, and errors caused by AI and its long-term impacts are still unknown. Governments have started to automate their processes with intelligent algorithms and cognitive machines [24, 53]. For instance, in the U.S, machine learning algorithms are starting to be used for legal processes [44]. In China, algorithms are used for predicting policing [42]. In U. K., facial recognition identifies people on the street [28]. Nevertheless, government decision-making based on AI is critical and in its infancy. For this reason, this research aims to explore state-of-the-art government decision-making based on AI, guided by the research question: How is government decision-making grounded on artificial intelligence (AI)? With this, it is intended to advance knowledge about the implications and challenges (specifically organizational and environmental factors, goals, benefits, and risks) of AI in government decisions and bounded rationality.

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The structure of the paper is as follows. The second section aims to further the relationship between AI and government decision-making based on four categories (organizational and environmental, goals, benefits, and risks). The third section presents the systematic literature review. The fourth section analyzes three cases and discusses findings. The final section presents some conclusions and future direction.

2 UNDERSTANDING GOVERNMENT DECISION-MAKING BASED ON ARTIFICIAL INTELLIGENCE

With time, the capacity to decide has become more complex, requiring new knowledge and various tools (management, statistics, and technology) to support the technical, psychological, and organizational aspects during decision-making [22]. The complexity of decision-making in public organizations is greater when its purpose involves other people or could affect welfare. In this regard, decision-makers must operate with legitimacy and clarify fundamental aspects of the content and form of the decision, especially when new technology such as AI is incorporated. The design, implementation, and use of technologies in organizations have been analyzed from socio-technical perspectives that consider organizational, environmental, and technological factors, as well as the technology-organization interaction outcomes [17, 32, 43]. These factors must consider in a precise way the organizational internal and external aspects, goals, benefits, and risks of each decision [34].

This section conceptualizes decision-making and AI techniques and presents four categories to analyze government decision-making based on AI.

2.1 Decision-Making and Artificial Intelligence Techniques

2.1.1 What is Decision-Making? A key aspect of organizational management is decision-making. It involves a strategic exercise to select a way forward among several possibilities within organizations. The decision-making process requires estimating the alternatives' consequences, precision, and efficiency. For this reason, the more likely it is to achieve the desired effect, and the more efficient it is, the better the decision will be [38].

For Simon [40], rational decision-making consists of choosing the alternative that produces the best outcome immerse in bounded rationality. Individuals are not just limited rational because he/she does not know the total number of options or the total number of consequences, but also considering that he/she does not know the total number of expected alternative outcomes. Given the existence of non-programmed and programmed decisions throughout the organization, these last ones being the most abundant, the processes in which the actors are involved are decision-making processes (decisions' sequential set) [39].

In the public sector, decision-making plays a fundamental role in the success of projects, namely budget decisions, criminal penalties, fiscal policy, and natural resources conservation. More and more governments worldwide visualize AI implementation's benefits for assistance in decision-making [46]. AI could store, analyze, and disseminate information for a specific purpose in decision-making [5]. For some, AI-driven decisions could be less bureaucratic and trustworthy [21], but on the other hand, they can be inflexible, opaque, and manipulated.

2.1.2 Artificial Intelligence Techniques Overview. AI as science aims to approach the living beings' behavior, both cognitively and mechanically. Each AI technique represents a specific application for decision-making assistance. However, some AI-based applications embraced one or more techniques. For instance, the robots to combat the pandemic caused by COVID-19 are a combination of techniques such as robotics, natural language processing (NLP), machine learning (ML), and computational vision [37].

The AI potential in organizations can aid in information discovery, prediction, automation of mainly routine tasks, and new models design and simulation that could improve decision-making and organizational efficiency [46]. Some specific AI applications deal with ML allowing algorithms to generalize answers from data, inducing "computational knowledge." Artificial life involves studying life and environments that exhibit the qualities of living things in simulation environments. NLP is used to improve human-machine and even human-human communication and can be used for government-citizen interaction. Genetic algorithms are an evolutionary technique that allows multivariate and multiobjective optimization and heuristic search [31]. These are some examples of AI techniques but there are some others, which in combination, could assist in process optimization, workforce activities, and as an assistant for decision-making.

2.2 Analysis on government decision-making based on artificial intelligence

2.2.1 Organizational and environmental. There are notable differences in the decision-making process made within public organizations versus the private sector. For example, private companies' procedures tend to be more agile, while public organizations face interruptions, even conflicts that limit their decision-making processes. In addition, the objectives pursued by both organizations underlie their decision-making processes. The primary role of private organizations is to generate returns for their shareholders, while the public sector should focus on providing public services [15].

The literature on public decision-making has demonstrated several biases in human judgment that take it away from the rational model of decision-making [11]. Decision-makers constantly resort to non-systematic methods, using their judgment, appreciation, and intuition, or deciding at their convenience. Likewise, they often show a power's position, limiting the opinions exchanged, and ignoring professional arguments [3].

Over time, governments have sought to improve decision-making through rigorous analysis of public programs and services. For instance, the evidence-based management movement and the result-based public sector management aim to minimize the practical limitations of traditional rational processes, legitimate decision-making processes, and resource optimization [19]. The recent discussions focus on using reliable information and rigorous methodologies to ensure decision quality.

Nowadays, in the knowledge era: data and information are decisive in decision-making and public policy. Also, environmental data is so abundant, and governments must have the motivation

*(("**Artificial Intelligence**" OR "Algorithms" OR "Artificial Vision" OR "Artificial Life" OR "Autonomous Vehicles" OR "Expert Systems" OR "Classification Systems" OR "Robotics" OR "Artificial Neural Networks" OR "Pattern Recognition" OR "Virtual Reality" OR "Data Mining" OR "Machine Learning" OR "Fuzzy Logic" OR "Natural Language Processing" OR "Deep Learning" OR "Sentiment Analysis" OR "Genetic Algorithms" OR "Intelligent agents") AND ("**Government**" OR "Public Sector" OR "Public Administration" OR "Public Policy") AND ("**Decision Making**" OR "Decision-Making")).*

Figure 1: Logical search performed in Web of Science and Scopus

and technical capacity for its analysis. At this point, AI has opened a range of opportunities as a methodological option to enhance the use of all this information in public sector decision-making [3, 19, 20]. AI and its diverse techniques and applications are gaining more and more ground in public sector decision-making and public policy.

2.2.2 Goals. Governments worldwide are keen on providing solutions based on AI to generate public value and improve service quality. Also, AI techniques could improve data interoperability and Big Data analysis.

However, one of the most analyzed issues is AI governance providing an ethical, moral, and non-discriminatory sense. Thus, several countries and international organizations have devoted themselves to generating guidelines on AI use. Among the goals identified in these practical tools are equity, legality, accountability, efficiency, productivity, citizen centricity, service quality, participation, democracy, and the benefit of society [33, 35, 49].

2.2.3 Benefits. There is a tendency among some researchers and practitioners towards AI adoption: cyber-optimism, where the possible AI benefits and advantages are exacerbated. Cyber-optimists foresee possible outcomes related to efficiency, accuracy, and process automation [4].

As a result, AI could empower creative activities, freeing workers to perform non-value-adding operational tasks [29]. In addition, with big data exploitation, it may be possible to generate scenarios and predictive models useful for strategic decision-making [45, 46]. Finally, AI ethical usage can improve transparency, accountability, productivity, and service's quality for public value creation [10, 47].

2.2.4 Risks. In contrast to the previous trend, an ideology that may be more objective is cyber pessimism, when some risks are exposed. Currently, with the AI's existent and limited potential, several pitfalls are of concern for decision-makers and designers of AI-based systems [6].

Data quality and legacy biases in AI-based models are a peril for decision-making, as biased decision-making, or high error levels can result. Automated manipulation and discretion by AI are other threats found when implementing AI in government [50]. There are also problems related to algorithmic opacity and the lack of explainability of some AI-based techniques and systems [24], which is aggravated in government decision-making based on AI [9, 18].

3 STATE-OF-THE-ART GOVERNMENT DECISION-MAKING BASED ON ARTIFICIAL INTELLIGENCE

This section shows a systematic literature review based on the PRISMA approach and presents the state-of-the-art characteristics.

3.1 PRISMA Method

This section conducts a systematic literature review in Web of Science and Scopus using the PRISMA approach. The paper identification process consisted of 4 steps:

Stage 1: Identification

In this stage, a logical paper search was performed in Web of Science and Scopus. We decided to use these two scientific platforms as they contain articles found in the most influential journals worldwide.

We filtered the documents only for business, economics, public administration, management, and political science areas. The logical search applied to topics (titles, abstracts, keywords) included techniques related to AI and synonymous related to the public sector and decision-making.

We found 353 papers by performing the logical search (Figure 1):

At this phase, we discarded 206 documents not belonging to the government area (e.g., computer science and private sector) or that were repeated. We left 147 papers.

Stage 2: Screening

In the second stage, a screening of the titles and abstracts was performed, and 73 papers unrelated to AI and decision-making in government were excluded. We only included the papers that analyzed AI-based decision-making in the public sector, which did not include other technologies such as Big Data, the Internet of Things, or information technologies. In addition, we discarded some papers that focused on specific sectors (e. g. agriculture and transportation) that did not contribute to our purpose. We left 74 papers.

Stage 3: Eligibility

At this stage, 74 documents were analyzed. After analyzing the full-text documents 37 articles were left.

Stage 4: Included

Finally, we identified 37 articles on state-of-the-art government decision-making based on AI (Figure 2).

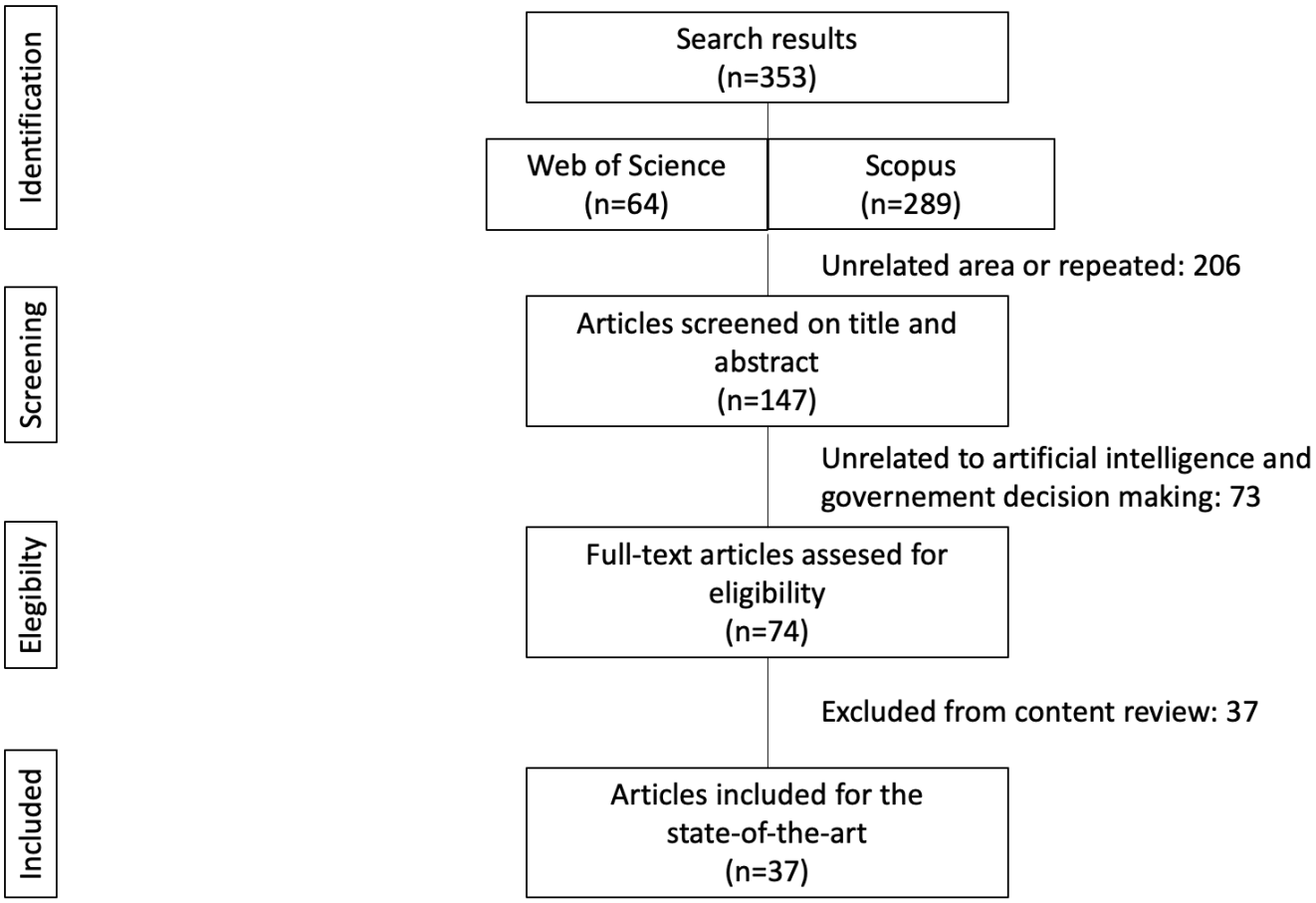


Figure 2: Paper selection process based on PRISMA methodology

3.2 Characteristics of the Studies

Table 1 shows the state-of-the-art government decision-making based on AI analyzing the four categories established during the literature review: 1) Organizational and environmental factors (O&E), 2) Goals, 3) Benefits (B), and 4) Risks (R).

The first state-of-the-art paper dates back to 1994. However, up to the 21st century's first decade ending, government decision-making based on AI increased the research interest. At the beginning of 2017, a boom in the study started, which coincides with the interest in studies related to AI public sector (Figure 3).

In the state-of-the-art government decision-making based on artificial intelligence, 2 of the papers are conference proceedings, and 35 belong to high-impact journals. Technology in Society is the journal with the most documents; there are other papers in influential journals such as Policy Sciences, Public Administration Review, Technological Forecasting and Social Change, and Government Information Quarterly (See Appendices).

4 FINDINGS

This section briefly analyzes three cases of government decision-making on AI and discusses findings.

4.1 Cases on Government Decision-Making based on Artificial Intelligence

This section maps AI-based decision-making for three international cases selected because they are in countries with significant progress in the AI area (Table 2).

4.2 Discussion

AI is an emerging science and technology that has the promise to surpass human beings' behavior. However, in our analysis, this situation is still distant, as it has served as a support in specific and routine activities without reaching deep structures of the decision-making processes in public organizations [14]. Furthermore, much decision-making problems are immersed in bounded rationality, improvisation, and ethical dilemmas [36]. AI can give greater certainty in decision-making by providing scenarios, simulations, and information to emulate situations, improve effectiveness, and process a large amount of data.

In state-of-the-art government decision-making based on AI, one topic is related to organizational and environmental aspects such as changes in automating processes with AI, the generation of errors, the replacement of civil servants by robots and machines, as well as

Table 1: Papers included to AI and Government Decision-Making (n = 37)

Authors	Title	O&E	Goals	B	R
(Ahmad, 2020)	Refugees and Algorithmic Humanitarianism: Applying AI to RSD Procedures and Immigration Decisions and Making Global Human Rights Obligations Relevant to AI Governance	X	X		X
(Barcellos de Paula & Marins, 2018)	Algorithms Applied in Decision-Making for Sustainable Transport	X	X	X	
(Benčina, 2007)	The use of fuzzy logic in coordinating investment projects in the public sector	X	X	X	
(Bullock, 2019)	Artificial Intelligence, Discretion, and Bureaucracy	X		X	X
(Busuioc, 2021)	Accountable Artificial Intelligence: Holding Algorithms to Account	X	X	X	
(Capdeferro Villagrasa, 2020)	La inteligencia artificial del sector público: desarrollo y regulación de la actuación administrativa inteligente en la cuarta revolución industrial	X	X	X	X
(Caron et al., 2020)	Gouvernance municipale et information: étude exploratoire sur l'utilisation optimale des données 311	X	X	X	
(Cheaitou et al., 2019)	Decision making framework for tender evaluation and contractor selection in public organizations with risk considerations			X	X
(Cobbe et al., 2020)	Reviewable Automated Decision-Making: A Framework for Accountable Algorithmic Systems	X			X
(Cox, 2019)	Muddling-Through and Deep Learning for Managing Large-Scale Uncertain Risks				X
(Di Vaio et al., 2022)	Data intelligence and analytics: A bibliometric analysis of human-AI in public sector decision-making effectiveness	X	X	X	X
(Dickinson & Yates, 2021)	From external provision to technological outsourcing: lessons for public sector automation from the outsourcing literature	X		X	X
(Dwivedi et al., 2021)	AI(AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice, and policy	X	X	X	X
(Galaz et al., 2021)	Artificial intelligence, systemic risks, and sustainability	X	X	X	X
(González et al., 2017)	Fuzzy Logic in The Design of Public Policies: Application of Law	X	X	X	
(Green & Chen, 2021)	Algorithmic Risk Assessments Can Alter Human Decision-Making Processes in High-Stakes Government Contexts	X		X	X
(Hartmann & Wenzelburger, 2021)	Uncertainty, risk, and the use of algorithms in policy decisions: a case study on criminal justice in the USA	X	X	X	X
(Hemphill & Kelley, 2021)	AI and the fifth phase of political risk management: An application to regulatory expropriation	X		X	
(Henman, 2020)	Improving public services using artificial intelligence: possibilities, pitfalls, governance	X		X	
(Ingrams et al., 2021)	In AI we trust? Citizen perceptions of AI in government decision making	X		X	X
(Juan et al., 2010)	Optimal decision making on urban renewal project	X		X	
(Kaun, 2021)	Suing the algorithm: the mundanization of automated decision-making in public services through litigation	X	X	X	
(Kim et al., 2021)	Platform Government in the Era of Smart Technology	X			
(Kuziemski & Misuraca, 2020)	AI governance in the public sector: Three tales from the frontiers of automated decision-making in democratic settings	X	X	X	X
(Lee & Lim, 2021)	From technological development to social advance: A review of Industry 4.0 through machine learning	X	X	X	
(Minetto et al., 2021)	Measuring Human and Economic Activity from Satellite Imagery to Support City-Scale Decision-Making during COVID-19 Pandemic			X	
(Nathan & Hyams, 2021)	Global policymakers and catastrophic risk				X
(Raikov, 2018)	Accelerating technology for self-organizing networked democracy			X	
(Sætra, 2020)	A shallow defense of a technocracy of artificial intelligence: Examining the political harms of algorithmic governance in the domain of government	X		X	X
(Sarma, 1994)	Decision-making in Complex System		X		
(Saveliev & Zhurenkov, 2021)	AI and social responsibility: the case of the AI strategies in the United States, Russia, and China	X	X		

Authors	Title	O&E	Goals	B	R
(Suksi, 2021)	Administrative due process when using automated decision-making in public administration: some notes from a Finnish perspective	X			
(Tavakoli & Hosseini Nourzad, 2020)	Win-win pricing method for BOT projects using a simulation-based evolutionary optimization	X	X	X	
(Taylor, 2019)	AI in Defense	X		X	X
(Valle-Cruz, Fernandez-Cortez, & Gil-García, 2021)	From E-budgeting to smart budgeting: Exploring the potential of AI in government decision-making for resource allocation	X	X	X	X
(Young et al., 2021)	AI and Administrative Evil	X			X
(Zhang et al., 2021)	Factors influencing the use of AI in government: Evidence from China	X	X		X
Total		31	19	27	20

Source: Own elaboration.

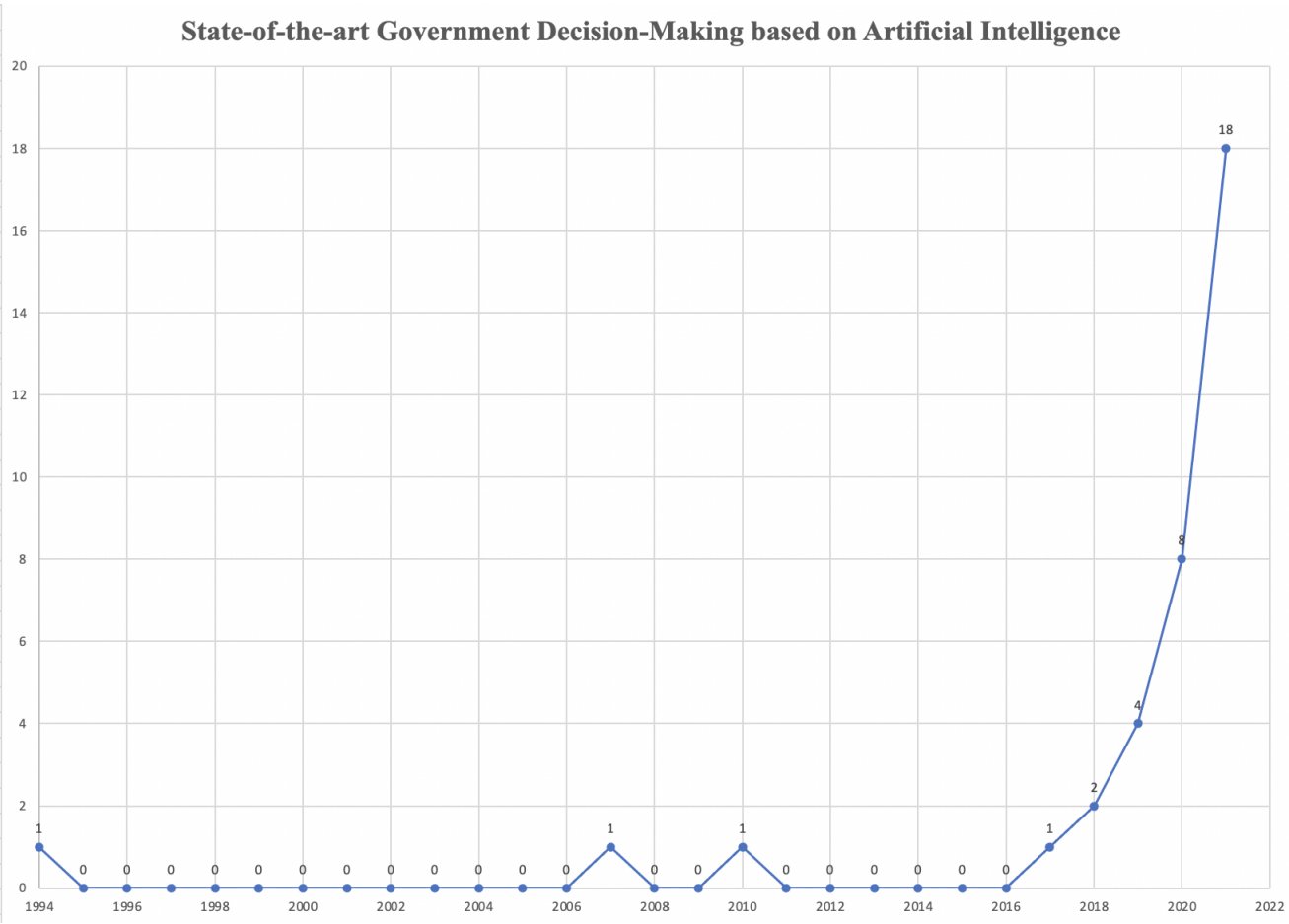


Figure 3: Frequency of papers related to AI and government decision-making (1994-2021)

collaboration with the business sector and some NGOs to enhance AI use for the benefit of society. Some of these arguments are in the cases analyzed; for example, in the use of algorithms in criminal justice in U. S., there is an attempt to reduce uncertainty and subjectivity in data analysis, make more transparent decision-making, and avoid negative consequences for society [51]. Another example of China's use of AI to combat the COVID-19 pandemic is the possible AI-human collaboration and even the medical personnel substitution in some activities [12, 41].

The second topic is the benefits, especially concerning efficiency, error reduction, transparency, 24/7 customizable services, pattern

Table 2: Cases on Government Decision-Making Based on Artificial Intelligence

Case		Use of Algorithms in Criminal Justice in U. S. [7].	AI use in the generation of public policies in the Netherlands [27].	China's Use of AI to combat the COVID-19 pandemic [1, 25]
Decision-Making and AI Techniques	Decision-Making	Optimal application of justice. Suppress biases of human decision-making.	AI Innovations. AI can support policymaking-based evidence.	AI has the potential to address wicked problems. Agile and innovative decision-making.
	AI Techniques	ML.	ML.	Robotics, drones, facial recognition, ML.
Government decision-making based on AI	Organizational and environmental	Routine use of technology and the proliferation of purposeful data for decision-making.	Humans and machines complementation. Knowledge and experience to meet standards in public policy. Transparency, trust, equality, ethics.	AI technologies can facilitate AI-human collaboration.
	Goals	Achieve fair outcomes and facilitate them by algorithmic decision-makers.	Capitalize on long-term social benefits and economic opportunities safeguard public interests,	Prevention and control.
	Benefits	Improve the ability of justice system employees to identify relevant information, detect crime risks, and improve justice delivery performance.	Process large amounts of data, quickly and consistently. Improve public services and work processes.	Increased effectiveness.
	Risks	Risk in use and interpretation. Discrimination.	Bias, subjectivity, opacity, and amplification of social inequalities.	Massive surveillance.

detection, simulations for decision-making, and thus public value generation. In the analyzed cases, we identified an improvement in relevant information identification for better decision-making, transparency, fairness, the increase in efficiency, early warning, traceability, and prevention [8].

Although it is a critical issue, the third topic is related to risks. Scientific studies mention some dangers of inequity, discrimination, racism, unfairness, systematic manipulation, opacity, and algorithmic biases. The analyzed cases have evidence of racist bias risks [26] to job performance, privacy, and human rights violation [16].

Finally, the fourth topic concerns goals, which has been a proposed topic in ethical strategies or guidelines on AI [33, 35, 52]. Some of the most relevant aspects identified in the scientific literature are related to the benefit of society, automation, service efficiency, and public value generation. The AI cases show goals related to improving decision-making, public services, and sharing high-quality and accurate information with the public.

5 CONCLUSIONS AND FUTURE WORK

This paper contributes to understanding what government decision-making based on artificial intelligence looks like. Although some relevant studies address the issue in the public sector, they do not focus exclusively on AI-based decision-making. This paper aims to explore state-of-the-art AI government decision-making. To enrich the study, we briefly analyzed three international cases. Results show a study increase in AI-based decision-making, seeking the benefit of society but also avoiding its imminent dangers by unscrupulous or manipulated use. In addition, the findings may highlight the existing gap for public sector managers and decision-makers to engage in the subject and, in the not-too-distant future, improve the likelihood of success in the implementation and use of AI in decision making.

Future work will conduct a more exhaustive case analysis and the addition of new research (theoretical and empirical) to gain a deeper understanding of government decision-making based on AI, contributing to an AI-decision-making framework. This type of analysis has the potential to be useful for practitioners and researchers interested in the design, implementation, and AI strategic use in the public sector.

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A APPENDICES

Table 3: Journals and conferences containing AI and Government Decision Making topic.

Journal	Papers
Technology in Society	3
Policy Sciences	2
Public Administration Review	2
Technological Forecasting and Social Change	2
American Review of Public	1
AI and Law	1
Asia Pacific Journal of Public Administration	1
Canadian Public Administration	1
Computer Law & Security Review	1
Construction Management and Economics	1
Economic Computation and Economic Cybernetics Studies and Research	1
Futures	1
Government Information Quarterly	1
IEEE Transactions on Big Data	1
Information Communication and Society	1
International Journal of Information Management	1
International Journal on Minority and Group Rights	1
Journal of Benefit-Cost Analysis	1
Journal of Cleaner Production	1
Kybernetes	1
Management Decision	1
Perspectives on Public Management and Governance	1
Policy and Internet	1
Public Management Review	1
Revista de Internet Derecho y Política	1
RUSI Journal	1
Socio-Economic Planning Sciences	1
Systems Practice	1
Telecommunications Policy	1
Thunderbird International Business Review	1

Source: Own elaboration

The Impact of Data Governance on OGD Publication – An Ethnographic Odyssey

Auriane Marmier
Swiss Graduate School of Public Administration (Idheap), University of Lausanne, Rue de la Mouline 28, CH-1022 Chavannes-près-Renens
auriane.marmier@unil.ch

ABSTRACT

Over the past decade, Open Government Data (OGD) strategies have become a continuing concern in administrative services. This is even truer than at any time. Given the current situation, data management, specifically consistent data publication, has been central to public institutions. The Covid-19 pandemic has shown that data collected by public administrations could make valuable contributions. However, in Switzerland, the pandemic has highlighted the limitations of public organizations' capability to lead the publication of their data. Based on an ethnography and a literature review, this paper explores how data governance components impact OGD publication process and presents a model of OGD governance. For this purpose, we identify key data governance components necessary to OGD publication - structural, procedural, and relational - and illustrate how OGD challenges rarely arise from the publication of OGD or the open nature of data itself, but a lack of data governance.

CCS CONCEPTS

• **Information systems** → Data management systems.

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1 INTRODUCTION

With the emergence of the open government policy under the Obama presidency, Open Government Data (OGD) - which are transformed government data to be openly published, shared, and reused by anyone for any purpose - became a continuing concern in worldwide administration services. The Washington Post recently reported that business groups, including the Software Alliance, the Information Technology Industry Council and the Internet Association, pressure the Biden administration to coordinate open data efforts across the government [1]. From an academic perspective, many authors such as [2] and [3] claimed that open access to government data has increased rapidly and represents a growing part of government management activities. Due to their daily activities, governments not only collect and create a plethora of data, but they also appear as the central actors in charge of these strategic assets [4]. This is even truer now than at any time. The Covid-19 pandemic provides concrete examples and has shown that public administrations' data might help better understand the situation, identify clusters, and plan adapted measures [5]. Moreover, the pandemic has also demonstrated how necessary the availability and exchange of data in crisis management has become. While collecting data has always been a structural component in public organizations occupations, the Covid pandemic recently reveals limitations of data handling in public organizations. [6] notably state that government test results may contain numerous errors, and it is unclear if these data provide valuable information to decision-making and generate value [7]. In the same vein, leading media outlets describe a chaotic data collection and information exchange situation. In Switzerland, the country where this study originates, there seems to be a lack of interoperability between the Federal Government and lower-tier administration (i.e. the 26 Cantons the Swiss's administration is divided in), skills deficit as well as a lack of communications between the actors concerned [8]. In many cases, disciplines, practices, tools, and techniques for collecting, cleaning, and organizing government data seem different. This makes data ownership, strategies as well as data publication, among others, often unclear, adding new data management and governance complications [4, 7] and leading public sectors organizations face an increasing number of OGD challenges [9].

Although there is a growing body of literature on OGD publication regarding sociological, technical, and legal challenges [7, 10-15], few papers consider data governance as the root of the problem. Based on an in-depth literature search, [16] define data governance as *"a cross-functional framework for managing data as a strategic enterprise asset. In doing so, data governance specifies decision rights and accountabilities for an organization's decision-making about its data. Furthermore, data governance formalizes data policies, standards and procedures, and monitors compliance"*. Recognize as the main challenge in (big) data value creation, data governance provides organizations insights and information necessary to run a data-driven organization [9] and appears relevant for facilitating open data use [17]. [18] highlighted that only effective data governance may allow value creation, and Soares [19] stated that to leverage data as valuable assets, people, processes, and technologies must be effectively managed through data governance programs [9]. [20] describes a data governance program as a framework providing data security, allowing data policies and standards development,

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and thus assisting decision-makers. While data governance receives increasing attention in the private sector as an appropriate solution to resolve organizational issues with data [7], so far, little is known regarding the impact of data governance on OGD publication [21]. [22] show that only three percent of the data governance papers written between 2007 and 2017 focus on the e-government research field. Hence, we believe that the publication of government data in open access is not the only reason that makes public organizations overwhelmed by OGD publication, but that OGD barriers find their origins deeper in data governance issues. Based on an extensive review of the literature on OGD and data governance and combined with an ethnography inquiry, this paper attempts to formulate theoretical assumptions in order to develop an OGD governance model. In doing so, we seek to extend the current discourse and better understand to what extent data governance practices may impact the publication of OGD [4]. Accordingly, we aim to answer the following research question:

- To what extent do data governance practices impact the OGD publication?

For this purpose, we first discuss the data collection approach of both literature review and ethnography as well as the data analysis. Then, to make the ethnography easier to understand, we present the context in which it happened. In the fourth part, we present and discuss results by cross-checking the findings of existing literature with the analyses of ethnographical data collected. In doing so, we seek to identify the crucial data governance practices and their effects on the OGD publication process. This step allows us to define convergences between the theory and the practice and formulate eleven hypotheses clustered in three majors' components. Finally, we conclude this paper by presenting our OGD governance model.

2 METHODOLOGICAL APPROACH

2.1 Data collection

To a better knowledge of data governance practices and their potential impacts on the OGD publication, we conducted a comprehensive literature review on two types of publication (Table 1). We first examined (i) practice-oriented publications, i.e. relevant official documents such as *Swiss OGD strategies*, *cantonal strategy*, *legislative agenda* [29-31], *reports of the European Commission [32, 33]*, as well as (ii) scientific literature on OGD and data governance. From a practice-oriented publication perspective, we led research throughout the project and focused on the city and cantonal websites and the Swiss and European OGD platforms. We notably researched with different web browsers, using keywords such as *data governance strategy, OGD strategy, or data governance practices in Switzerland*. From a scientific publication perspective, we conducted a systematic literature review in September 2021 and integrated materials published between 2001 and 2021 on two platforms - *Web of science* and *AIS library*. We considered these two platforms a good starting point to study data governance state of knowledge given that the first tends to regroup public administration papers while the latter clusters literature on Information System (IS) research. On both platforms, we used the two following search strings - "*data governance" AND "public sector"*, and *"Open Government Data" OR "open government data"*. As a result, we found a total of 496 papers. After removing duplicates, editors' comments, and introductions to mini tracks, we finally obtained 464 scientific papers. To further reduce the number of relevant papers, we created an excel database including an ID, the title and the abstract of the papers, authors' name, and year of publication, in which we made a key words research. Thus, we were able to selectively focus on papers that contained the terms "open data","data governance" and "data governance practices" words in their abstract. This operation leads us to focus on 22 papers intensely.

In order to identify the daily practices of municipal departments involved in the OGD municipal sample preparation process and closely investigate their mechanisms, we conducted an ethnographic inquiry. Ethnography is described by [23] as a methodological and practice-based approach that seeks to pinpoint human interactions with other humans, objects, environment or institutions to better understand their operations. According to many authors, this qualitative research design facilitates exploration in a real-life context of departments and strongly contributes to pinpointing fractures and rifts workers [24-26]. Furthermore, through multiple sources of evidence, ethnography aims to describe both the group members' point of view and the perceptions and interpretations of researchers [27]. Hence, for a researcher, ethnography allows exploring the roles of departments members, their actions and contributes to a better comprehension of the flow of organizational activity, events, and dynamics in their daily work [26, 28]. Therefore, to observe how the OGD publishing process works and from a more global perspective to understand better how municipal departments apprehend management and data governance, we participated in six meetings, exchanged hundreds of emails, and participated in one hackathon. We collected data using direct observations and unstructured interviews realized during this period with three housing department members and three IT department members supporting digital initiatives (Table 1). In addition, as recommended by ethnography literature, we kept a logbook. [24] argued that an ethnography logbook helps limit participants' perceptions and provide researchers with objective information. In the logbook, we resumed and described interactions with department members, registered the meeting minutes, and added a copy of the email exchange. We also included the results of our observations (e.g. feelings).

2.2 Data Analysis

To analyze data collected through the review of material published, the ethnography, and thus deeper understand the data publication process, we followed a content analysis approach [34]. According to scholars, the content analysis approach is generally used to examine qualitative data such as interviews, semi-structured interviews, documents but can also be applied to various nonverbal data, such as feelings or gestures [35-37]. In doing so, this approach allows to analysis a large amount of data by revealing different categories. Furthermore, as the qualitative content analysis also focuses on the underlying meaning of words [38], this analysis is especially useful for understanding more profound a phenomenon [39]. To this end, we thus followed a well-defined step-by-step process proposed by [35]. We started by studying data governance practices mentioned in the literature. As recommended by the authors, we first familiarized ourselves with the data by reading and rereading material and

Table 1: Data gathering

Field Data	Literature sources
Meetings minutes	Scientific papers:
Direct Observations	AIS Library
Unstructured interview	Web of Science
Logbook	Practice – oriented publications:
Emails	European commission reports
Information models	Cantonal and Federal digital strategies
Database extractions	Legislative agenda

Table 2: Definitions and references of data governance components

Definition	References
Structural components refer to the roles and responsibilities of a public organization and the allocation of decision-making authority from a data governance perspective.	[19] [51] [52] [53] [54] [55] [56] [57] [58] [59] [60] [61]
Procedural components comprise data strategies, policies, standards, processes, and procedures that provide data to be appropriately recorded, maintained safely, exploited effectively, and shared adequately.	[16] [19] [51] [52] [53] [54] [55] [56] [57] [58] [59]
Relational components relate to business alignment, employee competencies and organizational culture that support decision-making.	[16] [17] [19] [59] [60] [61] [63] [64]

keeping an eye on the recurrent information. This enabled us to identify the essential practices for the success of data governance programs. However, while the literature comprises similar data governance practices, the semantic diversity of terminology hampers information understanding and makes compilation and analysis difficult. To address this issue, we followed the results of [16], which gathers the different practices observed in the literature under three major data governance components - structural, procedural and relational (Table 2).

To study the ethnographic results, we also applied the content analysis approach. Following the same logic, we first familiarized ourselves with the content of the ethnographic material. Then, from the initial information noted in the first step, we generated a code for the information that seemed relevant. Next, we organized previously defined codes according to components highlighted in the literature review. Finally, to examine to what extent practices observed in the literature and during our ethnography were convergent, we applied the triangulation technique [40]. This enabled us to cross-check the ethnography inquiry data against scientific and practice-oriented literature and thus compare theoretical perceptions of data governance practices with actual municipal practices.

While the term triangulation may lose some clarity when it refers to science methodology [41], it is a metaphor that describes a technique allowing the investigation and comprehension of a situation from several perspectives [42-45]. Based on the cross-checking of different data sources such as quantitative survey, participant observation, historical analysis, comparison and discourse analysis [42], the triangulation technique is used to increase the validity and trustworthiness of the results [43]. By comparing multiple data sources, triangulation pinpoints convergence or divergence in data collected [45, 46]. The triangulation technique allows ethnography to thus struggle with bias implied by a single source of data or method as well as improve the veracity of the study [42, 47, 48]. Thus, as many authors in organizational research [45], geographical studies [44] or computer science [46], we triangulated obtained results in our ethnographic observations, practice-oriented literature and academic studies.

Before discussing the results obtained by triangulation, we describe the context of our ethnography in the next part. While ethnography appears well suited to investigating specific social and cultural phenomena, the inquiry's contextualization is needed to better understand them.

3 CONTEXT

In Switzerland, discussions to make government data publicly available appeared for the first time in the E-Government Strategy 2008-2015 [49]. After that, the Federal Council developed a new strategy for "*an information society in Switzerland intending to optimize information resources*" [50]. In this context, several initiatives concerning data availability have been launched, followed by creating the first Swiss Open Data Strategy, known as "Strategy OGD 2014-2018" [50]. This strategy notably pursued objectives such as encouraging innovation and economic growth, fostering transparency and participation of citizens, and increasing the efficiency of public administrations on all political levels [51]. In line with prior researches [e.g. 52, 53], the Swiss Federal Council considered that the best way to achieve the strategic objectives of the OGD was to develop a national OGD platform that made public data accessible

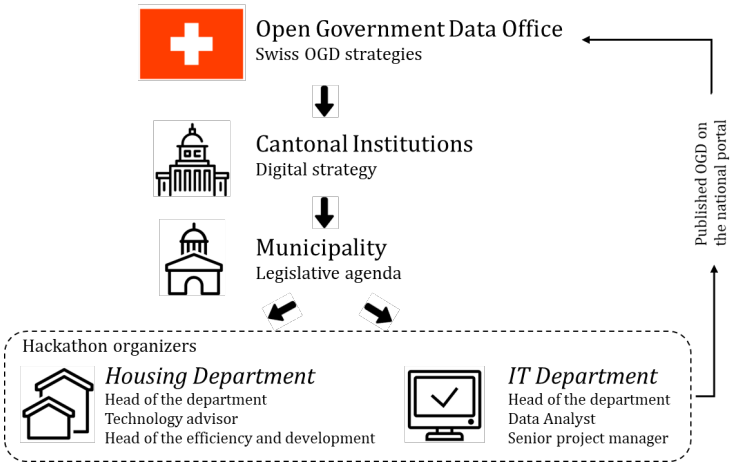


Figure 1: Context and actors of the ethnography

to a wide range of individuals. As a result, in 2016, the Swiss Federal Council ordered the development of an OGD platform [30]. However, as advanced by several scholars and confirmed by the strategy results, focusing only on technical aspects was not sufficient to support the utilization of OGD. Consequently, the "Strategy OGD 2014-2018" evaluation revealed that the strategy's objectives were only partially met [54]. Despite implementation costs approaching several million, the commitment of public service actors only enabled the development of critical infrastructure elements intended to host public administration data. Following the experience of the first strategy, the Swiss Confederation revised its objectives and encouraged joint planning and harmonization of activities related to the publication of data, the creation and use of a central register of official data. In addition, the 2019-2023 strategy for developing OGD has become more active in drawing up the legal framework, improving data quality and describing metadata [54].

When the OGD publication project discussed in this paper took place in 2018, the first national OGD strategy had just ended, and the objectives of the second strategy were under discussion. In this context, the Canton of Vaud launched its digital strategy to promote innovation and position the Canton as a *data territory*. To this end, the Canton of Vaud intends to concentrate its actions on five cross-cutting and interrelated themes, including developing an open data policy. The central city of the canton naturally decided to align its digital city strategy with the objectives of the Canton. In this sense, the city decided to organize a Hackathon in May 2019 to boost the implementation and deployment of the open data policy (Figure 1). The purpose of the hackathon was to show public service employees and citizens specific applications of the OGD. For this purpose, the IT department planned the development of an OGD sample from municipal departments data, notably through the understanding of data, the identification of those that deserve interest, their description, and the search for appropriate anonymization rules. In doing so, the IT executive considered this hackathon as a preview to better understand what the OGD publishing process involves. Following a smart city policy, the housing department participated in the project. Consequently, personnel of the IT department, with the collaboration of the housing domain experts, engaged in the OGD samples preparation so that hackathon participants could use them. Given that one objective of the city was to strengthen political commitment to partnerships between its departments and the University, we joined the project as open data experts to prepare an OGD municipal sample in September 2018.

4 FINDINGS AND ANALYSIS

The triangulation technique has rapidly pinpointed that the data governance practices promoted in the literature often appear to be OGD publication challenges in ethnography. Based on these observations, we present and build our hypotheses through the three components previously identified – structural, procedural, and relational.

4.1 Structural Components

Results of the literature review show that practices such as the role and responsibilities of stakeholders as well as decision-making authorities [55] received particular attention. Clustered under the term *Structural components* and frequently called *organizational data structure* [19, 56], *standardization* [57] or *formalization [58]*, several authors stressed that the distribution of roles and responsibilities is a crucial factor of data governance [59-64]. [63] proposed the establishment of data roles and responsibilities as one of its critical success factors. According to the author, the first step to guaranteeing a successful data-driven strategy should be to establish distinct roles and responsibilities attached to any data governance activities. While literature does not provide a common understanding of roles and responsibilities [16, 65, 66], there is a consensus that IT guys cannot handle data alone (and even less published as OGD). In this sense, the literature strongly recommends establishing a global data governance office, with at least a data governance leader and data steward from different organization domains to support data-driven activities, from acquisition, management and storage to re-utilization [67].

However, the results of our ethnographic inquiry show that the role and responsibilities of the individuals involved in the project were not well defined, and data-related activities were still de facto considered IT duties rather than as a global management discipline. Although departments discussed the project's objectives and proposed some actions, we never defined or understood each actor's roles and responsibilities. For example, as data producers, the housing domain experts were committed to making data collected by their department available to the IT department to perform anonymization tasks. Nevertheless, there were no more specific tasks than "making data available" and "finding anonymization rules" assigned to project participants. Moreover, we did not notice any data steward, data officer, or decision-maker appointed to lead this project, leading to decision-making issues. While the data producer department looked skeptical about giving data access, nobody could force them to share information relative to their data. Given this lack of decision-making responsibility, we did not access databases and metadata. Thus, we have not been able to anonymize data, which considerably affected the initial project and led members of the IT department to take part in the hackathon as participants. Consequently, in this OGD publication project, the absence of roles allocation with no authority for decision-making negatively affected the project's progress and achievements.

Thus, we believe that the enforcement of structural data governance practices such as *the roles and responsibilities of a public organization and the allocation of decision-making authority* positively affect the publication of OGD. [59] explained that these components are extensively reported in data governance frameworks to foster quality, value, and suitable data reuse. Especially, the leading roles of data governance bodies such as who is responsible for data-related activities (e.g. data producer, owner, publisher), who decide processes and policies to implement (e.g. data stewardship) and who assign data activities' duties (e.g. data governance office) [58, 63, 68]. Therefore, this leads us to present three first hypotheses:

- H1: The OGD publication is positively affected by the definition of roles
- H2: The OGD publication is positively affected by the distribution of responsibilities
- H3: The OGD publication is positively affected by a decision-making authority

4.2 Procedural Components

Our findings also show that although procedural components have been widely studied in OGD barriers literature, especially, data quality standards, metadata procedures, data platforms and infrastructures as well as described as enablers of OGD sharing [12-14, 69, 70], the existence and application of clear policies, process and standards remain largely insufficient. The small data and information collected by the IT personnel confirm this idea. They were incoherent, unclear, and poor quality (e.g. reports, links to websites). When the IT department requested information or metadata, it received an Excel file like an empty survey with no explanation. Then we received what was supposed to be a relational model (i.e. how data are stored in a database) in PDF file forms. Many variables had neither names nor inscriptions to understand the file. It was just a complex mix of numbers and strange characters (e.g. X22H6T8) in thousands of boxes. One of the researchers mentioned: *"I have tried to "understand" the structures, and it seems almost impossible to make sense of the documents obtained. There is no legend, and I cannot guess what X22H6T8 means only by screening this PDF"*. When the IT department asked for more information, they finally received some extractions (i.e. PDF version of the database) with no details but a sentence explaining that they cannot do better.

We cannot say if data quality standards or more internal organization documents regarding metadata procedures exist. However, apart from the Canton's desire to appear as a "*data territory*", mentioned in the legislative agenda, we did not find any materials to plan, organize, or conduct the process of OGD publication or even a data governance program. The recruitment of external workers by the IT department to identify personal and sensitive data and investigate de-identification solutions (i.e. anonymization et pseudonymisation) for the departments tends to show that guidelines or policies for handling data are not defined. In that sense, an employee revealed that while the legislation exists on data protection, the standards, processes, and strategies to provide accurately recorded data, store them securely, foster effective reuse, and allow appropriate shareability are still scarce.

Yet, these fundamental elements for the data governance implementation play a critical role in data treatment as they stipulate actors what to do and in which domains [55, 60]. Data procedural components are widely reported in the data governance literature and put data strategies, policies, standards, processes, and issues management at the center of data governance research [16, 55, 60]. Several authors notably mentioned data processes and procedures and interpreted them as "*guidelines and rules necessary for dealing with data*" [63]. For some authors, they reflect the desired organizational behavior in terms of data quality [19, 56, 58, 64], data access [60, 71], data collection and storage [72], metadata management [56, 58, 73], data lifecycle [19, 56, 64], and data platform and architecture [19, 56, 74]. As they concern all steps of the data lifecycle, from the recording to the sharing [60, 64, 75], some authors stated that adopting procedural components ensures data management as a strategic asset [59]. For instance, a metadata strategy provides content that makes data understandable and reusable (Khatri and Brown 2010), while quality standards facilitate interoperability [69]. Therefore, as we remarked that the IT department struggled to access and comprehend the data management of the housing department, we believe that there is no consistency in the management of departmental data and no specific rules or standards for municipal data. Accordingly, we argue that the implementation of data governance procedural practices presented above may positively impact the publication of OGD. We thus present a second set of hypotheses:

- H4: OGD publication process is positively affected by standards
- H5: OGD publication process is positively affected by policies
- H6: OGD publication process is positively affected by data strategies
- H7: OGD publication process is positively affected by data process and procedure

- H8: OGD publication process is positively affected by data architecture and platform rules

4.3 Relational Components

From the beginning to the end of the project, we have never been able to identify a shared common discourse. Although we defined key objectives during the kick-off meeting - preparing an OGD sample - we rapidly understood that the strategies of both departments differed from the main one. While the IT personnel seemed more concerned with preventing confidentiality risks (i.e. by applying an appropriate level of anonymization), the housing domain experts sought to promote their activities in developing a smart city. We noticed that while the IT department strived to access and understand housing department data, domain experts focused on hackathon sponsorships and press conferences. It is interesting to note that the domain experts never took part in strategic discussions except for meetings on the hackathon's practical organization. Nevertheless, we observed a greater involvement of the housing domain experts when the project's main objective changed (i.e. when the hackathon's goal was no longer to present the OGD sample but to find solutions to the problems of the housing department). Domain experts attended meetings and actively organized the event. This study's observations echoed the findings of [76], who found that the alignment of departments frequently fails because there are no overall objectives. [77] also noted these alignment issues. The authors did not observe a universal vision or a common perception involving common expectations to complement, cooperate and contribute to organizational effectiveness in public sector managers. Yet, according to [33], effective data governance relies primarily on an alignment with business objectives and both, academic and practice-oriented literature have found that strategic alignments were crucial challenges in OGD publication [57, 60, 75].

[78] suggest that stakeholders encounter divergent interests because public sector culture stems from complex institutional cultures with different political and administrative interests. For the authors, cultural issues may impact the alignment of objectives and the behavior and attitudes of public employees regarding OGD. This was clear during the ethnography. While the housing department was not legally considered the data owner, we noticed tensions in sharing and communicating regarding data and metadata. Employees of the housing department were always speaking about "their data" and remained deaf to our demands. Consequently, we rapidly observed a strong resistance between the two departments. Although IT personnel repeated several requests for access to the housing department's data set and metadata, it took them three months to access limited and inadequate data knowledge and four months to get a PDF version of some databases. Until the end of the project, we never accessed to information needed to anonymize data. Given the housing domain experts' behavior on data matters, it did not surprise us when they first delayed, then reprogrammed, and finally cancelled sessions organized to go forward. As the IT executive later said: "As you probably noticed, the IT department suffers from a huge lack of support from other departments, and for their data, the city's departments have little respect for collaboration". However, the attitudes and behaviors expressed by the housing domain experts and IT personnel regarding the OGD publishing process go against data governance recommendations. Furthermore, they have been identified by [78] as a factor that could substantially affect the success of OGD.

While some authors have started to stress the importance of the impact of employees' data competencies [55], and knowledge [63] as well as training [16] on data governance, our findings suggest gaps in data knowledge skills and competencies. After talking to various people working for the city, we noticed that OGD and data management remain subjects ignored by public sector employees and highly controversial when people know them. While IT department personnel had been working on the project for more than six months, we were surprised when they questioned the definition of sensitive data, the usefulness of open data, and how to benefit financially. Furthermore, when the IT department requested database and metadata access, we noticed that the housing department interlocutors were unfamiliar with data management and governance vocabularies, such as metadata or databases. Yet, more and more papers discussed *self-organizing ability* [17], *organization* [60], *capacity for coherent implementation* [33] or *facilitating connections between data producers and users* [59] as an enabler to treat data as strategic assets. [16] showed that training employees involved in data processes help them to act accordingly to data policies, processes, and procedures [63, 79]. [63] put the employee data competencies as the first critical success factor. According to the authors, they have a fundamental role in the success of a data governance program.

Thus, this study produces results in line with previous works in this field and shows that the lack of relational practices such as alignment, culture, and competencies negatively impact the OGD publication process. For this reason, we add three more hypotheses to our model:

- H9: OGD publication process is negatively affected by the lack of alignment between stakeholders
- H10: OGD publication process is negatively affected by the lack of communication and culture
- H11: OGD publication process is negatively affected by the lack of knowledge and capabilities

5 CONCLUSION

Many researchers focus on distinct challenges present in the OGD ecosystem without considering that they can derive from data governance interferences. This study goes further by establishing a link between data governance components and OGD publication and shows a convergence between the application of data governance practices and the completion of data-driven processes. Although this ethnography represents local departments struggling to address OGD publication, the paper illustrates how these challenges rarely arise from the publication of OGD or the open nature of data itself, but a lack of data governance practices. Based on the triangulation approach of [40], we cross-checked our ethnographical observations with a review of the extant literature and noticed that little or no key data governance practices recommended by the literature to solve organizational data difficulties had been implemented. Therefore, we derive accurate components, specify hypotheses, and finally build the model of OGD governance (Figure 2). The model states that three structural components (H1, H2, H3), five

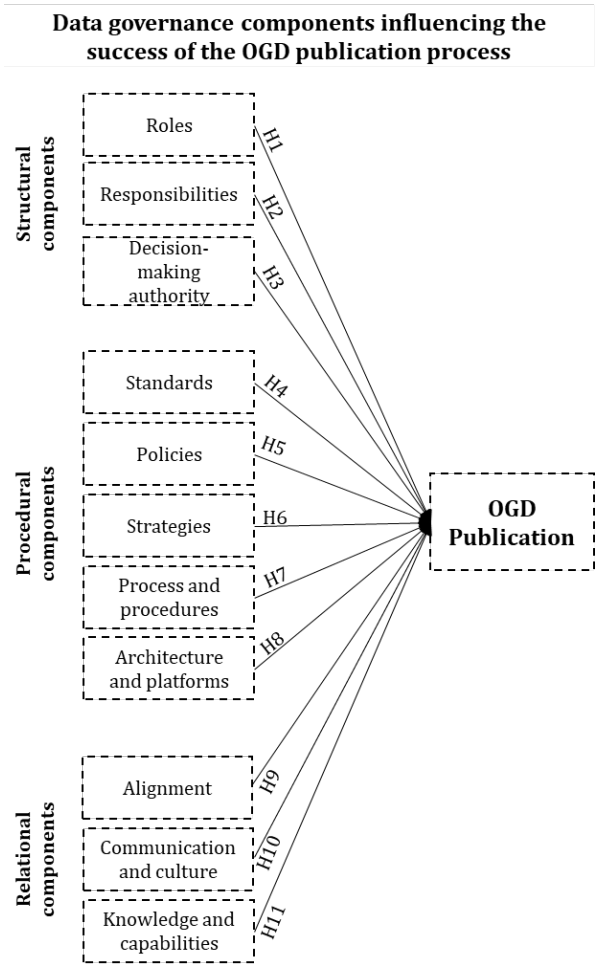


Figure 2: The model of OGD governance.

procedural components (H4, H5, H6, H7, H8) and three relational components (H9, H10, H11) seem to influence the success of the OGD publication process.

By establishing a causal relationship between data governance practices and OGD publication success, this paper extends existing OGD research and enlarges data governance literature in the public sector. It aligns with [7] research that encourages case studies to investigate how data governance is framed, which are the discourses and the consequences. In addition to providing a case to the literature on OGD publication in a context where only a few empirical studies have been started, this paper develops a first model that explains the importance of data governance on public sector data-driven activities. By cross-checking detailed observations obtained through an ethnography inquiry with a literature review, this study proposed a model that helps researchers better comprehend the OGD publication process and the dynamics that underlie data-driven activities. Furthermore, this first model appears as a starting point for OGD governance research and may form the basis for general theorization [80].

Besides extending data literature in the public sector, this study suggests ways forward by outlining avenues for practitioners. The OGD governance model illustrates and depicts the connection between data governance and OGD publication and highlights critical practices encountered by municipal departments in data-driven activities. By showing that challenges faced in OGD initiatives and, to a broader extent, data initiatives correspond to the lack of data governance, this paper seeks to help inexperienced public organizations comprehend that data-driven activities are not as simple as uploading dataset on a computer. These activities require more attention and imply a large-scale change effort at the structural, procedural, and relational levels. Furthermore, this model shows the public sector that implementing these data governance practices is of primary importance in data-driven activities and may lead to the success of, or on the contrary, its failure. As stated by the general data protection regulation (GDPR), implementing an appropriate governance strategy considerably reduces the risks of data exploitation. This is particularly important since the great majority of data owned by the public sector may be personal or sensitive. Leading media frequently speak about the infiltration of government databases to steal personal data. Yet, according to the experts, data hacking could be reduced by implementing a data governance program, including training, sufficient prominence in organizations and board support, and transparent processes and standards, among others [81]. For these reasons, we call on the departments involved in any data-related projects to establish a public-private partnership to set up a concrete data governance program and fill the lack of data capabilities.

Although our paper provides food for researchers and practitioners, additional case studies are necessary to further probe the OGD process. This study presents only one case study. Therefore, it may appear as a limitation as it does not generalize findings. We also recognize that the lack of terms homogenization may represent a limitation. The multiplicity of terms to define a similar concept led us to create clusters, which may reduce the level of detail. Finally, the highly contextualized nature of the study as well as problems of control mechanisms, do not provide the replicability of the study. Yet, this approach is common in IS literature and considered a good research practice [82]. Indeed, the case study approach may be a starting point for developing exploratory and explanatory contributions [80]. Consequently, we plan to continue expanding this paper by testing our hypothesizes through survey research conducted alongside OGD publishers. We schedule to distribute questionnaires to key employees of the most prominent Swiss and French public sector organizations involved in the publication process and then analyse the questionnaires' results through the structural equation modelling (SEM) approach. To further extend this study, we also recommend using the findings to study the complex relationships between OGD actors inside the OGD ecosystem. While previous research has pointed out the importance of OGD ecosystems, findings reveal the need to focus on symbiosis in ecosystems, i.e. "the living together of unlike organisms" [83]. Given the presented results, we call for more practice-based research regarding the data governance practices in the public sector in order to support public organizations and help them to find concrete solutions and adapt their practices to the rapid technological evolution. Also, observations that municipal departments lack data governance knowledge,

we see a need for more support using, preferably, some techniques such as formation, information, and the provision of sufficient resources (i.e. experts, communication tools).

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Automated impact assessment - How digitizing government enables rapid and tailor-made policy responses.

Mariia Maksimova
University of Tartu
Tartu, Estonia
mariia.maksimova@ut.ee

Art Alishani
University of Tartu
Tartu, Estonia
art.alishani@ut.ee

Mihkel Solvak
University of Tartu
Tartu, Estonia
mihkel.solvak@ut.ee

Robert Krimmer
University of Tartu
Tartu, Estonia
robert.krimmer@ut.ee

ABSTRACT

As interest in the digital transformation of public administration grows, the main challenge remains to improve government governance systems and integrate a wider range of evidence into decision-making processes. The successful digitalization and application of such approaches improves the quality, responsiveness and flexibility of public administrations. The digialtization of processes has made it possible to use micro-level data to assess the impact of a policy or program and apply the feedback to improve the design and delivery of public services. Evidence-based policy-making evaluates programs based on their visible impacts. Large-scale data collected through digitized governance, coupled with econometric impact assessment, provides an ideal working toolkit for this. However, the current situation of European governments is one of slow adoption, as they are often slow to respond to new challenges. This is due to the static one-off impact assessment approaches used, the results of which quickly become outdated. With further digitalization, improvement of systems, and a rapidly changing situation, there is a need to speed up institutions' ability to quickly draw working solutions to offset the effects of unexpected events in society and economy and react without delays if policy effects dissipate. This paper demonstrates how a high level of digitalization in government allows addressing such issues by automating causal impact assessment and making it a continuous part of the service delivery. The use case is an automated system for assessing active labour market policies in Estonia using individual-level data from government digital registers. Building on this, it shows how impact assessment automation depends on automatically generated data, only available due to the digitalization of other public services, and how versatile it is when it comes to proving casual evidence in a suddenly changing environment.

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CCS CONCEPTS

• **Applied computing** → **E-government**.

KEYWORDS

impact assessment, digitalization, proactivity

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1 INTRODUCTION

Public authorities face an increasing demand to provide citizens with quality services that are remotely accessible and available on any device. To effectively meet growing demands, governments need to embed new information and communication technologies (ICT) to facilitate interactions with end-users. The potential of ICT to increase the effectiveness of public administrations lies not only in making interactions more efficient, transparent and convenient [52, 63], but also in opening new ways for data exchange between different administrative areas, introducing common standards and making digital public services more human-centered [17, 51, 64]. Thus, the increasing availability of public sector data is helping officials to implement promising strategies that lead to new ways of managing operations, promoting the (re)use of public sector data and increasing efficiencies at various operational levels. The vast amount of historical and personal data that public administrations have access to also creates space for the use of increasingly advanced analytics, leading to the creation of new public values and the introduction of new data assessment mechanisms that support evidence-based policy-making and reduce administrative latency [24, 40].

The integration of data from different sources plays a crucial role in the implementation of digital government strategies that improve such areas as public effectiveness, operational efficiency, data management, and service delivery. Governments also have vast datasets of continuously updated personal and historical data, enabling the use of innovative analytics to generate new insights and inform public decision-makers. In addition, the growing ICT capabilities of public administrations are drawing attention to new

areas and ways in which relevant data mechanisms can increase policy responsiveness, and improve impact assessments and the accuracy of interventions. However, this is not an easy transition, and it does not come without its challenges. Current research identifies barriers that cut across different domains such as legal, management, security, ownership, quality, ethical, and privacy concerns [3, 21, 24, 40, 41].

Additionally, the use of big data arrays to evaluate ongoing actions and predict possible outcomes is a topic that is attracting attention from both business and government agencies. On the public administration side, the benefits of using data analytics to solve collective problems in various fields are noted, including city management [19, 22, 49, 59] or using social media data to support evidence-based policies [45]. In order to achieve high-quality results, public administrations are expected to develop their ICT management skills further and implement new technologies that support decision-making. Systems and tools based on previous generation technologies cannot always cope with such assigned tasks. As such, there is a growing demand for modern solutions that build on past successes and integrate new approaches that build on data to address pressing problems. Therefore, support public administrations in the delivery of digital transformation programs that go beyond electronic versions of current complex paper-based practices. As a result, it could be argued that developing methods that use open and real-time data to assess public decisions can provide a variety of benefits, including 1) optimizing resource spending through the development of efficient policies, and 2) improving budget spending and distribution of public goods, 3) improving the effectiveness of existing spending. This minimizes risks and takes opportunity costs into account. The labour market is one of the areas that can benefit significantly from such a development, as it is a vulnerable area that requires quick responses in situations where the nature and scale of challenges are difficult to predict.

The purpose of this paper is to showcase how the variety of micro-level data enables the creation of automated impact assessment tools. For this purpose, this study presents the case of the MALLE framework of active labour market policy impact assessment used by the Estonian Unemployment Insurance Fund (EUIF). By performing this research, the arguments put forward how higher-level digitalization in the public sector allows the development of precise tools and facilitates tailored policy responses. The rest of this study is organized as follows. Section 2 presents the main approaches to impact assessment. Section 3 discusses the digitization and automation of impact assessment and outlines the Estonian architecture supporting MALLE. In section 4, the case study is presented. Section 5 discusses the opportunities that public administrations could open up by reducing process latency and delivering proactive digital public services. Section 6 outlines the conclusions of the study.

2 BACKGROUND

2.1 Impact assessment and policy change

New emerging technologies are finding many applications among public administrations. This socio-technical transformation is creating new patterns of stakeholder interactions, and public policy mirrors these patterns, reflects their needs, and becomes a means of their implementation. In this way, state regulation is becoming a tool aimed at streamlining and ensuring sustainability through established and fixed norms and rules. However, government policies can have social, economic, and environmental consequences that lead to deviations from established norms and accepted programs and ultimately reduce the effectiveness of the implemented government regulatory system. Therefore, there is a need to introduce an impact assessment mechanism to determine the adequacy and effectiveness of states.

Impact assessment is a preliminary method of assessing the impact of a policy based on a variety of indicators in areas that the policy will impact upon implementation [20, 25]. In this regard, the effectiveness of the implemented policies can be assessed by using macroeconomic indicators and sociological surveys [46, 61], as well as examining the performance indicators of the government agencies [16, 50] directly involved in their implementation. The benefits of implementing impact assessments in public administration include the ability to identify social, economic and environmental benefits and costs. In doing so, it promotes more balanced decision-making at the state level. It also allows for a systematic expansion of the evidence base to support policy proposals, which can improve the ability to consider a range of implications of policy options even in the early stages of their development.

Impact assessment is used both at national level [2, 26, 42] to develop new strategies and at international organisations [38, 62]. This approach has established itself as common practice in numerous countries, as evidenced by the practice of its international application. In order to make the most effective decision, the data available must be used to produce the most significant results. In the past, effectiveness assessment was primarily a means of assessing the results of policies upon their implementation at the state level, but now, with more detailed information with higher granularity at an individual level and access to historical data, models can be developed that predict the outcome at lower levels of influence. Consequently, it is not limited to the assessment of public policies, but also to the assessment of individual indicators at the micro level. A high granularity of data is an important part of the evidence for policy as it allows to find more details about it [14]. This cannot be achieved without a sufficient degree of digitalization in public administration and automation, which would reduce the time required to process individual inquiries.

2.2 Digitalization and automating impact assessment

Global competition, knowledge economy and information society are among the prominent trends shaping today's society and in this regard, digital transformation is an integral part of today's life. The changes in modern society are mainly related to the changing role of information in the world. In the past, the term information society was primarily used, a society in which the phenomenon of information determines the social structure [8]. The technical means of communication, especially telecommunications, play a decisive role in the development of the information society, with the structure-forming role of information in the formation and development of society being the focus. A characteristic feature of the modern stage of development of society recognizes the leading

role in the development not so much information itself, but knowledge as its form, which led to the emergence of a new concept - the knowledge society [12]. While the notion of the information society is linked to the idea of technological innovation, the notion of the knowledge society touches on aspects of change in different areas of life and reflects the transition from using information for descriptive purposes to answering the question "how?" (See Figure 1).

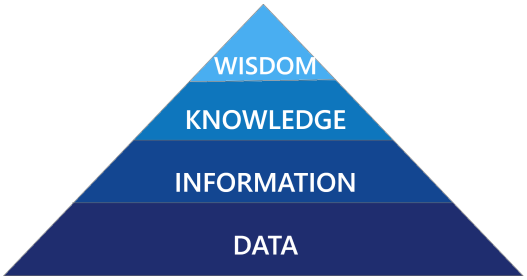


Figure 1: The DIKW hierarchy (Reprinted from: [1])

With digitalization, public administration can be made more transparent, accessible, and responsive by facilitating easy communication between the government and the public. As information sharing in the public sector becomes more open, decision-makers are taking into account citizens' needs, ideas and priorities, which can now be expressed through new channels or highlighted through their interactions with the government. It is an essential part of the digitalization of public administration to create a system that can both deliver public services in an electronic format and collect and store the data generated in the delivery of these services. By opening up possibilities to work with automatically generated data that is the by-product of this process, digitalization creates new possibilities for more responsive and flexible policies.

Therefore, digitization has led the state to collect a large amount of data on citizens, along with changes in indicators of socio-economic progress, which are increasing over time. The data is also accessible at the individual level of citizens' transactions, which makes it possible to assess the situation at a micro-level. With the ability to use micro-level data, it is possible to assess policy effectiveness more accurately and timely since it previously took 1-2 years to obtain stakeholder feedback and impact assessment [30]. Assessing policies at the micro-level is now a routine task for economic researchers and public service providers. In the last few decades, a large number of published individual evaluations have been carried out, summarized in several meta-analyses covering hundreds of studies (see on labour economics Card et al. [10], Card et al. [11]). Such an approach used to seem almost impossible due to the lack of data for full analysis and computing power, but now it is becoming part of the daily decision-making process.

Accordingly, different methods and technologies can be used in evaluations depending on the objective. When analyzing labour policy, they use either randomized designs [5], in which people or companies are randomly assigned to policy programmers, or more commonly, quasi-experimental designs [6], in which participants are compared with similar non-participants using statistical methods. It should be noted that randomized experiments and evaluations based on certain changes in the law (so-called natural experiments) cannot be automated because they require ad hoc-evaluations. Today, some countries are already introducing automated assessment tools for work actions. In Germany, TrEffeR (Treatment Effects and Prediction) has been introduced, a model for evaluating ongoing active labour market measures and identifying the effects on an individual basis, as well as for different subgroups and local areas European Commission [18], Stephan et al. [57]. The Public Employment Service (PES) of the Flemish region of Belgium (VDAB - Vlaamse Dienst voor Arbeidsbemiddeling en Beroepslopleiding) has implemented a profiling model that estimates the likelihood of becoming long-term unemployed [15]. Thus, easy access to registry data, improved computer speeds, and more flexible econometric and statistical tools have helped automate quasi-experimental approaches so that these evaluations can become routine.

2.3 Estonian digital government context

Public sector organizations can access new data sources to deliver proactive digital public services when converting analog processes to digital formats. However, current practices governing the collection and storage of user data are relatively closed and challenging due to various organizational boundaries, data silos, and legal obstacles. Access to separate data storage might work to provide individual services, but it is not sufficient to develop a comprehensive picture of citizen events and provide proactive services. As a result, the need for functioning systems that support data exchange between actors involved in services is evident and crucial for the development of well-functioning digital government ecosystems and sufficient complementary services that increase the value of the system as a whole.

Estonia's e-government is based on four essential infrastructure elements [55]. The first is the electronic identification system (eID) for citizens, for which several forms are available. The most popular is the use of a physical chip card, which also acts as an identification card. Another variant is the SIM card (Mobile-ID), which enables the use of a mobile phone for secure access to electronic services and signing documents. As of January 2022, about 1/6 of the holders of different identification cards have a mobile ID (https://www.id.ee/). The following variant of electronic identification system is Smart-ID, a cloud solution consisting of an application that allows user identification even if the device on which it is used has no SIM card. About 60% of the holders of various identification cards also have a smart ID (https://www.id.ee/). Although there are many methods of electronic identification, all systems are based on the principle of secure identification for accessing electronic services or signing documents.

The second element is a centrally managed distributed data exchange layer called X-Road, which enables data exchange between different actors. It is a one-stop-shop solution to access all data generated by the public sector in the country. This X-Road has been in use since 2001 and was originally designed to access various national databases. However, as it develops, it now allows large data sets to be modified and transferred and allows users to perform searches on them. As of January 1, 2022, 672 institutions and enterprises and 1,494 information systems are already integrated into

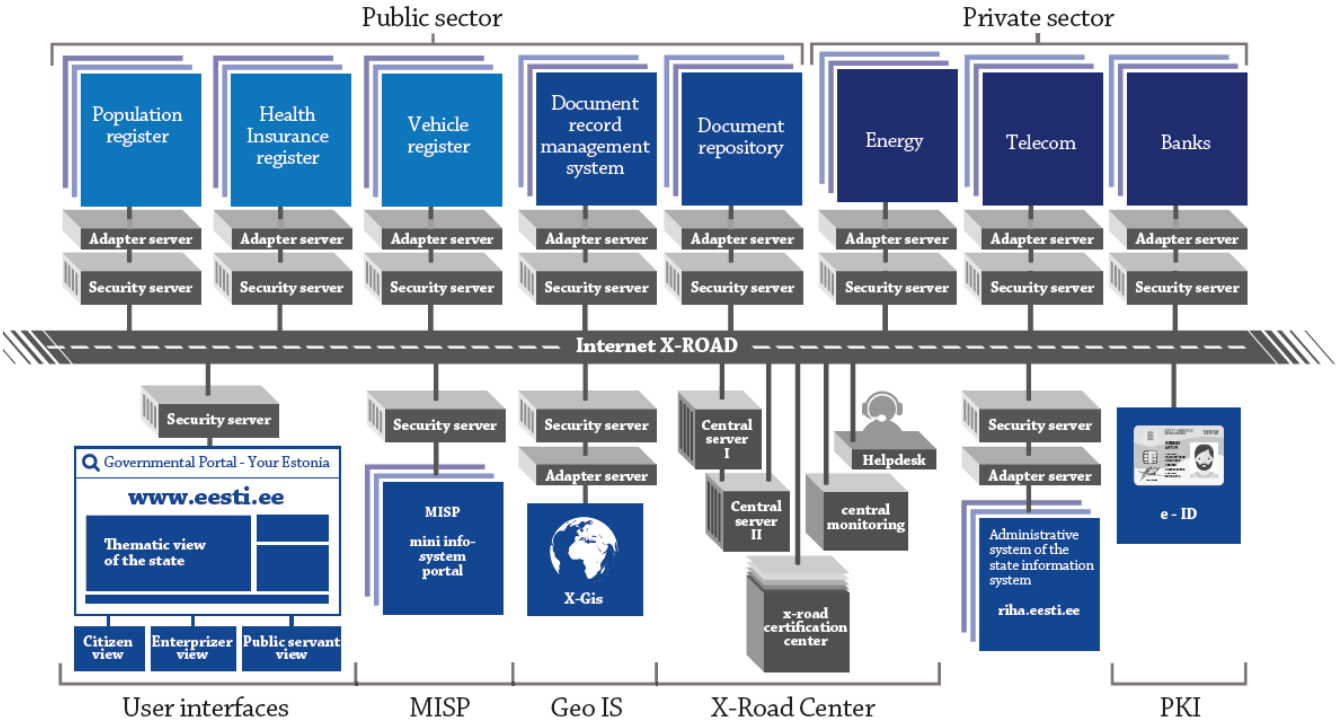


Figure 2: Schematic picture of X-road (Reprinted from: [56])

it (https://www.x-tee.ee/factsheets/EE/#eng). Approximately 200 million service requests are generated each month, of which only 3% are requests from citizens. The X-Road as such can be seen as an essential tool that enables daily data exchange and communication between different actors. The standardization of the process made it possible to reduce citizen involvement in service delivery, simplify information sharing, avoid duplication of data across multiple government agencies, and create a secure environment for these processes.

Regarding the X-Road system architecture (See Figure 2), most call requests are logged centrally by the X-Road Center in the central compliance monitoring log. External users cannot access data exchanged between parties connected to X-Road. The identities of the parties, mainly service portals and base registries, are also stored centrally. The central log stores limited information about service consumption for traffic monitoring and compliance purposes. This includes information about who sent the service request, to which service provider and when the response to the request was received. Also, as part of establishing a centralized log, requests are consolidated into a single record.

The standardization of the data exchange process and the centralization of data storage do not directly affect the owners of the data. Owners are also responsible for providing data, ensuring accuracy, updating and keeping data up-to-date. The integration of such a system does not bring any added value if the activities of each public administration agency involved in the process are not digitalized, since such a system is only a tool and a step on the way of digitalization. Thus, X-Road provides constant and uninterrupted access to government databases, but is not responsible for their quality and assumes no responsibility for their owners. The standardization of the data exchange process and the centralization of data storage do not directly affect the data owners. The latter are responsible for providing the data, ensuring its accuracy and keeping it up to date.

The RIHA (Republic of Estonia Information System Authority) repository system is a third element that acts as an e-service catalogue/registration for the state information system (https://www.riha.ee/Avaleht). At the same time, however, it is also an environment in which various procedural and administrative interactions take place. By law, registration with RIHA is mandatory for databases and information systems, and all databases are responsible for keeping the description of their content up to date. This is due to the principle of data storage adopted in Estonia, which is called "once only" [28]. It is that the information should not be duplicated anywhere else in the ecosystem. It helps reduce the cost of collecting and storing information and simplifies the system of interaction between authorities offering various electronic services. In addition, the system offers various reusable components such as XML assets and classifications that make it easier for new actors to connect to the system. The purpose of RIHA is to create a transparent, balanced and effective management of the information systems available in the country.

The fourth and last component is the national portal, which is a user interface for receiving electronic services (https://www.eesti.ee/et). All four elements together form a developed digital system of e-government functionality. In order to better understand how such digitalization allows rapid tailor-made policy responses, this paper proposes to examine the use-case of the active labour market policy impact assessment, which uses X-Road to get the data on the micro-level and use it for assessment model. By identifying actual usage-case and pointing out the benefits of this approach, we clarify the main argument of this paper that without high digitalization and real-time access to the data scattered across different government agencies, it becomes very difficult to react and respond to rapid changes. It is essential in current times due to the shift towards evidence-based policies and citizens' demand for more efficient, proactive, and tailored actions of the public administration.

3 ACTIVE LABOUR MARKET POLICY IMPACT ASSESSMENT - MALLE FRAMEWORK

The situation in the labour market is a critical area for government activity. It is of crucial importance as it influences economic development, citizens' living standards and the development and specialization of different professional and social skills [44]. While states continue to strive to enhance viability and increase the well-being of citizens, it has become increasingly difficult to achieve these goals without having programs in place that provide targeted support and respond to recent trends and situations. Therefore, it is of great concern to policy makers that labour market policies put in place should be properly evaluated to assess their impact and relative contribution. This paper provides a summary overview of the automated labour market policy impact assessment tool used in Estonia.

The quantitative evaluation of active labour market policy measures is a demanding and essential task that labour economists both in academia and in the public employment service regularly meet. Previously, the Estonian Unemployment Insurance Fund (EUIF) conducted evaluations of services on an ad hoc basis, about a study every two years, or commissioned external researchers to carry out analysis. However, with increased computing power and easier access to micro-level registry data within the EUIF, counterfactual impact assessment can now be done much more quickly and automatically. This reduces process latencies and enables a monthly iteration of the evaluations if required. To illustrate how EUIF labour market policy measures are automated, this paper provides an overview of what data is used and how it is combined, how the assessment is done and how the results are used.

In Estonia, micro-econometric evaluation of active labour market programs dates back to the early 2000s. The studies include the evaluation of labour market training programs [4, 13, 32, 34, 58], wage subsidies [4], and business start-up grants [60]. In addition, there are evaluations of labour market programs provided by other public institutions [35]. All recent studies were based on linked administrative micro-data from the Estonian Unemployment Insurance Fund and Tax and Customs Board. The studies used various matching methods, such as propensity score matching or exact matching. The majority of recent impact evaluations of active labour market policies in Estonia have been implemented by Estonian Unemployment Insurance Fund [32, 58, 60]. The lack of evaluation studies by academics is mainly due to the strict data protection regulations, which make it difficult for researchers outside the EUIF to access the micro data. More freely access to anonymized logs of service usage is possible, but it is quite difficult to trace a request for a service by an individual through automated requests between systems. In addition, the anonymization of logs makes further joining of records from different systems impossible.

Since 2021, the first version of the automated tool for active labour market policy evaluation - MALLE (stands for MAchine Learning in Labour Economics) (See Figure 3) was implemented in EUIF. It is an internal model that was jointly developed by analysts of EUIF and researchers of the University of Tartu with the support of private IT companies. The purpose of the tool is to speed up and automate labour market evaluations. The tool consists of three parts: 1) command files that automatically access data from EUIF databases and preprocess the data for evaluation, 2) command files written in R that perform statistical matching and write down matched micro level data, and 3) files for interface that visualise evaluation results either in Tableau or R Shiny and do necessary on-line calculations, such as impact effects in subgroups and approximate confidence intervals. The tool uses propensity score matching [9, 33] with some strict constraints, optionally combined with regression adjustment in the second step. Statistical matching combined with regression adjustment is one of the common approaches to assessing the impact of labour policies. It enables extensive background data and previous labour market experiences to be taken into account in order to make participants and non-participants comparable. Since effects in subgroups also have to be estimated after matching, which can lead to unbalanced treatment and control groups, a regression model is applied to reduce the effect of unbalanced covariates.

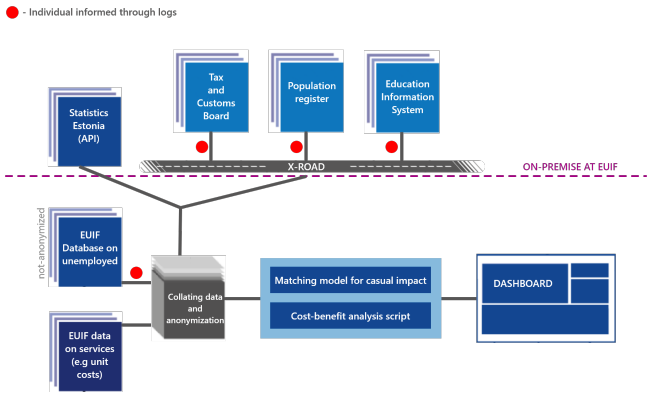


Figure 3: MALLE framework

The matching was based on the propensity score that was estimated using a logit model including various socio-economic variables and past labour market information. The variables matched exactly were: unemployment calendar month (control group had to be unemployed at the same calendar month when the labour market service was provided), observation period (both treatment

and control group observations had to be observed for the same time period 1-24 months), other services received during the same unemployment spell, a few measure-specific variables (e.g. ability to work in case of work-related rehabilitation, knowledge of Estonian in case of language courses). Model used 5 nearest neighbours (or more if there are controls with exactly the same value) to construct control and treatment groups. The matching procedure is done with R package "Matching". It estimates the effect of treatment variables on employed probability and gross monthly labour earnings up to two years after the beginning (or end in the case of wage subsidy) of active labour market measure.

The June 1, 2021 version of the model assesses the following labour market services: labour market training (separately vocational training, Estonian language training, computer training, general skills), work practice, wage subsidy, work-related rehabilitation. The variables used for matching include general information about the unemployed background such as age, gender, education, language, everything related to their previous employment experience and earnings, previous periods of unemployment and receipt of services or benefits, measures on work-related disabilities, location. All the data come automatically from the EUIF information system, which relies on other registries (Employment register, Tax and customs board register, Education register, population register), but a few items, e.g. working abroad or before the registers were created, are entered to the information system manually.

The technical implementation is carried out by combining R software and Tableau. R Server has access to Oracle database tables, data tables are then cleaned, merged and variables are defined. The matching is done with impact assessment, the average treatment effects on treated (ATT) on matched data is computed:

$$ATET = E_X\left[\left\{E\left(Y_1 \mid D=1, X^{Exact}, p(X^{Rest})\right) - E\left(Y_0 \mid D=0, X^{Exact}, p(X^{Rest})\right)\right\} \middle| D=1\right]$$

ATT is found from regression model:

$$Y = \beta_0 + \sum_{k=1}^{24} \beta_{1k} \times D \times T_k + \sum_{k=1}^{24} \beta_{2k} \times T_k + \beta_3 \times X + u$$

Matching also yields aggregated results with optional Abadie-Imbens standard errors and a micro-level dataset. After matching treated and controls are found, one can use either a Shiny application in R or Tableau to visualize the results. The application calculates the effect of the labour market policies based on the micro-data and calculates approximate standard errors (which currently ignore the uncertainty due to propensity score estimation and one-to-many matching) (See Fig.4). It also contains some basic information on the quality of the matching process (similarity between treated and non-treated groups) (See Fig.5).

The current model uses R (version 3.6.0), operated with RStudio (version 1.1.463), in a Linux machine (release 3.10.0-1062.1.2.el7.x86_64). The model is run on 16 cores (Intel(R) Xeon(R) Gold 6154 CPU @ 3.00GHz) with 200 GB RAM. The approximate time the model takes

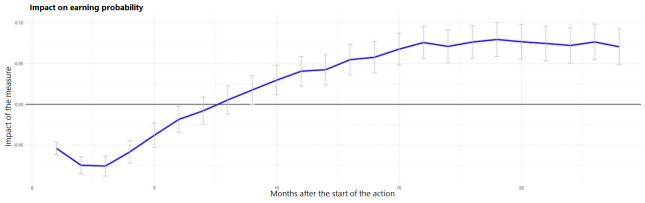


Figure 4: Impact of Estonian language courses on earning probability

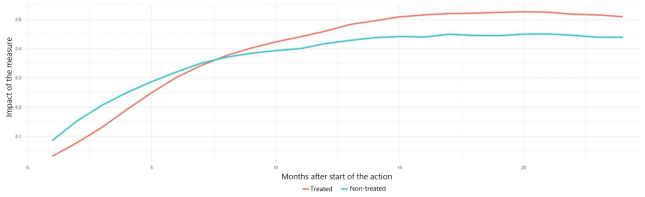


Figure 5: Impact of Estonian language courses on earning probability, treated vs non-treated groups

to get the data, do the matching and save micro-level datasets is about the following:

- Preparation of data from anonymised database – up to 20 minutes
- Matching for seven different treatments and storage of all micro data – about a day
- Loading of matched data into online tools 2-3 minutes
- Online calculations of effects in subgroups and approximate standard errors – a few minutes, depending on the size of the treatment group, number of subgroups.

4 DISCUSSION AND CONCLUSIONS

The role of ICT and data remains crucial in informing policy-making and enabling public administrations to experiment with new ways of developing modern digital public services that are inherently user-friendly, delivered in a timely manner and executed proactively in the background [29, 54]. It remains important to compare the stated goals with tangible results and to see what works the best in the policy-making cycle. This in turn requires integrated data from different sources and appropriate econometric methods and models to assess public administration actions and responses [14]. As the MALLE framework shows, an appropriate combination of data and econometric models can provide policymakers with significant support, complementary tools and decision-making bases [14]. Building on this, this study makes three observations.

Firstly, as a system based on automatically generated data, the advantages of the MALLE compared to the existing system in the EUIF are that it is fast, flexible and automated. For policymakers, it provides access to more up-to-date and authentic information. It enables more tailored policy responses and programs, and reduces process latencies by allowing assessments whenever they are needed. From conducting assessments every two years, the EUIF can execute it each month in an automated matter. This system also creates more space for human-centric and proactive services

that are tailored to users' life events, are context-sensitive, and arm officials with better evidence to support decision-making [36]. However, the current version has some weaknesses, such as simplified standard errors. Therefore, there is a trade-off between the accuracy of the estimates and the speed and flexibility to get the results. The automation allows routine evaluations to be performed quickly when using a quasi-experimental approach. The online tool enables flexible target group selection. Hypotheses can also be quickly put forward as to why some measures work better and how the effectiveness of measures has changed during the crises. In this way, it can be checked whether some measures work better for certain groups.

Second, MALLE also highlights how an established e-government architecture, particularly in the case of X-Road in Estonia, enables the extraction of administrative data to support the development of proactive digital public services and smart frameworks for impact assessment. Administrative data is often collected by public organizations and includes large datasets from various fields such as employment, environment, housing, public health, social security, education, etc. These datasets, while used to support public administrative functions, are typically representative and cover large population groups from citizens and businesses, are regularly updated, are reasonably accurate, and are occasionally available in real or near real time. As such, interest in administrative data is growing significantly given the value and insights it offers decision-makers when combined with other types of data, including big data [23, 31, 43, 47, 53].

Third, this study supports the argument that high levels of digitalization enable the creation of additional advanced tools that support decision-making and proactive digital public services. The successful implementation and deployment of digital government infrastructure, such as the case of X-road in Estonia, creates room for further developments that were not intended initially. In the case of MALLE, this system adds value not only by assuming what is happening in the labour market, but also by using micro-level data to monitor the situation more frequently and to support the shift towards an economy that increasingly builds on data to function in or close to real-time. In the field of public services provision, transactions at the user level allow identifying citizens' demand for certain services [39] and analysis on the group level can identify additional patterns and demands. That can be used both to optimize the processes and allow the state to recommend specific services in a proactive manner [27, 37, 65]. In addition, similar systems could also be developed for the private sector. Governments are increasingly collecting information about companies, consumer behaviour, and indicators regarding the general situation in various areas and industries. Therefore, it is becoming possible to use data to anticipate and monitor the situation of individual companies and also analyze the status of industries [7, 48]. Hence, develop systems that signal when organizations are at risk and formulate proactive policies to respond to various adverse events.

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Using Knowledge Graphs to provide public service information

Rafail, Promikyridis
Department of Applied Informatics, University of Macedonia
r.promikyridis@uom.edu.gr

Efthimios, Tambouris
Department of Applied Informatics, University of Macedonia
tambouris@uom.edu.gr

ABSTRACT

Public authorities all over the world publish an increasing amount of information about the Public Services (PS) they provide to facilitate discovery and use by citizens and businesses. Proper management (storing, processing, querying) of this information is necessary to make it fully exploitable. This includes adopting a common PS data model to facilitate interoperability, such as the Core Public Service Vocabulary (CPSV) developed by the European Union. In addition, the choice of technology is important as it is closely related to the quality of information. The aim of this paper is to investigate the benefits of adopting knowledge graphs to manage PS information that are structured using CPSV data model. For this purpose, we capitalize on previous research enriching CPSV and using RDF to develop a relevant knowledge graph and evaluate its use by employing various usage scenarios. The results suggest the use of knowledge graphs can provide benefits by exploiting domain-specific rules however there is still work to be done before the public sector widely adopts their use.

CCS CONCEPTS

• **Applied computing** → Computers in other domains; Computing in government; E-government.

KEYWORDS

CPSV, Knowledge Graphs, eGovernment, public service descriptions, Grakn.ai

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1 INTRODUCTION

Over the years, the volume of published open government data on the internet is rapidly increasing. Public authorities publish their data to both improve the transparency of public administration and provide high quality information. However, lack of organization, lack of interoperability as well as the form of the data (non-machine-readable), do not allow their full exploitation.

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Although public services are publishing more and more public service descriptions online, there is no commonly accepted relevant data model [1]. In 2013 and 2014, European Commission took an important step towards resolving this issue by introducing the Core Public Service Vocabulary (CPSV) [2] and Core Public Service Vocabulary – Application Profile (CPSV-AP) which exploits the Resource Description Framework (RDF) as an underpinning technology [3]. CPSV has so far been implemented using various technologies, including HTML, relational databases [4] and RDF stores.

Knowledge graphs is a recently introduced technology that has attracted significant attention [5]. Because of reasoning ability and structure, they can solve problems that are difficult or even infeasible to be solved otherwise [6]. This reasoning ability derives from the use of rules. A good example is the following rule. If a person **x** is born in a place **y**, and the place y is a **country,** then y is the country of birth of x [7]. Despite their increasing use in the private sector, the use of knowledge graphs as a modeling tool for CPSV has not been exploited.

The aim of this paper is to investigate the benefits of adopting Knowledge Graphs to manage PS information that are structured using CPSV data model. Specific aims include (a) to develop a knowledge graph compliant to the CPSV model (b) to investigate the potential benefits of using knowledge graphs for public service description. For this purpose, we capitalize on previous research enriching CPSV and using RDF to develop a relevant knowledge graph and evaluate its use by employing various usage scenarios

The rest of this paper is structured as follows. Section 2 outlines background work and Section 3 presents the methodology. Section 4 presents the results of our work while section 5 provides the conclusions, limitations and future work. Finally, the Appendix presents listing of part of the code that was used in this study.

2 BACKGROUND WORK

In this section, we outline previous work related to CPSV and knowledge graphs.

2.1 Core Public Service Vocabulary (CPSV)

The extensible and technology-neutral model Core Public Service Vocabulary (CPSV) first released in 2013 by the European Commission in the framework of ISA and ISA^2 programs [2]. The goal was to facilitate the exchange of information between the various individual public services. Based on the observed shortcomings and in order to describe any type of public service effectively, in 2014, the Core Public Service Vocabulary – Application Profile (CPSV-AP) [3] was launched. This model (Figure 1) also introduces the concepts of life and business events. The core class of the model is the *Public service* class that represents the service itself. Some other important classes are the *Evidence* class that represents any type

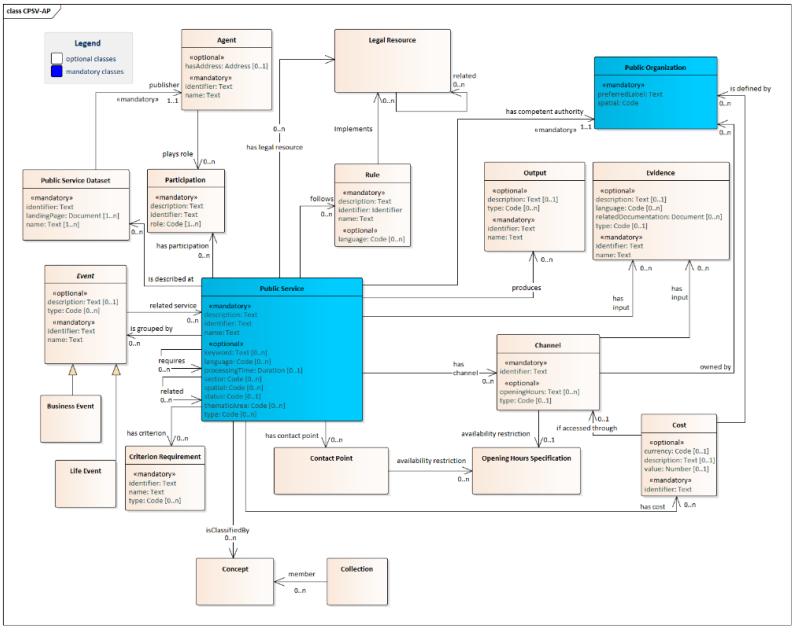


Figure 1: CPSV-AP v2.2 model adapted from [8]

of document needed for executing the Public service, the *Output* class that represents any type of document produced by the Public Service, the *Public Organization* class that represents the authority organization of the public service. [8]

2.2 Knowledge Graphs

According to [9] *A knowledge graph acquires and integrates information into an ontology and applies a reasoner to derive new knowledge.* The most important feature of knowledge graphs are the rules. A set of rules leads to the creation of logical conclusions. It applies reasoning over the data and allows the discovery of hidden information, thus answering complex queries. For reasoning, they can use deductive reasoning. It is the most suitable type of reasoning for knowledge graphs because of its well-defined conclusions. Other types of reasoning are inductive and abductive reasoning. Finally, the knowledge stored in a knowledge graph takes the form of a graph with entities as nodes and relations as edges.

3 METHODOLOGY

The methodology employed in this work includes the following steps.

Step 1. Identify relevant work. In this step, we study the literature for relevant research and data. We are particularly interested in research on the use of CPSV and open public service descriptions that we could potentially reuse.

Step 2. Design knowledge graph schema. In this step, we design the knowledge graph schema based on the model of the selected research.

Step 3. Introduce rules. In this step, we create and introduce the rules in the knowledge graph schema.

Step 4. Populate knowledge graph with data. In this step, we migrate the data of the selected research and populate the developed knowledge graph.

Step 5. Construct Usage scenarios. In this step, we present three scenarios for better understanding the benefits of the main characteristic of knowledge graph, namely the employment of rules.

Step 6. Evaluate results. In this step we evaluate the results.

For the development of the knowledge graph, we choose Grakn.ai for two main reasons. It is a free-to-use software application and we are already accustomed to using it because of previous research [10, 11]. Grakn supports object-oriented programming but also offers a flexible knowledge graph schema with entities and their relations, automated reasoning of data during execution and a high-level query language (Graql) using deductive reasoning [12]. It is worth mentioning that our research carried out before the acquisition and conversion of Grakn.ai to Vaticle.

4 RESULTS

This section presents the main results of our work.

4.1 Identify relevant research

The review of relevant literature culminated in selecting [13] as a basis for our work. This work is deemed suitable for our purposes as (a) it contains a systematic literature review of all PS models in the academic literature and compares them with CPSV, and (b) it contains RDF data about public services compliant with the CPSV model. In that work, the authors after conducting a systematic literature review, concluded in integrating additional concepts in CPSV-AP model resulting in the so-called *CPSV-AP enriched model* (Figure 2). Some important additional concepts of CPSV enriched

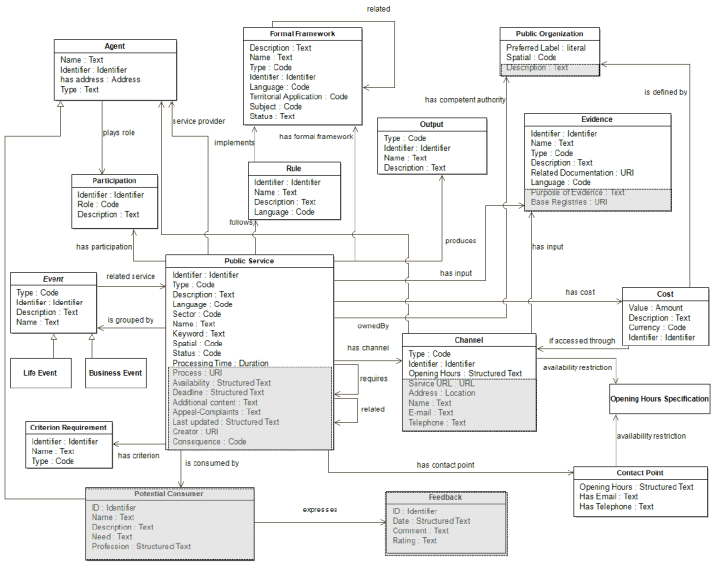


Figure 2: CPSV-AP enriched model (adapted from [13])

Table 1: Additional concepts of CPSV-AP enriched model (adapted from [13])

Concept	Description
Consequence	Information about the executed PS that needs to be forwarded to interested parties
Purpose Of Evidence	The purpose served by a piece of evidence
Potential Consumer	Information about potential consumer(s) of the public service
Need	The need(s) of a societal group that targeting by the public service
Feedback	Host any type of feedback
Rating	Rating of the quality of the public service description
Profession	The targeting profession(s) by the public service
Comment	Text of any feedback

along with their descriptions are presented in table 1 (adapted from [13]).

Finally, to demonstrate the added value of the CPSV-AP enriched model they created usage scenarios based on data in RDF format. These data were from 45 public services of Epirus as well as some additional data from the Greek official portal of public administration in html format, for those insured by the Social Insurance Institute (IKA) [13].

4.2 Design Knowledge Graph schema

4.2.1 Creation of Entities. A crucial step in developing the knowledge graph is the creation of Entities with their Attributes. Each class of Figure 2 is an entity in the knowledge graph schema and each field is an attribute to the corresponding entity. In total there are 18 entities and 39 attributes in our schema.

4.2.2 Creation of relations between entities. Next step is the creation of the relations that connect the entities of the schema. These relations are based on the CPSV-AP enriched model (Figure 2). In addition to these, we add extra relations that serve our need of creating rules. In total there are 28 relations from CPSV-AP enriched model.

4.3 Introduce rules

Once the process of creating entities and relations is complete, we can introduce the rules in the knowledge graph schema. Rules are an integral part of knowledge graphs. Their creation requires the appropriate level of understanding of the model and the margins it give us. Another important factor when designing rules is the purpose of the use of the knowledge graph. In this case our interest revolves around the provision of PS descriptions and we are looking for ways to improve this through rules. Once we have decided which rules to insert into the schema of the knowledge graph, one last step is to create relations that will allow the concepts of the graph to be connected when the conditions of each rule are met. Finally, to use these rules we just need to query the knowledge graph with the corresponding relation.

In total, the knowledge graph contains 8 rules. Table 2 presents the rules with a brief description and the potential recipient of their use. A potential recipient could be a citizen/business, the public

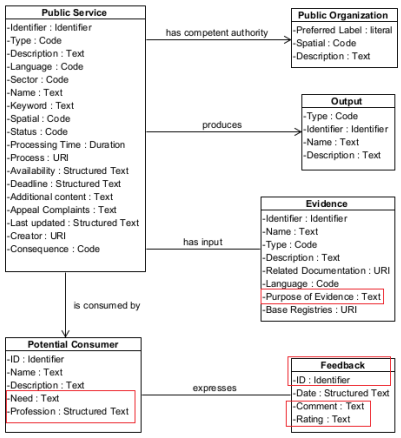


Figure 3: Classes that participate in the rules

authorities themselves or both. The following subsections present brief descriptions of the introduced rules. Also, figure 3 presents the part of the class diagram with the classes and fields that participate in the rules of the knowledge graph.

4.3.1 Rule consequence. The consequence rule allows the detection of public services that triggers other public services as the output of the first is an input of the second. An example is the 'obtaining a birth certificate' service which could launch the service 'payment of child benefit'. In natural language the rule states that **if** a public service has an input (evidence) **and** a different public service has an output **and** the input is the same document (same identifier) with output. **Then,** through the rule, these two public services relate to each other with the consequence relation.

4.3.2 Multiplicity check: Has Competent Authority 1-1. The use of this rule detects if a public service is connected with two public authorities i.e., it has two competent authorities at the same time. If this is the case, then the condition that a public service can have only one competent authority is violated. With this rule, public servants can check whether this CPSV model constraint is violated and take relevant actions.

4.3.3 Matching a public service with a purpose. Each "Evidence" document that is required as input in public service serves a specific purpose (attribute of entity evidence). For this reason, linking a public service to the purposes derived from the documents it accepts as inputs could be useful. This rule makes this connection when evidence serves a purpose and this evidence is an input to a public service. So, anyone potentially interested in public services related to a particular purpose could easily identify them.

4.3.4 Matching a public service with a need. A potential consumer has a need that leads him to use a public service. Therefore, it is useful to know what needs a public service can serve. When a potential consumer uses a public service and that consumer has a specific need then this need is linked to the public service. So, citizens or businesses with a particular need could easily find which public service is suitable for them based on their needs.

4.3.5 Matching a public service with feedback. This rule applies when a potential consumer uses a public service and leaves feedback. We suggest this feedback should be directly related to the public service because it is useful for public authorities to know what potential consumers think on specific public services. The conditions required for this connection to take place include (a) the potential consumer uses a public service and (b) that consumer leave feedback. We thus enable potential stakeholders to be informed on the feedback concerning any public service.

4.3.6 Matching a public service with rating. This rule is closely linked to the previous. We suggest it is useful for public authorities to know what the ratings of specific public services are. The rating contained in feedback is related directly with the public service. The conditions required for this connection to take place are these listed in sub-section 4.3.5, plus the existence of rating in feedback.

4.3.7 Matching a public service with a comment. This rule is also linked to that of sub-section 4.3.5. We suggest that it is useful for public authorities to know what the comments of specific public services are. The comment contained in feedback is related directly with the public service. The conditions required for this connection to take place are these listed in sub-section 4.3.5, plus the existence of comment in feedback.

Table 2: Rules with their description and the potential recipient of their use

Rule	Description	Potential recipient
Consequence	Relates public services	Both
Multiplicity check: Has Competent Authority 1-1	Relates public services with public authorities	Public Authorities
Matching a public service with a purpose	Relates public services with purposes of evidence	Citizen/Business
Matching a public service with a need	Relates public services with potential consumer needs	Citizen/Business
Matching a public service with feedback	Relates public services with potential consumers feedback	Public Authorities
Matching a public service with rating	Relates public services with ratings given by potential consumers through feedback	Public Authorities
Matching a public service with a profession	Relates public services with potential consumers professions	Citizen/Business
Matching a public service with comment	Relates public services with comments given by potential consumers through feedback	Public Authorities

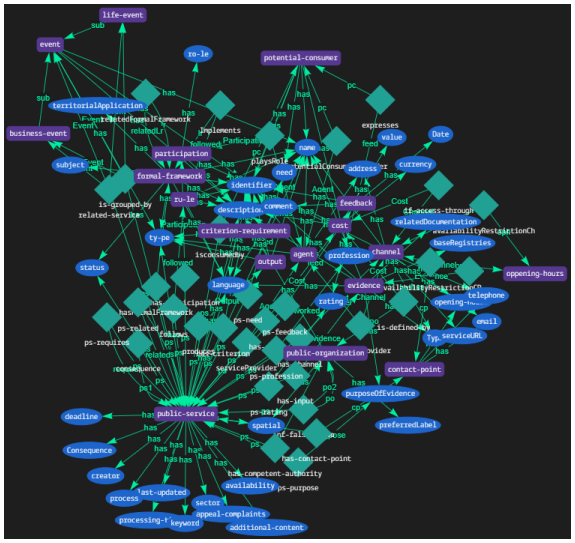


Figure 4: The developed knowledge graph in Grakn Workbase

4.3.8 Matching a public service with a profession. When a potential consumer of a public service has indicated a profession in their profile, we suggest that the service can serve the specific profession and thus we connect the two with a relation. The conditions required for this connection to take place are (a) the potential consumer uses the public service and (b) the consumer indicates a profession in their profile. Using this rule, citizens or businesses related to a particular profession can easily find which public service are suitable for them based on their profession.

4.4 Populate knowledge graph with data

In order to populate the knowledge graph, we used public service descriptions that were developed in previous research and was freely provided [13]. More specifically, we started from 1751 lines of RDF data included in the RDF store and ended up with 1160 lines describing all data in the knowledge graph database. It is noted that blank lines were not counted in both measurements.

4.5 Construct Usage scenarios

In this section we present three usage scenarios. For our purposes, we created some additional public service data that were not present in the selected research, i.e. [13]. These include potential consumers with specific needs to use a public service and feedback from each of them.

4.5.1 Usage scenario 1. The first scenario answers the following question: 'Which public service of "Having a baby" life event has as input documents that are outputs of other public service of the same event?'. Using rules, we can easily answer this question because rules achieve the proactiveness of public services or otherwise no-stop government. The birth of a child triggers a series of interrelated public services of "Having a baby" life event. This correlation occurs because the output documents produced by one public service serve as inputs to another public service of the same life event. This way, the beneficiaries can receive the benefits automatically, without having to do anything themselves. An example presented in the following query. (Figure 5)

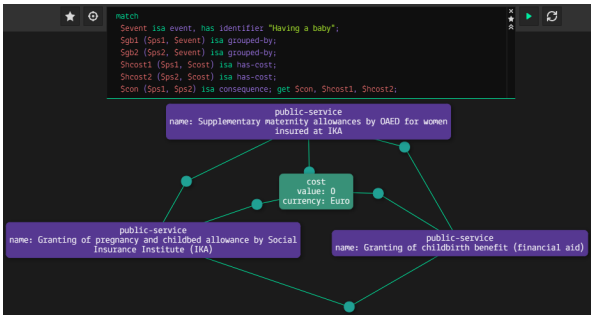


Figure 5: Results from Graql query in Grakn Workbase (Scenario 1)

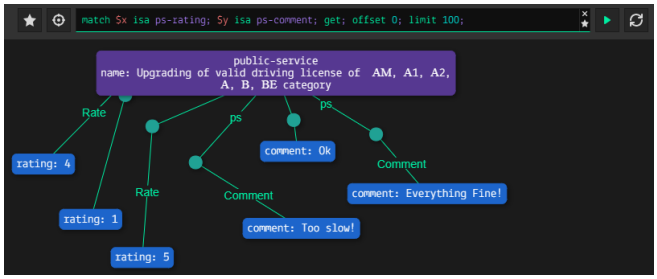


Figure 6: Public service with comments and ratings in Grakn Workbase (Scenario 2)

4.5.2 Usage scenario 2. In the second scenario, a public servant is interested in what citizens think about the public service. For this purpose, they look at the comments left by citizens as well as relevant ratings (Figure 6). In this scenario, rules 4.3.6 (*Matching a public service with rating*) and 4.3.7 (*Matching a public service with a comment*) were applied.

4.5.3 Usage scenario 3. In this last scenario, three citizens with specific needs used a public service. By using rule 4.3.4 (*Matching a public service with a need*) the used public service is connected to the specific needs (Figure 7). It is therefore possible, through the rule, for interested citizens in the future to know what needs this public service serves.

4.6 Evaluate results

The results suggest that knowledge graphs can be a reliable and useful tool in storing, processing and managing all knowledge contained in public services information. Due to their structure, they can organize and categorize entities with minimum effort. Portability is also a useful feature as it allows reusing a knowledge graph schema with minimal changes. Furthermore, imposing logic on data through rules allows knowledge graphs to produce new knowledge based on existing. Finally, querying knowledge graphs is an easy process since it approaches natural language.

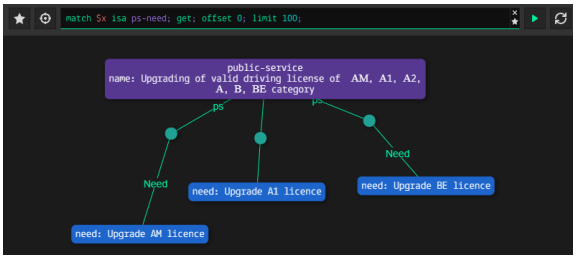


Figure 7: Public service with needs that serves in Grakn Workbase (Scenario 3)

Although the results of our research are encouraging, there are several challenges to be addressed. Creating a knowledge graph is a relatively complex process and not supported by sufficiently mature tools to be used by public servants. The lack of easy-to-use knowledge graphs management tools combined with the lack of easy-to-use querying interfaces are factors that prevents their use on a large scale. Also, the subjectivity about rules is another challenge to be overcome. Although deductive logic is applied, it is largely influenced and based on the skills of the knowledge graph developer.

5 CONCLUSIONS AND FUTURE WORK

The aim of this paper was to develop a knowledge graph compliant to the CPSV model and to discover the potential benefits of using knowledge graphs for public service description. For this purpose, we presented a knowledge graph for an enriched version of CPSV and populated it with pre-existing RDF data. Our results suggest that knowledge graphs could benefit the management of public service descriptions. Rules are the most important concept of knowledge graphs. Applying logic on data (reasoning) allows the extraction of knowledge that would be difficult to derive otherwise. The results are promising however the killer application that will make the big difference and lead to the widespread use of knowledge graphs is still to be identified.

The research presented in this paper has some limitations. First, for the selection of relevant research, we did not carry out a systematic literature review. Furthermore, our development experience was only gained from using Grakn.ai thus additional platforms should be investigated. Future work includes extending the knowledge graph schema with the Core Criterion and Core Evidence Vocabulary (CCEV) specification recently issued by the European Commission [14]. Also, the pilot application of the knowledge graph adapted to specific public services and the conduct of evaluation and interviews by both civil servants and citizens is something that can be further investigated. Finally, the creation of a platform for developing and managing knowledge graphs can lay the foundation for proving that knowledge graphs could be a useful tool for public administration.

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APPENDIX

This section present examples of code for the creation of the knowledge graph.

A TABLES (LISTINGS)

A.1 Public Service entity creation in Graql

The core class from the CPSV-AP enriched model is 'Public Service' and its creation is described in Table 3 (Listing 1). The rest of the entities in our schema are created in a similar way.

The second line of code defines the name of the entity. Lines 3 to 6 indicate the roles that this entity can play in various relations with other entities. Line 7 defines the primary key of the entity. Finally, lines 8 to 25 define the attributes of the entity that are derived from the fields of the 'Public Service' class.

A.2 Consequence relation creation in Graql

Table 4 (Listing 2) contains the code for creating the consequence relation. The rest relations are created in a similar way.

Table 3: Public Service entity creation in Graql (Listing 1)

```
1. Define
2. public-service sub entity,
3. plays require,
4. plays ps,
5. plays ps1,
6. plays related,
7. key identifier,
8. has name,
9. has description,
10. has spatial,
11. has processing-time,
12. has sector,
13. has keyword,
14. has ty-pe,
15. has language,
16. has status,
17. has thematicArea,
18. has process,
19. has availability,
20. has deadline,
21. has additional-content,
22. has appeal-complaints,
23. has last-updated,
24. has creator,
25. has Consequence;
```

Table 4: Consequence relation creation in Graql (Listing 2)

```
1. define
2. consequence sub relation,
3. relates ps,
4. relates ps1;
```

Table 5: Consequence rule creation in Graql (Listing 3)

```
1. inf-consequence sub rule,
2. when {
3. $ps isa public-service, has identifier $id1;
4. $ps1 isa public-service, has identifier $id2;
5. $out isa output, has identifier $idout;
6. $ev isa evidence, has identifier $idev;
7. (ps: $ps, Evidence: $ev) isa has-input;
8. (ps: $ps1, Output: $out) isa has-output;
9. $idev == $idout;
10. $id1 != $id2;
11. }, then {
12. (ps: $ps, ps: $ps1) isa consequence;
13. };
```

A.3 Consequence rule creation in Graql

Table 5 (Listing 3) presents the creation of the consequence rule.

A.4 Data migration example from RDF to knowledge graph (graql)

In Table 6 (Listing 4) we present the process we followed for the migration of the data through an example.

The example of Table 6 (Listing 4) concerns the fourth public service of our data set. This section defines its attributes and relations with the other entities.

Table 6: Public service 4 definition in RDF [13] and knowledge graph database (Listing 4)

RDF store	<http://data.dai.uom.gr:8890/PublicServices/id/ps/ps0004> a cpsv:PublicService ; dct:title "Approval of application for the participation in exams for obtaining a construction machinery operator license" ; dct:description "Application submission for the participation in exams in order to obtain a construction machinery operator license" ; dcat:keyword "license" ; cv:sector "M71.1.2 - Engineering activities and related technical consultancy" ; dct:type "General public services n.e.c." ; dct:language "el" ; cv:isGroupedBy <http://127.0.0.1: 3345/Starting+business%3A+Needing+a+license%2C+permit+or+certificate+to+start+or+continue+an+activity> ; cv:hasCompetentAuthority <http://data.dai.uom.gr:8890/PublicOrganization/id/nuts3/GRC_PRF_IPEIR> ; cpsv:hasInput <http://data.dai.uom.gr:8890/PublicServices/id/doc/BachelorDegree> ; cv:hasFormalFramework <http://data.dai.uom.gr:8890/LegalFramework/id/law/3982_2011> ; cpsv:produces <http://data.dai.uom.gr:8890/PublicServices/id/doc/Certificate0004> ; dct:spatial "http://publications.europa.eu/resource/authority/atu/GRC_PRF_IPEIR" ; cv:hasChannel <http://data.dai.uom.gr:8890/PublicServices/id/channel/ServiceBureau> ; cv:processingTime "P15D" ; cv:hasCost <http://data.dai.uom.gr:8890/PublicServices/id/cost/cost0003> ; dcat:keyword "Operator" ; cpsv:hasInput <http://data.dai.uom.gr:8890/PublicServices/id/doc/DrivingLicenseB> ; cv:hasFormalFramework <http://data.dai.uom.gr:8890/LegalFramework/id/pd/113_2012> ; dcat:keyword "Machinery" ; cpsv:hasInput <http://data.dai.uom.gr:8890/PublicServices/id/doc/HealthCertificate> ; cv:hasFormalFramework <http://data.dai.uom.gr:8890/LegalFramework/id/cmd/0005_2013> ; dcat:keyword "Construction" ; cpsv:hasInput <http://data.dai.uom.gr:8890/PublicServices/id/doc/Certificate0018> , <http://data.dai.uom.gr:8890/PublicServices/id/doc/Certificate0003> , <http://data.dai.uom.gr:8890/PublicServices/id/doc/ReceiptPayment> .
Knowledge graph	$ps4 isa public-service, has identifier "<http://data.dai.uom.gr:8890/PublicServices/id/ps/ps0004>", has name "Approval of application for the participation in exams for obtaining a construction machinery operator license", has description "Application submission for the participation in exams in order to obtain a construction machinery operator license", has keyword "license", has keyword "Operator", has keyword "Machinery", has keyword "Construction", has language "el", has spatial "http://publications.europa.eu/resource/authority/atu/GRC_PRF_IPEIR", has processing-time "P15D", has ty-pe "General public services n.e.c.", has sector "M71.1.2 - Engineering activities and related technical consultancy"; $gb4 (Event: $event1, ps: $ps4) isa grouped-by; $hau4 (ps: $ps4, po: $po1) isa has-competent-authority; $hop4 (ps: $ps4, Output: $op4) isa produces; $hco4 (Cost: $cos3, ps: $ps4) isa has-cost; $hch4 (ps: $ps4, Channel: $ch1) isa has-channel; $hin4-1 (Evidence: $ev3, ps: $ps4) isa has-input; $hin4-2 (Evidence: $ev14, ps: $ps4) isa has-input; $hin4-3 (Evidence: $ev5, ps: $ps4) isa has-input; $hin4-4 (Evidence: $ev50, ps: $ps4) isa has-input; $hin4-5 (Evidence: $ev9, ps: $ps4) isa has-input; $hin4-6 (Evidence: $ev8, ps: $ps4) isa has-input; $hlr4-1 (lr: $fr5, ps: $ps4) isa hasFormalFramework; $hlr4-2 (lr: $fr32, ps: $ps4) isa hasFormalFramework; $hlr4-3 (lr: $fr20, ps: $ps4) isa hasFormalFramework;

Enhancing Firms' Financial Support Decision-Making with Predictions of Technological Resilience to Economic Crises

Euripidis, Loukis
University of the Aegean
eloukis@aegean.gr

Niki, Kyriakou
University of the Aegean
nkyr@aegean.gr

ABSTRACT

Economic crises of different durations, intensities and geographic scopes are often appearing in market-based economies, while at the same time the economic stability periods become shorter. They have several negative impacts on firms, which include a decrease of their technological investments in various technological resources (e.g., production equipment, ICT, etc.). This can result in firms' technological backwardness and obsolescence, and finally lower competitiveness and growth, or even threaten the survival of many firms. At the same time, economic crises can have some positive impacts on firms as well, as they put pressure on them to exploit more efficiently their resources by rationalizing and improving the relevant processes and practices they follow for using and exploiting their resources, including the technological ones, which can have positive impacts on their competitiveness and growth. Therefore, institutions that provide financial support to firms, such as government agencies (through various government firms' financial support programs), banks (through the provision of various kinds of loans), and institutional investors, in their relevant decision-making should take into account not only criteria concerning firms' economic performance during normal economically stable periods but also criteria concerning their 'technological resilience' (with respect to their main production technologies, ICT, etc.) during economic crises periods as well. This is important because low technological resilience in economic crisis periods can result in severe technological backwardness and obsolescence, and finally lower future competitiveness and growth, and even threaten their survival. This paper proposes a methodology for enhancing government agencies', banks' and, institutional investors' decision-making concerning the financial support of firms by adding to pre-existing relevant criteria predictions of firms' technological resilience to economic crises. Having as theoretical foundation the resources and capabilities theory from the strategic management domain, we view technological resilience as a two-dimensional concept, which consists of a) the extent of reduction of technological investments during economic crises, and b) the extent of rationalization and improvement of their technological resources' exploitation processes and practices during economic crises. These predictions are based on existing data from government agencies (Statistical Authorities), which are used to construct relevant prediction models through artificial intelligence techniques from the area of machine learning. Also, an application of this methodology is described, which gives satisfactory results.

KEYWORDS

economic crisis, technological resilience, technological investment, technological rationalization, artificial intelligence, machine learning

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1 INTRODUCTION

Economic crises that result in recessions (=contractions of economic activity) of different intensities are repeatedly appearing in market-based economies, while at the same time, the economic stability periods become shorter [1]-[6]. In [2] are mentioned the numerous significant economic crises that have appeared in the last century; a decade ago, we experienced the severe 2007 Global Financial Crisis, which had quite negative consequences for economies and societies worldwide, while recently, we experienced the economic crisis caused by the COVID-19 pandemic [7], and currently, we are at the beginning of another economic crisis caused by significant increases in the prices of energy and other important essential goods. Economic crises have severe negative consequences for firms: a) decrease in firms' production, procurement, and personnel employment, which have severe negative short-term impacts on firms; and b) decrease of their technology investments in various important technological resources (e.g., production equipment, ICT, etc.), which have severe medium- and long-term impacts on firms, as they can result in firms' technological backwardness and obsolescence, leading to lower competitiveness and growth, and can even threaten the survival of many firms. At the same time, economic crises can have some positive impacts on firms as well [1][2][4][5], as they put pressure on them to exploit more efficiently their resources, including the technological ones (e.g., production equipment, ICT, etc.), by rationalizing and improving the processes and practices they follow for using and exploiting these resources and generating value from them, which can have positive impacts on their competitiveness and growth. In particular, during economic crises, the market demand for most products and services decreases, so the competition among firms increases for this reduced market demand, and the most efficient competitors, who

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exploit their inputs and resources more efficiently, and can therefore offer to customers products and services with higher 'value for money', will gain larger shares of this reduced market and survive; on the contrary, the remaining and less efficient competitors will gain only small shares of this reduced market and will experience a large decrease of their sales revenue, and some of them might even not survive. Therefore, firms strive to become more efficient and competitive during tough times of economic crises in order to be among the former and not among the latter firms. The above economic crisis impacts are stronger in high-tech sectors, as well as for sectors characterized by higher levels of technological change and evolution; however, these impacts will be strong for all sectors concerning the ICT, as there is a wide adoption of and reliance on ICT throughout the economy, as well as a strong tendency for 'digital transformation' [8], and exploitation of some disruptive ICT, such as artificial intelligence (AI) [9].

The intensity of the above technology-related negative as well as positive impacts of economic crises differs significantly among firms [2]-[4],[6]: some firms manage to cope better with the crisis and have minimal (or even not at all) decrease of their technological investments, and at the same time can exploit more efficiently their technological resources, by rationalizing and improving the processes and practices they follow for using and exploiting their technological resources, during the crisis, so they exhibit 'higher technological resilience to economic crises' (being the 'technological winners in economic crises'); on the contrary some other firms cannot cope with the crisis and have to resort to drastic decrease of their technological investments during economic crises periods, and at the same time are not able to exploit better their technological resources, by significantly rationalizing and improving the efficiency of processes and practices they follow for using and exploiting their technological resources, so they exhibit 'lower technological resilience to economic crises' (being the 'technological losers in economic crises'); furthermore, there will be also 'intermediate' firms, which exhibit 'moderate technological resilience to economic crises'. Strategic management literature [10] has traditionally emphasized the importance of both resources acquisition and capabilities development for firms: it has theorized that it is necessary not only to acquire resources but also to develop appropriate processes and practices for using and exploiting these resources efficiently, in order to create higher levels of capabilities for performing their main tasks and functions, and finally achieve higher levels of performance; this holds even more for firms' technological resources (e.g., production equipment, ICT, etc.), since their efficient use and exploitation, is more complex and sophisticated, and requires significant effort and extensive knowledge.

The importance of firms' resilience, defined as their capacity to 'survive, adapt and grow in the face of turbulent change' [11], has been widely recognized by management literature due to the rapidly changing firms' economic environment in the last decades (due to technological change, economic crises, etc.). Particularly important is a firm's 'technological resilience' to economic crises, defined as the degree of maintaining its technological capacity and level with respect to the main technologies it employs (e.g., the main production technologies and ICTs it uses) during economic crises. Based on the abovementioned resources and capabilities theory [10] from the strategic management domain, we regard the technological resilience of a firm to economic crises as a two-dimensional concept, having as main components:

- the extent of decrease of a firm's technological investments during economic crises (higher levels of it indicate lower technological resilience),
- the extent of rationalization and efficiency improvement of the processes and practices the firm follows for using and exploiting its technological resources during economic crises (as higher levels of it indicate higher technological resilience).

The levels of firms' technological resilience to economic crises should be taken seriously into account by public and private institutions that provide various forms of financial support to firms, such as government agencies (running various kinds of firms' financial assistance, support, and subsidy programs), banks (providing various kinds of loans), or institutional investors (making investments in various kinds of firms) in their relevant financing decision-making. As economically stable periods become shorter and economic crises periods longer, the above public and private institutions should enhance their decision-making about firms' financial support by taking into account not only the usual criteria concerning firms' economic performance during normal economically stable periods but also criteria concerning their 'technological resilience' (with respect to their core production technologies, ICT, etc.) during economic crises periods as well. This is quite important since a firm's low technological resilience in such economic crisis periods can result in severe technological backwardness and obsolescence, and finally lower future competitiveness and growth, even threatening its survival.

This paper proposes a methodology for enhancing government agencies', banks', and institutional investors' decision-making about financial support of firms by adding to pre-existing relevant criteria, which concern mainly economic performance during regular economically stable periods), some additional criteria concerning firms' predicted technological resilience to economic crises. The predictions of the above two dimensions of technological resilience are based on data from government agencies, mainly Statistical Authorities, which are used to construct relevant prediction models through AI techniques from the area of machine learning (ML) [9, 12-14]. Also, a first application of this methodology is described, which gives satisfactory results.

The proposed methodology will be pretty valuable to all government agencies running various kinds of firms' financial assistance, support, and subsidy programs (e.g., central, regional, local economic development agencies), as well as all banks and institutional investors, for making better decisions concerning the financing of firms. It can also be more widely beneficial to all firms for enhancing their decision-making concerning strategic medium- or long-term co-operations with important partners, suppliers, or even customers, by taking into account their technological resilience as well (among the other criteria they usually take into account); if such strategic partners, suppliers, and customers exhibit low levels of technological resilience to economic crises that will appear in the future, this is going to result in technological backwardness and obsolescence of them, with negative impacts on the success of these strategic co-operations.

Initially, we present the background of our methodology in section 2, then the methodology in section 3, and the abovementioned application in section 4, while section 5 summarizes our conclusions.

2 BACKGROUND

As mentioned in the Introduction, during economic crises, firms usually reduce their technological investments in production equipment, ICT, and other technological resources, which in the medium- and long-term results in technological backwardness and obsolescence, leading finally to lower competitiveness and growth, while it can even pose threats to the survival of many firms, especially in high-tech sectors [1-6]. At the same time, economic crises can have some positive impacts on firms as well [1, 2, 4]: during economic crises there is an increase in the competition among firms for the reduced market demand for most products and services, and this puts pressure on the firms to exploit better and more efficiently their resources, by rationalizing and improving the processes and practices they follow in order to use and exploit their resources, including the technological ones, so that they can finally offer to their customers (who become more 'price sensitive' during economic crises) products and services with higher 'value for money'; this can have positive impacts on their efficiency, competitiveness, and growth after the crisis.

However, the above impacts of the economic crises differ considerably among firms. Some firms can cope better with the crisis, have a higher capacity to make the required adaptations to the special crisis conditions, and offer higher value-for-money products and services (which are highly valued by the numerous customers who experience a severe drop in their income due to the crisis), and therefore have minimal (or even not at all) decrease of their sales revenue so they can afford only a minimal (or even not at all) decrease of their technological investment. On the contrary, some other firms cannot cope with the crisis, as they cannot make the required adaptations to the special conditions it gives rise to, and offer appropriate products and services with higher value-for-money, so they have a severe decrease in their sales revenue, and therefore have to make drastic decrease of their technological investment. Furthermore, some firms are able to significantly rationalize and improve the efficiency of the processes and practices they follow for using technological resources during the crisis, so they can extract more benefits and value from them in order to address the increasing competition and the special conditions of the economic crisis, while some other firms cannot. Therefore, based on the abovementioned resources and capabilities theory [10], we can distinguish between four categories of firms concerning their technological resilience to economic crises:

- Firms exhibiting a small extent of decrease of technological investments during crises, and at the same time a large extent of rationalization and efficiency improvement of their technological resources' use and exploitation processes and practices during economic crises; these firms exhibit a high level of technological resilience to economic crises and can maintain their technological capacity, so they can be called 'technological winners in economic crises'.
- Firms exhibiting a large extent of decrease of technological investments during crises, but at the same time a small extent of rationalization and efficiency improvement of their technological resources' use and exploitation processes and practices during economic crises; these firms exhibit a low level of technological resilience to economic crises, so they experience major reduction of their technological capacity and can be called 'technological losers in economic crises'.
- Firms exhibiting a large extent of decrease of technological investments during crises, but at the same time a large extent of rationalization and efficiency improvement of their technological resources' use and exploitation processes and practices during economic crises; these firms exhibit a moderate level of technological resilience to economic crises, as on the one hand, they decrease technological investments, but on the other hand they can extract more benefits and value from their existing technological resources, so they experience a moderate loss of their technological capacity.
- Firms exhibiting a small extent of decrease of technological investments during crises, but at the same time a small extent of rationalization and efficiency improvement of technological resources' use and exploitation processes and practices during economic crises; these firms exhibit a low level of technological resilience to economic crises as well, on the one hand, they do not decrease significantly technological investments, but on the other hand they cannot extract more benefits and value from their technological resources, so they experience a moderate loss of their technological capacity.

As discussed in more detail in section 3, we expect that the individual characteristics of a firm, such as human resources, technological resources, processes, structure, etc., will determine the category to which the firm will belong with respect to technological resilience to economic crises.

3 THE PROPOSED METHODOLOGY

Previous economic as well as management science research, has identified the main elements of a firm that determine its performance; we can expect that these elements might determine to a considerable extent firm's performance during a crisis in coping with the difficult economic crisis conditions, and therefore the degree of its resilience to the economic crisis, including its technological resilience. Economic research traditionally identifies the main production factors of a firm that determine its output and performance: a) its capital (meant as the different kinds of production equipment it uses), and b) its labor (Cobb – Douglas production function), while later, the wide use of ICT lead to discrimination between non-computer capital and computer capital, and also between non-computer labor and computer labor; subsequently the importance also of firm's 'organizational capital' (meant as processes and structures adopted by the firm) as well as 'human capital' (meant as the skills and knowledge of firm's human resources) for its output and performance were recognized [15-17]. At the same time, management science research has developed several conceptualizations of the main elements of a firm that determine its performance; the most widely recognized one is the 'Leavitt's Diamond' framework [18]. According to it, the most critical elements

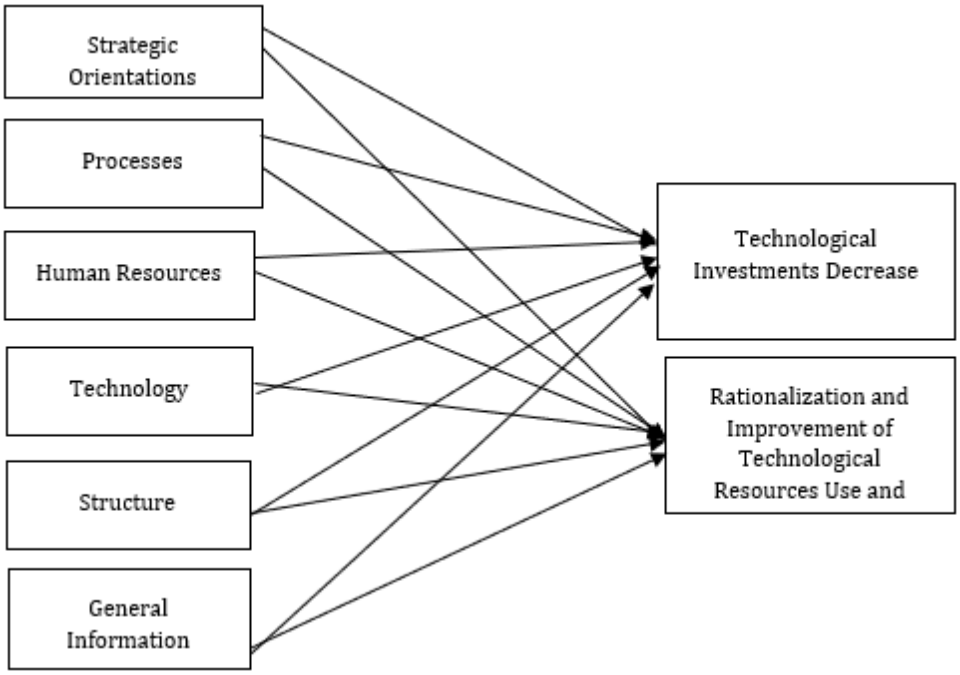


Figure 1: Structure (dependent and independent variables) of models of technological resilience to economic crises

of a firm that determine its performance are: a) its task (strategies and processes); b) people (skills of human resources); c) technology (= the technologies used for implementing administrative and production tasks); and d) structure. An extension of it has been developed subsequently, which analyses the above 'task' element into the 'strategy' and 'processes' elements [19]. We remark that most of the above five main elements of a firm that determine its performance according to this framework correspond at least to some extent to those determined by relevant economic research: the 'technology' corresponds to capital (non-computer and computer one), the 'people' correspond to labor - human resources, the 'structure and the 'processes' part of the 'task' correspond to organizational capital. Therefore, we expect that firm's characteristics concerning the above five main elements (strategy, processes, people, technology, and structure) might be good predictors of its performance and resilience, including its technological resilience, during economic crises.

The proposed methodology is using/leveraging existing government firm-level data for large numbers of firms from an economic crisis period (which in most countries are possessed by the Statistical Authority) concerning, on the one hand, the above five principal firm elements that determine its performance (to be used as independent variables):

- strategies: the extent of adoption of the main strategies described in relevant strategic management literature [10], such as cost leadership, differentiation, focus, innovation, export, etc.
- processes: characteristics of a firm's processes, such as complexity, formality, flexibility, etc.
- human resources: characteristics concerning the education and skills level of a firm's human resources
- technology: characteristics concerning the use of various essential production technologies, ICT, etc.
- structure: characteristics concerning various aspects of the structure of the firm, such as its main structural design [20],
- and also, we can include general information about each firm, such as sector, level of firm's comparative performance in this sector, etc.

moreover, on the other hand, data (to be used as dependent variables) about:

- the extent of a firm's technological investments decreases during economic crisis,
- the extent of rationalization and efficiency improvement of technological resources' use and exploitation processes and practices of the firm during an economic crisis.

Using the above data, we can construct prediction models of these two dimensions of a firm's technological resilience to economic crises (extent of decrease of technological investments, the extent of rationalization and efficiency improvement of technological resources' use and exploitation processes and practices), based on the above characteristics of it, using ML algorithms (e.g., Decision Trees, Random Forests, Gradient Boosted Trees, Support Vector Machines, Generalized Linear Modelling, etc.) [9, 12-14]. The structure (dependent and independent variables) of these models of technological resilience to economic crises are shown in Fig. 1

We can construct either overall firm's technological resilience models or more specialized ones focusing on the main production technologies used by the firm, ICT, etc.

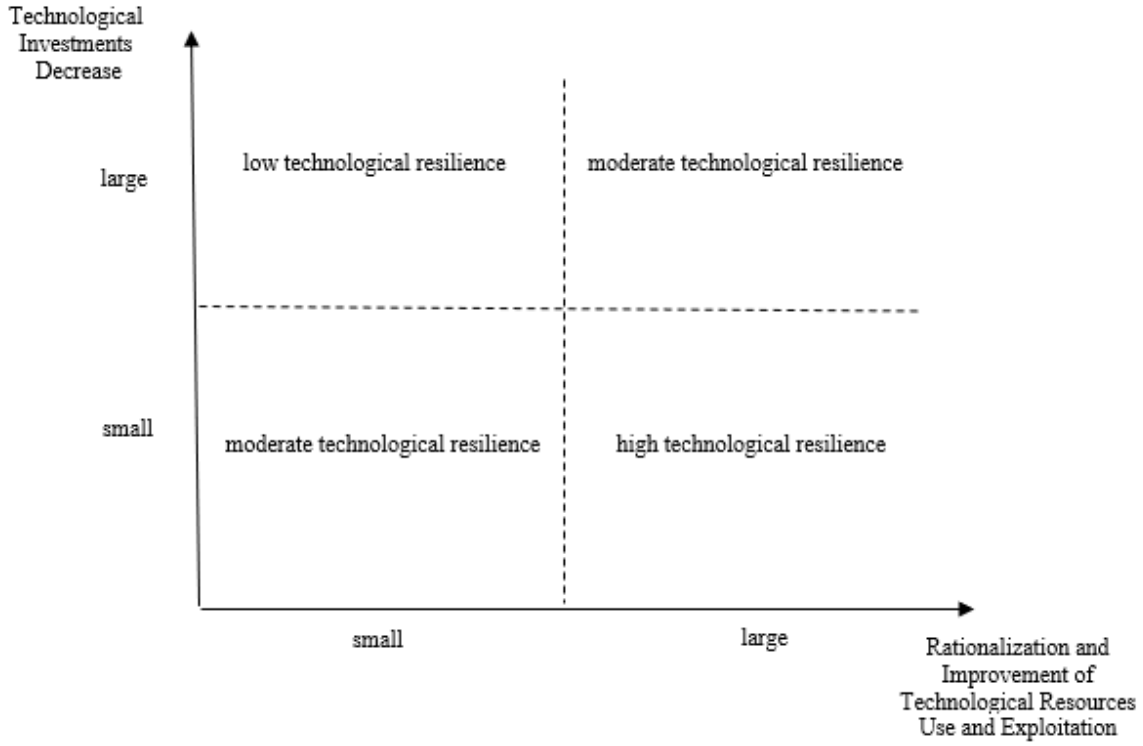


Figure 2: Categories of firms with respect to technological resilience to economic crises

The predictions of these two dimensions of the technological resilience to economic crises we can estimate for a firm using the above-constructed prediction models can be used: a) for classifying it in one of the four categories of firms with respect to technological resilience to economic crises, which have been defined at the end of section 2 (see Fig. 2); and b) as additional criteria for making decisions concerning the provision of financial support to the firm (in addition to the usual 'traditional' criteria used for this purpose, which concern mainly firm's economic performance during normal economically stable periods).

4 APPLICATION

We applied the proposed methodology using data concerning 363 Greek firms for the economic crisis period of 2009-2014 from the Greek Statistical Authority in order to construct prediction models of the two dimensions of firm's technological resilience concerning the ICT (ICT investment reduction and ICT exploitation processes rationalization and improvement due to economic crisis), based on firm's characteristics. In particular, we used data regarding the ICT investment reduction and ICT exploitation processes rationalization and improvement due to the economic crisis in the period 2009 – 2014 of 363 Greek firms. For the former, we used four ordinal variables: (1) the extent of reduction of investments in ICT hardware during the economic crisis (ICT_H_INV_RED), (2) the extent of reduction of investments in ICT software during the economic crisis (ICT_S_INV_RED), (3) the extent of reduction of investments in ICT training of personnel during the economic crisis (ICT_T_INV_RED), and (4) the extent of reduction of investments in ICT consulting services during the economic crisis (ICT_C_INV_RED); these five variables were measured in a common six levels scale (increase, no change, small reduction, moderate reduction, large reduction, very large reduction). Based on these four variables, the ICT investment reduction variable (ICT_INV_RED) was calculated as their average, which was our first dependent variable. For the latter, we used four ordinal variables: (a) the extent of rationalization/improvement of the processes and practices the firm follows for the development of ICT strategies and plans linked to the overall business strategies and plans (ICT_STR_PR_RAT), (b) the extent of rationalization/improvement of the processes and practices the firm follows for the implementation and management of ICT projects (ICT_PM_PR_RAT), (c) the extent of rationalization/improvement of the processes and practices the firm follows for the operation and support of its information systems (ICT_OP_PR_RAT), (d) the extent of rationalization/improvement of the processes and practices the firm follows for the support of ICT users (ICT_US_PR_RAT). These five variables were measured in a common five levels scale (not at all, to a small extent, to a moderate extent, to a large extent, to a very large extent). Based on these four variables, the ICT processes rationalization variable (ICT_PR_RAT) was calculated as their average, which was our second dependent variable.

We also used as data about 40 characteristics of these 363 firms, which involve their strategic orientations (12 variables concerning the extent of adoption of cost leadership, differentiation, export as

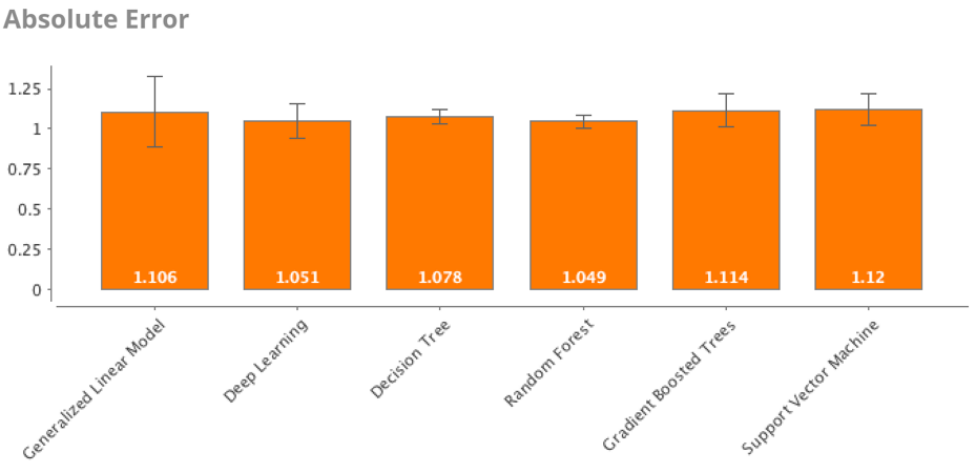


Figure 3: Mean absolute prediction errors of the five ML algorithms for the prediction model of ICT_INV_RED.

well as products/services and process innovation strategies), human resources (9 variables concerning shares of firm's employees of various educational levels, as well as shares of firm's employees using computers and having access to firm's Intranet as well as the Internet, and share of ICT personnel), technology (13 variables concerning the extent of use of ERP, CRM, SCM, Business Analytics (BA), Collaboration Support (CS) and e-sales systems, as well as social media and cloud), structure (1 variable concerning the use of 'organic structural forms of work organization, such as teamwork and job rotation), and also general characteristics (5 variables concerning size, sector as well as comparative performance in the sector); these 40 variables were used as independent variables in both models. These 363 firms cover a wide range of sectors and sizes: 40.2% of them are in the manufacturing sector, 9.4% in construction, and 50.4% in the services sector; also, 52.6% of them are small, 36.1% medium, and 11.3% large businesses.

Using the above data, we constructed prediction models for the ICT_INV_RED and ICT_PR_RAT variables based on the 40 firm characteristics mentioned above, using the RapidMiner software, with five different ML algorithms for the case of continuous dependent variable: Generalized Linear Modelling, Deep Learning, Decision Trees, Random Forest, Gradient Boosted Trees, and Support Vector Machines. Fig. 3 shows the prediction performance of the five models for the ICT_INV_RED variable, evaluated through the mean absolute prediction error. Similarly, Fig. 2 depicts the mean absolute prediction error of the models for the ICT_PR_RAT variable. The mean absolute error of each predictive model was calculated by dividing the data set is divided randomly into two parts. The first part includes 90% of the records and is used to train the prediction model, while the second part includes the remaining 10% of the records and is used to test the model. The model trained by the first portion of the input data (the initial 90%) is then used to predict the dependent variables ICT_INV_RED and ICT_PR_RAT on the second part of the data (the remaining 10%). The absolute difference between each record's predicted and actual value (error) is calculated. This value represents the absolute prediction error. The process is repeated ten times, and the mean value of the absolute error over all ten iterations is calculated as a measure of the prediction performance of the algorithm. This value represents the mean absolute prediction error shown in Fig. 3 and Fig. 4

We can see in Fig. 3 that these five prediction models for the ICT_INV_RED have similar levels of prediction performance, with error rates ranging from 1.049 to 1.114. The Random Forest algorithm exhibits the lowest mean absolute error (1.049). In Fig. 4, we can see that the five prediction models for the ICT_PR_RAT also have similar levels of prediction performance ranging from 0.842 to 0.891. The Gradient Boosted Trees algorithm exhibits the lowest mean absolute error (0.842). The above results are satisfactory with respect to prediction performance, given the small size of the dataset we have used (data from 363 firms).

5 CONCLUSIONS

In the previous sections has been described a methodology for enhancing government agencies', banks', and institutional investors' decision-making concerning the financial support of firms by adding to pre-existing relevant criteria (concerning firm's economic performance during normal economically stable periods) predictions of firm's technological resilience to economic crises. This is quite useful, taking into account that economic crises of different durations, intensities, and geographic scopes are appearing with increasing frequencies in market-based economies, while at the same time, the economic stability periods become shorter. In our analysis, we adopt an approach based on 'resources and capabilities' theory [10] from the strategic management domain and include both the negative impacts of the economic crises on firms' technological level (decrease of investments in technological resources) and also the positive ones as well (rationalization and improvement of the exploitation of technological resources). This is done by conceptualizing a firm's technological resilience to economic crises as a two-dimensional concept, which consists of a) the extent of decrease of technological investments during economic crises (higher levels of it indicate lower technological resilience); b) the

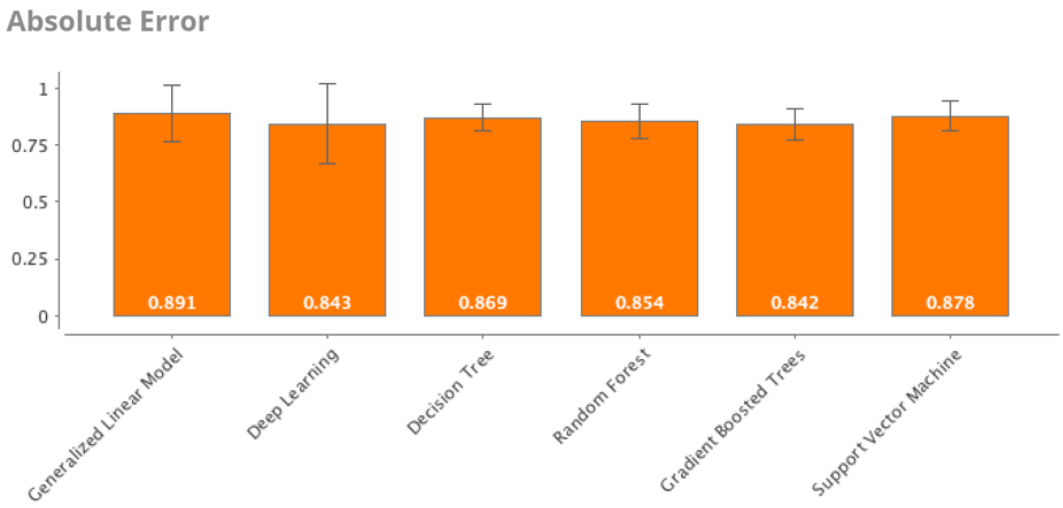


Figure 4: Mean absolute prediction errors of the five ML algorithms for the prediction model of ICT_PR_RAT.

extent of rationalization and efficiency improvement of technological resources' use and exploitation processes and practices during economic crises (higher levels of it indicate higher technological resilience). The prediction of these two aspects of a firm's technological resilience to economic crises is based on a wide range of firm's characteristics (concerning firm's strategies, processes, technology, structure, and general information). For estimating these prediction models are used existing government data for economic crisis periods from Statistical Authorities.

The study described in this paper has interesting implications for both research and practice. With respect to research, it creates new knowledge in the highly important and rapidly growing area of government AI exploitation [21-23], which has attracted recently quite high interest from both academics and practitioners, and also in the areas of government data analytics and evidence-based decision-making, concerning a quite important type of decisions that government agencies, and also banks and institutional investments, have to make: the selection of firms that will receive some kind of financial support. The proposed methodology allows enhancing this type of financial decision-making by taking into account not only the normal economically stable periods, but also the quite threatening recessionary economic crises that repeatedly appear in market-based economies and have quite negative impacts (among others) on firms' technological level, which can result in technological backwardness and obsolescence, leading to lower competitiveness and growth, and can even threaten the survival of many firms. With respect to practice, it proposes a methodology of using existing historic government data for constructing prediction models of the abovementioned two aspects of firms' technological resilience to economic crises, which can be quite useful to public and private institutions that provide various forms of financial support to firms, in order to direct their scarce financial resources to firms that have not only good economic performance during normal economically stable periods, but also high technological resilience during economic crises periods. In particular, our methodology can be quite useful to government agencies running various kinds of firms' financial assistance, support and subsidy programs, to banks providing various kinds of loans and to institutional investors who make investments in various kinds of firms. It can also be more widely useful to all firms for enhancing their decision-making concerning strategic medium- or long-term co-operations with important partners, suppliers or even customers, by taking into account their technological resilience as well (among the other criteria they take into account).

Future research is required for further application of the proposed methodology using larger datasets, possibly with wider sets of independent variables (firms' characteristic), and for different kinds of technologies (e.g. various production technologies). Also, it is necessary to investigate the prediction performance of other ML algorithms, such as Deep Learning ones. Finally, the proposed methodology has to be extended and include more dimensions of technological resilience.

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Does web page loading speed matter? An analysis in the Brazilian Public Service Portals

Beatriz, B. B. Lanza
IDB, Center for Technology in Government SUNY Albany
beatrizlanza@gmail.com

Maria, A. Oliveira
SGI/SAD/MS, Superintendência de Gestão da Informação-MS
cida.oliveira@gtdgov.org.br

Yohanna, Juk
UFPR, Universidade Federal do Paraná
yohannajuk91@gmail.com

Thiago, J. T. Ávila
FGV-EAESP, Fundação Getúlio Vargas
thiago.avila@fgv.edu.br

Daniel, S. Valotto
UFPR, Universidade Federal do Paraná
danielvaloto@gmail.com

ABSTRACT

Anyone who browses the internet expects to get information quickly and securely, so the time it takes to load a website can be decisive for user loyalty. On non-governmental websites, users who access these websites on smartphones will abandon them if it takes more than three seconds to load. As public services have no competition, that is, the citizen will not have the option of obtaining the service elsewhere, he will not abandon it. But this experience will have a negative impact on the citizen. The objective of this work is to present research on the loading speed of Public Service Portals (PSC) in Brazilian states and the Federal District, to emphasize that this is a relevant attribute in the quality of public services, especially in countries that face great challenges. with the internet infrastructure. It was carried out a load test on the PSC of the 26 states and the Brazilian Federal District, comparing them with each other and with some international PSCs. Data were collected using the Testmysite tool (Google), using 4G internet. The results indicate that the loading speed of service portals is an important attribute that should be considered when developing or when improving high-quality public services, but only one than 27 PSC from Brazilian states presented a fast performance.

KEYWORDS

Digital Government, Portal Public Services, Webpage Loading Speed

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1 INTRODUCTION

Managers and researchers in the area of public administration, especially those concerned with Digital Government, must be aware of the attitudes and behaviors of users of public services. Some researchers have specifically studied behavioral aspects of public service users, for example [1], who considered that attitude is a strong determinant of behavioral intention, which implies that the governmental organization may find it beneficial to influence the use of available solutions positively.

Considering that performance expectation and effort expectation are the antecedents of attitude, this implies that individuals provide substantial importance to a digital government solution [1]. So this solution needs to be practical, easy to use, and fast. Therefore, designers, systems analysts, and developers responsible for government systems development and implementation projects should focus more on minimizing the complexities associated with exploring and using the systems and tools so that the acceptance and use of such solutions can be managed more successfully.

Possible ways to achieve these goals could include a broader and more accurate representation of user requirements for systems analysts, designers, and developers, or even selecting and comparing the system with other digital government systems that are more consistent with user requirements and have wide acceptance as well as effective communication of system capabilities (e.g. [2]; [3]; [4]; [5]).

Research on the quality of public service becomes even more relevant when looking at the provision of services through service portals [6]. According to [6], the literature has not advanced in its investigation or even in the proposition of a framework that evaluates the quality of public services offered in the form of portals services, despite it being one of the most common forms and presenting greater heterogeneity in the quality of services. Author [6] considers that services began to be offered individually by departments as the internet began to be incorporated into the public sector. Such a trend in the provision of services directly affects the experience of users who do not find all the services offered in a unified way in a single portal, leading to what the author calls "inconsistencies and redundancies."

In this context, it would be up to the user, the citizen, to understand the service offering architecture, which is not user-friendly. Thus, the use of "public service packages" is advocated, significantly facilitating the user experience. As argued by [7] and [6], quality is a common factor used as a predecessor of behavioral intentions.

High-quality service packages have a high potential for impacting users' behavioral intentions.

According to the latest analysis on Brazilian state and district government public service portals, mobile pages on some of these portals take up to twelve seconds to load. Even considering the average of these portals, which is 5 seconds, it is still far from being considered adequate. According to Google's own classification, speed above 4 seconds is slow [15] [16].

Users who access non-governmental sites on smartphones and tablets abandon these websites when the loading speed exceeds three seconds. However, as public services have no competition, the citizen will not have the option to obtain the service elsewhere; he will not abandon the service. But this delay will jeopardize the user experience,

When it comes to mobile pages, speed and weight matter, and governments need to keep citizens at the center so that their digital experiences are mobile-first. In a country like Brazil, where there is no equal access to the internet with broadband, the vast majority of users of public services use them on cell phones and, often, use public Wi-Fi - such behavior indicates that the speed of information loading is an important attribute. The cell phone is the main device used by Internet users in Brazil, reaching almost the total user population, about 99%. About 58% access the internet exclusively using their cell phone [17].

It is an important point that justifies the accomplishment of this work. Not only to draw the attention of public service portal managers but to direct the technical developers of these service portals that if the construction is not done well, also taking into account the communication and hosting infrastructure, this directly affects the loading time and, consequently, will directly affect the use of solutions made available to citizens.

This work aims to emphasize that the loading time of information from public service portals matters, especially in countries that face major challenges with low internet infrastructure. A survey will be used with the loading speed of public service portals in the Brazilian States and Federal District; then, the Brazilian result will be compared with countries referencing Digital Government. Furthermore, technical recommendations will also be presented to guide governments in building their portals.

The work is divided into five sections, including the Introduction and Conclusions. In the second section, we will present the current context of internet supply infrastructure in Brazil and information about relevant attributes related to the loading time of websites. Next, the theoretical foundation of the present study will be presented, anchored in scholars' perceptions about the use of government solutions to citizens in the form of service portals and the main attributes raised by the literature that influence the use of these solutions to the population. In the third section, the study's methodology is described, accompanied by the presentation of the research results. Finally, we present the final remarks.

2 BACKGROUND

2.1 Internet access profile in Brazil

Brazil has 152 million Internet users, which corresponds to 81% of the country's population aged ten and over. The estimate is from the ICT Households 2020 survey (COVID-19 Edition - Adapted Methodology), promoted by the Brazilian Internet Management Committee (CGI.br). The survey results indicate a growth in the proportion of households with internet access in urban and rural areas, all regions, family income brackets, and social strata. However, despite the greater reach of the Internet in Brazil, the indicators point to the persistence of inequalities in access, with a prevalence of users from higher classes, educated and young people. Brazilian internet usage also shows positive growth and remains above average in Latin America, moving from 34% of the total population in 2008 to 74% in 2020 [8]. OECD [8] claims that these indicators demonstrate "Brazil's significant potential for improvement regarding digitalization and digital inclusion during the next years" (p.2).

Although the data are positive and internet access has expanded in recent years in Brazil, driven by the Brazilian ICT sector and high-speed internet penetration [8], internet access does not always translate into online interaction by part of the users. Some aspects such as usability, accessibility, and web security vulnerabilities can be investigated to understand the population's adherence to digital services.

When talking specifically about access to e-government services, 60% of Brazilian citizens started interacting with the public sector through the internet in 2016. The use of information and communication technology (ICT) has become of great importance in delivering public services to users [9]. Some factors should accompany this trend, which would be assessing the quality of e-government services identifying strengths and weaknesses that can further improve user adherence and experience.

The private sector already carries out evaluations like this, considering aspects indicated by the Google Search Platform itself, called ranking factors that consider various points that positively or negatively affect the positioning of some service websites on Google's results pages. While these are fundamental factors for the private sector, the public sector does not have this type of concern regarding ranking, precisely because they are official government pages and have greater domain authority, already guaranteeing the best positioning in search pages.

However, these factors can still be of great value to improve the quality of service offered to citizens. Investing in usability, for example, can increase trust in e-government services. However, research indicates that e-government web portals tend to have usability and accessibility problems [9, 10].

Among these factors, we highlight the loading time and speed of e-government websites. Digital consulting firm Akamai conducted research that identified that page load times significantly impact conversion rates. Improving accessibility and page speed performance, in turn, improves audience reach and digital service adoption.

Citizen-government online interactions can be even better if aspects such as those mentioned are considered when offering public services in the same way that the private sector considers them.

2.2 User experience in online public service

The provision of public services by governments has been a relevant topic of discussion for some years now, and it became particularly

relevant during the Covid-19 pandemic, which demanded a mandatory digital transformation of several services, including public services. Information and Communication Technology (ICT) was presented to increasingly offer digital services to provide citizens with an online access channel and reduce the cost of public services [11]. Thus, great attention was paid by governments to encourage citizens to adopt online service delivery channels.

Governments have used a specific model for offering online services that include a structure and content tailored to their citizens' needs. At first, service portals were offered in a departmentalized way, which directly affects the quality of the service and the user experience itself [6].

The so-called 'Governmental Transformation' comes precisely from this process of rethinking the provision of public services, thinking about the experience of the citizen and not the organizational structure (departmentalized) of the governments themselves. The use of "one-stop online portals (OSPs)" was verified from this process. According to Wimmer and Tambouris, the online one-stop government allows citizens to have 24-hour access to electronic public services from their homes, on their phones, providing accessibility. Providing services in a citizen-oriented view calls for a new, service-oriented design approach..

Although the use of single portals for the provision of public services was discussed a decade ago, their implementation has not been as widespread, having been achieved by only a few jurisdictions. In this way, a theoretical, analytical gap on the subject can also be verified [6, 11]. [6] advances this theme by promoting a discussion of aspects of quality and satisfaction related to the provision of public services from the citizen's perspective and presents the main theoretical discussions on the subject. The studies identified by the author, in general, do not present a single focus of analysis and propose a wide range of different analytical dimensions to assess the quality of a portal, such as accessibility, security/privacy, and usability. In addition, the author also highlights other aspects addressed in the literature review, these processes being: 'integration', 'personalization', 'added value' and 'data quality'. [6] points out that the dimensions mentioned are important to assess the portal's quality specifically.

[18], in the incipient phase of eGOV transformations, developed a holistic approach that integrates the following perspectives for assessing the quality of OSPs: a) strategic framework – which refers to the view on the basic organizational requirements (the strategy, basic roles, the strategic decisions and constraints) develop for a one-stop Government system; b) processes and workflow – refers to general business strategies and basic roles are substantiated; c) interaction – refers to the integration of the process models, the people and information technology involved and the data and information objects belonging to the process; and finally d) information technology - concerned with the technical implementation of the IT components of the one-stop government system such as the portal, the service repositories, a standardized data and information exchange format, etc.

Although this discussion had already evolved since [18] 's proposition, this approach indicates that there are many ways to evaluate the maturity and quality of OSP, and this paper shall focus on a specific attribute related to the information technology field. The authors' also emphasizes that to succeed with a one-stop government portal, the specific needs of the different (external) user groups need to be investigated and appropriately addressed, and these aspects can be addressed in many ways, such as:

a) Functionality: Services relevant for the user group
b) Security: Technical aspects at the user's site
c) Reliability: The user should rely on the way the system works and count on its timeliness.
d) Multilinguality: The system should not be restricted to one language. The user should be able to choose the language in which s/he wants to use the system.
e) Usability: The user should feel that the system is easy to use, that he can operate it intuitively, that interaction objects have consistent behavior. Usability can also be understood in terms of how the user can achieve specified goals when accessing OSPs with effectiveness, efficiency and satisfaction in a specific context of use. Effectiveness refers to the accuracy and completeness with which users achieve specific goals. Usability can have further criteria described by [19]: i) Learnability, the system should be easy to learn so that the user can rapidly start getting some work done. ii) Memorability, the system should be easy to remember so that the casual user can return to the system after some period of not having used it; iii) Error rate, the system should have a low error rate so that users make few errors during the use of the system, and so that if they do make errors, they can quickly recover from them.
f) Navigation: The navigation concept must be designed so that the user knows where he is at the moment and what he can do at this point.

Among the usability aspects listed, a fundamental point is precisely the speed with which the user can interact with the government services portal, and this can be accessed from the loading speed of the website in question, thus considering the aspects listed by the author, regarding effectiveness, efficiency, and satisfaction.

Only limited studies focus directly on this aspect when talking about usability and loading speed of service portals [11]. However, none of them specifically focus on the structure of the portal or packages. [12] are the only authors that could be identified through the literature review that focus on an OSP life event.

We also highlight the approaches of [9], [13], [14], which, through case studies in their respective countries, determine the importance of investing in the fast loading of information to affect the use of OSP solutions by the citizens directly. Furthermore, while the results show an important attribute, governments do not always consider this a valid concern when building their digital solutions. The Tanzanian government, for example, does not consider this a priority, with more than half of its OSPs (56 out of 79) having low loading speeds for their main page and more than 37% of their websites having an average duration of more than 10 seconds. Furthermore, the author [9] points out that considering this attribute at the time of system development will ensure greater use and reflect lower costs than correcting these aspects after the OSP is published. This information points to the need to diagnose this information to promote awareness of these attributes on digital governments.

3 METHODOLOGICAL PROCEDURES

This work aims to show that attributes such as the loading time of information from public service portals matter, especially in countries that face significant challenges with the internet infrastructure, such as Brazil. Thus, this study fits as exploratory basic qualitative research [20].

To achieve our research purpose, we conducted a load test on the public service portals of the 26 states and the Brazilian Federal District. This research specifically focused on the state level to make it possible to reflect the Brazilian reality, given that Brazil still does not have a single, integrated portal with public services. The loading speed of the Brazilian federal government service portal (gov.br) was also measured, where all services provided by the federal government are available.

Brazil was analyzed because it is a country that still does not have a single public services portal. That is, all its 27 states and 5,570 municipalities have their service portals without single technical guidelines to be followed, is a typical example for portraying situations that allow exploring possibilities for improvement.

To collect the loading speed information, we used the Testmysite application from Google, available at <https://www.thinkwithgoogle.com/intl/pt-br/feature/testmysite/>, using the 4G network as a reference. This free tool is made available by Google and allows one to evaluate the speed of websites and offer recommendations to improve users' experience [21].

Data collection was carried out on January 13, 2022. In order to later have a broader aspect of comparing the results, the speed of the portals of the following countries was collected: United States of America, Chile, Uruguay and England. The choice of these countries was made at random, but at the same time considering the leading role in digital government in their region or continent.

The speeds of all service portals of Brazilian state governments and the Federal District were measured: Acre (AC), Alagoas (AL), Bahia (BA), Ceará (CE), Federal District (DF), Espírito Santo (ES) , Goiás (GO), Maranhão (MA), Mato Grosso (MT), Minas Gerais (MG), Pará (PA), Paraíba (PB), Paraná (PR), Rio de Janeiro (RJ), Rio Grande do Norte (RN), Rio Grande do Sul (RS), Rondônia (RO), Roraima (RR), Santa Catarina (SC), Sergipe (SE), and Tocantins (TO).

As for the states of Amapá (AP), Amazonas (AM), Mato Grosso do Sul (MS), Pernambuco (PE), Piauí (PI) and São Paulo (SP), the Testmysite tool was unable to complete the cycle to present the result of the velocity. The causes were not investigated, as technical issues are not part of the investigation scope of this research.

The loading speed results were classified by the Google application itself and comply with the following classification criteria: Fast: up to 2.5 seconds, Medium: from 2.5 to 4.0 seconds and Slow: above 4.0 seconds.

The data from the responses were tabulated, summarized and analyzed using the content analysis technique [7]. Then, the result of the loading time of Brazilian state portals was compared with the loading speed of the Brazilian Federal Government Portal (gov.br) and portals from countries that are a reference in Digital Government.

4 RESULTS AND ANALYSIS

4.1 Loading Speed in Brazilian State-level Online Portals

The speed of uploads from the leading or single service portals in the 26 Brazilian states and the Federal District was measured. The domains and links are shown in Table 1. The six states (UF) with the NA (not applicable) registration could not get the speed due to technical issues with the Testmysite application.

The result shows that only one Brazilian state, Rio de Janeiro, obtained the "Fast" rating (up to 2.5 seconds) for having obtained a loading speed of 2.3 seconds on its portal. Most of the portals measured (71.42% of the 21) were classified as "Medium," with a loading speed between 2.6 and 3.9 seconds. Four states (BA, CE, GO, MA) and DF were rated "Slow" as their website loading speed was between 4.0 and 11.8 seconds.

4.2 Examples in countries

The measurement of loading speeds by country shows that the USA, Uruguay, and England's public service portal was classified as "Fast," the portals of these countries took only 2.3 to 2.5 to load. However, Chile's loading time was 4.4 seconds, i.e., classified as Slow. The same happened with Brazil, which took 5.4 seconds for its page to load.

Considering the average loading speed of Brazilian state portals of 4.0 seconds, added to the loading speed of the Brazilian federal government portal (gov.br) of 5.4 seconds, the Brazilian average is 4.7 seconds. Based on this information, it was possible to perceive that the Brazilian performance has great potential for improvement, especially when we consider the performances of countries such as the USA, with a loading speed of 2.5 seconds, and the countries Uruguay and England, both with a loading speed of 2.3 seconds. Including Uruguay, a Latin American country with slow performance, but even better than the Brazilian result.

4.3 Technical Recommendations

As this work aims to point out that the loading time of information from public service portals matters, this chapter presents some technical recommendations to guide governments in the construction process to reduce the loading time of their service portals.

Companies like Google, for example, recommend technical actions to be used in optimizing the loading speed of commercial websites, which are useful for developers of public service portals. These recommendations range from (a) minimizing CSS (Cascading Style Sheet) code to eliminate unnecessary data to create faster response times and reduce bandwidth costs; (b) avoiding page redirects by replacing them with direct links; (c) minimizing JavaScript (Programming Language for the Web) code to eliminate code file of all unnecessary data to create faster response times and reduce bandwidth costs; to (d) serving static resources with an efficient caching policy to speed up page load time for recurring users [21].

For all portals that were classified as "Slow" and "Medium," a list of recommendations was suggested by the application. These easy-to-implement technical actions are highly recommended, especially for portals classified in these two levels. In the Brazilian case, Notably to the portals: a) from the state of GOiás (GO), which

Table 1: Speed in the 27 States and Brazilian Federal District

UF	*Speed(seconds)*	*Classification*	*URL*
AC	2,6	Medium	acre.gov.br/cidadao/
AL	2,8	Medium	alagoasdigital.al.gov.br/
AM	NA	NA	amazonas.am.gov.br/servicos/cidadao/
AP	NA	NA	superfacil.portal.ap.gov.br/
BA	9,6	Slow	sacdigital.ba.gov.br/
CE	4,3	Slow	ceara.gov.br/
DF	4,1	Slow	df.gov.br/category/servicos/
ES	2,9	Medium	conectacidadao.es.gov.br/
GO	11,9	Slow	go.gov.br/
MA	4,0	Slow	www.ma.gov.br
MG	2,7	Medium	mg.gov.br/
MS	NA	NA	www.ms.gov.br
MT	3,5	Medium	www.mt.gov.br
PA	2,6	Medium	estacaocidadania.pa.gov.br/
PB	3,9	Medium	portaldacidadania.pb.gov.br
PE	NA	NA	pecidadao.pe.gov.br
PI	NA	NA	www.pi.gov.br/servicos/
PR	3,7	Medium	pia.br.gov.br
RJ	2,3	Fast	www.rj.gov.br
RN	3,4	Medium	www.rn.gov.br
RO	3,1	Medium	rondonia.ro.gov.br
RR	3,2	Medium	portal.rr.gov.br
RS	3,2	Medium	www.rs.gov.br
SC	3,6	Medium	www.sc.gov.br
SE	3,3	Medium	se.gov.br
SP	NA	NA	cidadao.sp.gov.br
TO	3,5	Medium	servicos.to.gov.br

Table 2: Comparing loading speed of public service portals among countries

Country	*Speed(seconds)*	*Classification*	URL
Brazil	5,4	Slow	www.gov.br/
United States	2,5	Fast	www.usa.gov/
Chile	4,4	Slow	www.chileatiende.gob.cl/
Uruguay	2,3	Fast	www.gub.uy/
United Kingdom	2,3	Fast	www.gov.uk/

presented a time of 11.9 seconds to load its page; b) to the state of Bahia (BA) with 9.6 seconds; c) the state of Ceará (CE) with 4.3 seconds; the state of Maranhão (MA) with, the Federal District with 4.1 seconds. And also, the portal of the Brazilian federal government with the service portals of state governments and the Brazilian Federal District was compared with the result of the loading speed of portals from countries that are a reference in Digital Government.

Considering that this requirement directly affects users of public services with low broadband infrastructure, the recommendations suggested in this work can help mitigate the problems faced by users of public services. These are technical recommendations that can be easily implemented, in a shorter time and with less investment, while governments face the challenges of solving the problems of inadequate internet infrastructure in their countries, which demand more time and more investment. Brazil still has a long and significant challenge ahead, considering that 19% of the

5 FINAL REMARKS

The present work aimed to draw attention to the fact that the loading time of information from public service portals matters, especially in countries that face significant challenges with low internet infrastructure, as is the case in Brazil. As Brazil does not have a single service portal, the loading time of Brazilian state portals was used to get closer to the country's reality. In order to show that this requirement is far from ideal, the result of the research

Brazilian population over ten years old still does not have access to the internet [8], 35 million citizens.

This study had some limitations, for example, the absence of information from all Brazilian state units (26 states and the DF). This may not have reflected the real average page load time. The choice of countries at random can also be a significant limitation. A choice with more grounded justifications can help understand the importance of this requirement (loading speed of service portals) when inserted in the context of each country used as an example of comparison.

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Towards a Definition of a User Profile in E-government: The Mexican and the Spanish Cases

Rodrigo Sandoval-Almazan
Autonomous University of the State of Mexico
rsandovala@uaemex.mx

Adrian O. Millán Vargas
Autonomous University of the State of Mexico
aomillanv@uaemex.mx

Javier Cifuentes-Faura
University of Murcia, Spain
Javier.cifuentes@um.es

ABSTRACT

E-government is a global transformation that has permeated many governments worldwide. Practices for online tax payments, virtual organizations, and even online participation and cooperation are standard. However, the study of the users of these technologies has been scarce. This research aims to shed some light on users' profiles of online government services and proposes ideas that will help decision-makers improve the implementation of these services by redefining the profiles. We have studied data from national surveys in Mexico and Spain from 2018 to 2020, accessing two data records: 1. E-government downloaded formats, and 2. E-government online queries to understand the evolution of users' profiles based on age, gender, education, and socioeconomic level.

CCS CONCEPTS

• **CSS Concepts: Social and professional topics** → Computing / technology policy; Government technology policy; Governmental regulations.

KEYWORDS

e-government, citizen-profile, e-services, Mexico, Spain

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1 INTRODUCTION

Digital transformation in governments has seen an unprecedented boom in the last years. Bureaucratic processes, governmental procedures, and civil servant routines have adapted to this new reality of wicked problems [6] [22] and created a synergy between the digital government, open data, public innovation, and data governance [11] [3].

Digital government has had different phases. The first was accessing and developing online government services [14]. The second was the development of government portals and platforms [10] at all government levels. The next stage was the study of online citizen-government interaction, which has changed due to social networks and web 2.0. [9] [17].

More recently, the study of e-government has focused both on citizen participation [19] and on the use of artificial intelligence to have a personalized portal according to citizens' needs.

This research is between the second stage - the development of platforms and portals - and the more recent one that seeks how to engage citizens in online activities. The identification of profiles has been studied from different perspectives: from the life path: birth, schooling, marital status, death [8, 20, 26] and professional profiles: homemakers, professionals [13, 24] to the actual generated automated profiles, such as the case of Australia, where artificial intelligence is already being used [12].

The research question that leads this investigation: what characteristics should a user profile of digital government portals currently contain? Our study seeks to update previous research on the definition of profiles and provide new ideas to be more accurate in determining them, supporting decision-makers.

For this purpose, we collected data from Mexico and Spain from 2018 to 2020, using official institutions such as INEGI and INE, to compare the user profiles of both countries and achieve greater precision in our analysis.

This paper is divided into six sections, including this introduction. The second section reviews the literature to specify the current advances in e-government, the identification of profiles, and similar studies. The third section is the methodology that outlines our data collection and study method. The fourth section describes the obtained findings in both countries and makes a comparative effort between the two. The fifth section presents the discussion with a proposed user profile based on the Spanish and Mexican cases that can study Latin American efforts or be applied in other countries with similar characteristics. Finally, the sixth section presents conclusions and future studies on this topic.

2 LITERATURE REVIEW

This section consists of two subsections: a) directed to e-commerce and e-government studies related to identifying user profiles; b) comparison between similar studies.

2.1 User Profiles in E-commerce and E-government

The first attempt to explain e-government evolution was through stage models. These models show the maturity of e-government portals but do not reflect the changes in the user profiles. Layne and Lee [17] proposed the first stages: (1) cataloging, (2) transaction,

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(3) vertical integration, and (4) horizontal integration. Ten years later, Lee [18] expanded the knowledge of this model and found two underlying themes: citizen/service and operation/technology.

Research from Pieterson, Ebbers, and van Dijk [21] started from the assumption that user profiling offered the excellent potential for improving government e-services. They found that governments face different and more profound organizational obstacles than the private sector when engaging in user profiling. On the other hand, Dimitrova and Chen [5] were pioneers in analyzing the characteristics of users of e-government services in the United States beyond non-demographic features. They identified three that can determine profiles: perceived usefulness, perceived uncertainty, and civic mindedness.

Scholars Chan & Pan [4] conducted a comparative case study of implementing two e-government systems in a single government agency in Singapore. Their conclusions offered the alternative of involving prominent intermediaries and stakeholders in implementing e-government systems. Complementary research from De Meo [7] proposed a decision support system supported by a citizen profile database, which uses the social security number, age, education level, and income to compare with another service database that can link both.

Khan et al. [16] research in developed countries used traditional G2B, G2C, and G2G profiles to state that government skills can help identify user profiles. Other scholars like Ayachi, Mellouli & Elouedi [2] analyzed users' needs for digital government services based on their behavior on social networks. They proposed a new framework to provide citizens with tailored content and personalized services that met their needs and matched their profiles to ensure universal access to government services. This literature research demonstrates the existence of scholarly research about the interaction between government and user profiles.

2.2 User Profiles and E-government

Previous research on user profiles for e-government reported results. One of the first pieces of research related to user profiles was presented by Akman et al.[1] in Turkey, identifying e-government users' profiles and found that neither education nor gender can influence the use of e-government platforms.

Verdegem & Verleye [25] developed a comprehensive model for measuring user satisfaction in e-government. They rethought e-government strategies and developed a conceptual model derived from the ICT acceptance theory. They suggested nine key indicators for user satisfaction that can help build a user profile, such as infrastructure determinants, availability, knowledge, cost, technical aspects, ease of use, security/privacy, content, and usability.

Similar research from Susanto and Goodwin [23] developed a model to identify whether the use of SMS messaging with the government facilitated services. A survey of Indonesian users determined the validity of their model, which contained 13 constructs: ease of use, convenience, perceived responsiveness, behavioral control, self-efficacy, facilitating conditions, and normative and social influence.

Furthermore, Hung et al. [15]identified the factors determining users' acceptance of e-government services. For this purpose, they analyzed a sample of 331 users of e-government services in Taiwan. The authors concluded that perceived usefulness, ease of use, trust, interactivity, external influence, interpersonal influence, self-efficacy, and facilitating conditions are critical factors in enhancing users' acceptance of e-government services.

Our research is based on secondary data from two national surveys, considering gender and age as relevant indicators. These studies demonstrate the importance of identifying profiles within digital government based on user needs. We learned that indicators or constructs are related to external perception – trust, convenience, interactivity, and external influence. However, there is not much recent research about this topic that updates the new information needed during emergencies and crises and considers new young government users. This investigation aims to fill this gap and proposes new ideas for profile e-government users.

2.3 Method

The objective of this section is to describe the methodology. It is a quantitative, descriptive, and longitudinal study. This section is divided into three sections: 3.1. Description of the sample (Mexico and Spain); 3.2. Description of the considered variables; 3.3. Statistical analysis.

3 DESCRIPTION OF THE SAMPLE (MEXICO AND SPAIN)

The exploration and description of Internet use in Mexico and Spain have been an institutional attempt to understand the status and development of this Information and Communication Technology (ICT) in the different areas of social life. This work has been developed by applying an annual survey of national representation that measures various items related to the availability of electronic devices and the type of Internet use in homes and by users.

In the case of Mexico, the National Survey on Availability and Use of Information Technologies in Households (ENDUTIH) has been implemented by the National Institute of Statistics, Geography, and Informatics (INEGI), which characterizes the phenomenon of ICT availability and use at different levels (national, federal entities, urban, rural, and by socioeconomic status) since 2015. The ENDUTIH included questions focused on Internet use for government procedures since 2017. These questions seek to know the type of government interaction, the government procedures, and the frequency of interaction with the government through the Internet.

In Spain, the National Statistics Institute (INE) has implemented the Survey on Equipment and Use of Information and Communication Technologies in Households (EEUTICH) since 2002, which collects information on household ICT equipment (Internet connection, fixed and mobile telephony, computer equipment) and the population's use and new Internet habits: activities carried out, use of e-commerce, computer skills, and knowledge, measures adopted on protection, security and privacy, relations with e-government and teleworking. Within the EEUTICH, a module of questions is considered on the relationship with public administrations and services through the Internet, related to the contact and the interaction concerning citizens' obligations, rights, official documents, public educational services, and public health services.

Table 1: Analyzed Variables

Main variables		Factors	
Consult government information	Download government formats	Gender	Man
			Woman
		Age	16 to 24 years
			25 to 34 years
			35 to 44 years
			45 to 54 years
			55 to 64 years
			65 to 74 years
		Level of schooling	None
			Primary
			Middle school
			High school or technical/baccalaureate or vocational training
			Bachelor
			Master's
			Doctorate
		Socioeconomic status	Low
			Medium-low
			Medium-high
			High

Source: Author's data

Table 2: Comparison between Mexico and Spain of digital government users

	Mexico			Spain		
	2018	2019	2020	2018	2019	2020
Users who consult government information	22.20%	23.20%	18.90%	64.8%	62.4%	66,1%
Users downloading government formats	26.60%	23.90%	20.30%	44%	39.5%	44.4%

Source: Author's data

In both cases, related to the use of the Internet to interact with the government, the surveys allow knowing demographic, economic, and behavioral characteristics in users' use of the Internet, which, for this research, is a primary source for the profiling of users.

3.1 Variables

This research conducted a descriptive analysis of frequencies of the data from the national surveys referred to in the previous section. Data from 2018, 2019, and 2020 surveys were selected as they were the complete databases available to be compared between the two countries and allowed a longitudinal description of the development and current state of the profile of digital government users.

We identified the sociodemographic characteristics (gender, age, schooling level, and socioeconomic status) of Internet users who consulted government information and downloaded government forms. These variables have been used because they were available in both surveys.

3.2 Statistical Analysis

Internet users who download government formats report a decrease, going from 26.6% in 2018 to 23.9% in 2019, closing with 20.3% in 2020.

In the case of Spain, users' online queries for government information fluctuated in the review period, going from 64.8% in 2018 to 62.4% in 2019 and 66.1% in 2020. Concerning the use of the Internet in Spain to download government formats, a fluctuation was also observed, going from 44% in 2018 to 39.5% in 2019, ending at 44.4% in 2020.

3.3 Internet Users who Consulted Government Information

Mexico: the use of the Internet to consult government information by men has decreased in the last three years, going from 54.3% in 2018 to 53.4% in 2019 and 52.4% in 2020. It has been the opposite for women, with an equivalent growth of 45.7% in 2018, 46.6% in 2019, and 47.6% in 2020.

Spain: the percentage for men has fluctuated from 50.5% in 2018 to 49.9% in 2019 and ended at 51% in 2020. In the case of women,

Table 3: Comparison between Mexico and Spain of users seeking government information

		Mexico			Spain		
		2018	2019	2020	2018	2019	2020
Gender	Man	54.3%	53.4%	52.4%	50.5%	49.9%	51.0%
	Woman	45.7%	46.6%	47.6%	49.5%	50.1%	49.0%
Age	16 to 24 years	31.2%	30.5%	28.7%	12.9%	11.5%	11.7%
	25 to 34 years	28.6%	27.8%	26.1%	19.1%	18.3%	18.9%
	35 to 44 years	19.7%	20.1%	21.0%	26.4%	25.3%	24.3%
	45 to 54 years	13.5%	14.1%	15.6%	22.5%	23.8%	24.0%
	55 to 64 years	5.7%	6.7%	6.4%	13.8%	15.0%	15.1%
	65 to 74 years	1.3%	0.8%	2.1%	5.3%	6.1%	6.0%
Level of studies	None	.5%	0.03%	.1%	.4%	.8%	.8%
	Primary	2.2%	3.3%	3.0%	3.5%	3.4%	5.2%
	Middle school	14.3%	14.4%	17.0%	19.7%	20.0%	17.9%
	High school or technical/baccalaureate or intermediate vocational training	32.0%	34.5%	31.4%	41.5%	41.6%	41.6%
	Bachelor	45.6%	43.1%	42.9%	14.5%	14.7%	14.0%
	Master's	4.0%	3.5%	4.6%	18.7%	18.1%	18.8%
	Doctorate	1.0%	1.0%	1.0%	1%	1%	2%
	Other	.7%	.1%	.2%	0.26%	0.07%	0.11%
Socio-economic status	Low	5.4%	9.6%	8.8%	13.3%	11.8%	11.9%
	Medium low	42.2%	38.3%	45.9%	30.8%	31.2%	32.3%
	Medium high	33.1%	32.1%	28.6%	27.1%	27.9%	24.9%
	High	19.3%	19.9%	16.8%	28.9%	29.2%	30.9%

the fluctuation has gone from 49.5% in 2018 to 50.1% in 2019, ending at 49% in 2020.

Mexico reports a decreasing trend in the age group 16 to 24 years, from 31.2% in 2018 to 30.5% in 2019, closing with 28.7% in 2020. On the other hand, those in the group of 65 to 74 years is the one that has done it to a lesser extent, with a slight increase in 2020, being 1.3 % in 2018, 0.8% in 2019, and 2.1% in the last year.

In the case of Spain, the age group that has consulted government information the most in the reviewed period, unlike what has happened in Mexico, has been 35 to 44 years old, with a decreasing trend, going from 26.4% in 2018 to 25.3% in 2019, finally being 24.3% in 2020. On the other hand, as in the case of Mexico, those in the group between 65 and 74 years old is the one that has done so to a lesser extent, with 5.3 % in 2018, 6.1% in 2019, and 6% in 2020.

In Mexico, most Internet users who consulted government information have a bachelor's degree, showing a decrease in the three-year review, 45.6% in 2018, 43.1% in 2019, and 42.9% in 2020. Likewise, the group without studies was the one that consulted government information the least, with 0.5% in 2018, 0.03% in 2019, and 0.1% in 2020.

In the case of Spain, most Internet users who consulted information from the government have a baccalaureate or vocational training of medium degree, with a slight growth, which went from 41.5% in 2018 to 41.6%, sustaining 41.6% in 2020. Those Internet users who consulted government information the least do not have any level of schooling.

Finally, referring to the socioeconomic status, in the context of Mexico, Internet users who mainly consulted government information belong to the medium-low group, with 42.2% in 2018, 38.3% in 2019, and 45.9% in 2020. The group that consulted the least belongs to the low socioeconomic status, with a slight growth in the reviewed period, going from 5.4% in 2018 to 9.6% in 2019 and decreasing to 8.8% in 2020.

The case of Spain is similar to Mexico since the lower middle socioeconomic status of Internet users is the one that mainly consulted information from the government, with 30.8% in 2018, 31.2% in 2019, and 32.3 % in 2020. The ones that consulted the least are included in the low socioeconomic status, with a decrease from 2018 to 2019, from 13.3% to 11.8%, respectively, and a slight increase in 2020, with 11.9%.

3.4 Internet Users Downloading Government Formats

A change was observed in both sexes for those who downloaded government formats in Mexico. On the one hand, the percentage of men, from 51.5% in 2018, went to 52% in 2019 and 51.9% in 2020. In the case of women, the percentage was 48.5% in 2018, 48% in 2019, and 48.1% in 2020.

As for Internet users in Spain a similar fluctuation was observed in both sexes. Men went from 51 to 49.9% from 2018 to 2019, concluding at 52.5% in 2020; while women went from 49 to 50.1% from 2018 to 2019, ending at 47.5% in 2020.

Regarding the use of the Internet to download government formats in Mexico, in the same way as in the consultation of government information, the group that mostly did so was the group 16 to 24 years old, with 31.2% in 2018, 29.8% in 2019 and 31.2% in 2020. Likewise, users in the group of 65 to 74-years-old were the ones

Table 4: Comparison between Mexico and Spain of users who download government formats

		Mexico			Spain		
		2018	2019	2020	2018	2019	2020
Gender	Man	51.5%	52.0%	51.9%	51.0%	49.9%	52.5%
	Woman	48.5%	48.0%	48.1%	49.0%	50.1%	47.5%
Age	16 to 24 years	31.2%	29.8%	31.2%	12.8%	12.0%	12.0%
	25 to 34 years	28.7%	27.8%	27.8%	19.6%	19.8%	19.6%
	35 to 44 years	20.2%	21.9%	20.1%	26.5%	25.8%	25.5%
	45 to 54 years	13.1%	13.6%	14.2%	23.5%	23.7%	23.5%
	55 to 64 years	5.6%	6.4%	5.0%	13.0%	13.8%	14.2%
	65 to 74 years	1.3%	0.5%	1.8%	4.6%	4.9%	5.2%
Level of studies	None	.5%	.0%	.0%	.3%	.2%	.4%
	Primary	2.5%	1.9%	2.7%	1.5%	1.8%	3.2%
	Middle school	15.7%	15.1%	16.9%	14.9%	15.2%	15.9%
	High school or technical/baccalaureate or intermediate vocational training	33.9%	34.0%	32.4%	41.8%	41.1%	41.4%
	Bachelor	42.8%	44.9%	42.7%	16.6%	17.2%	15.4%
	Master's	3.3%	3.5%	4.2%	22.8%	22.5%	21.7%
	Doctorate	1.0%	1.0%	1.0%	2%	2%	2%
	Other	.5%	.1%	.3%	0.10%	0.10%	0.14%
Socioeconomic status	Low	6.5%	9.9%	9.2%	9.7%	10.5%	10.7%
	Medium low	45.8%	40.0%	47.2%	24.0%	27.9%	30.2%
	Medium high	30.6%	30.3%	27.6%	24.8%	28.8%	24.7%
	High	17.1%	19.8%	16.0%	29.0%	32.8%	34.3%

who used it the least, with 1.3% in 2018, 0.5% in 2019, and slight growth in 2020, reaching 1.8%.

Concerning the use of the Internet to download government forms in Spain, as in the case of consulting government information, the group that primarily did so was the group 35 to 44 years old, with a decreasing trend, going from 26.5% in 2018 to 25.8% in 2019, and 25.5% in 2020. In the same way, those who used it the least were those in the age group 65 to 74, with a slight growth: 4.6% in 2018, 4.9% in 2019, and 5.2% in 2020.

Regarding the use of the Internet to download government formats in Mexico, as in the case of consulting information, those who have done it the most are those who have a bachelor's degree, with 42.8% in 2018, 44.9% in 2019, and 42.7% in 2020. Those who used it the least were those in the group without any level of education, being 0.5% in 2018, 0.03% in 2019, and 0.04% in 2020.

In the case of Spain, both variables - download government and e-government queries - the age group that has used the service the most has a baccalaureate or vocational training. We observed a fluctuation in the three years of review, going from 41.8% in 2018 to 41.1% in 2019, closing with 41.4% in 2020. And the group that does not access both variables has some level of education, showing a slight fluctuation that goes from 0.3% in 2018 to 0.2% in 2019 and 0.4% in 2020.

For Mexico, (the variable of download format) is for those who belong to the lower-middle socioeconomic group, with 45.8 % in 2018, 40% in 2019, and 47.2% in 2020. Likewise, those who belong to the low socioeconomic status are the ones who used the Internet the least to download government formats, with a slight increase, being 6.5% in 2018, 9.9% in 2019, and 9.2% in 2020.

For Spain, the situation is different compared to Mexico (download formats) since the high socioeconomic status is the one that most did so, with 29% in 2018, 32.8 % in 2019, and 34.3% in 2020. Likewise, those Internet users who belong to the low socioeconomic group were the ones who downloaded government formats to a lesser extent, with 9.7% in 2018, 10.5% in 2019, and 10.7% in 2020.

4 FINDINGS

This research aims to understand the user profile of E-government in two countries. The leading research question: what characteristics should a user profile of digital government portals currently contain? We divide this section into three subsections according to our variables: 4.1. Information Queries; 4.2 Download Formats; 4.3 General Findings.

4.1 Information Queries

The task of information queries in e-government is one of the most useful for citizens. In this case, we have a significant difference in both countries: Mexico dropped the use starting at 22.2% (2018) to 18.9% (2020). On the contrary, Spain reported an irregular behavior in government queries from 64.8% (2018), dropped to 62.4% in 2019, and rose to 66.1% (2020). Both behaviors could be explained by the pandemic use in 2020.

The addition of the variable gender in the information queries tasks reports more complex behavior to understand the composition of different e-government profiles. For example, in the Mexican case, male behavior is consistent with the dropping tendency: 54.3% (2018), 53.4% (2019), and 52.4% (2020), a steady drop of 1% every

year. What is interesting is the increase in women's behavior by 1%: 45.7% (2018), 46.6% (2019), and 47.6% (2020)

Spain reported a similar dropping behavior of males in two years (50.5% (2018), 49.9%(2019) but an essential recovery in 2020 (51%). In contrast, female behavior is the opposite, a fluctuation from 49.5% (2018) to 50.1 (2019) and dropping to 49% (2020). More research is needed to understand the causes of this behavior in both countries.

Another tested variable in the e-government queries is age. Divided into two groups, the first group, aged 16 to 24, reports a decreasing trend of 31.2% (2018), 30.5% (2019) 28.7% (2020). The second age group, 65 to 74 age reports the contrary a slight increase in the last year 1.3% (2018), 0.8% in (2019) 2.1% (2020). This behavior could be explained by the new programs of the Federal Government related to this age segment that was published online.

In the case of Spain, the results are similar to Mexico. The first group aged 35 to 44 years observes a decreasing trend: 26.4% (2018), 25.3% in 2019, and 24.3% (2020). The second group aged 65 to 74, 5.3% (2018), 6.1 (2019, and a slight decrease 6% (2020).

Most queries on government information are done by people with a bachelor's degree in Mexico, showing a decrease during the period of the investigation: 45.6% (2018), 43.1% (2019), and 42.9% (2020). Likewise, the group with no studies is the one that least consulted government information, with 0.5% (2018), 0.03% (2019), and 0.1% (2020).

For Spain, online queries for government information have a baccalaureate or vocational training, with a slight increase every year: 41.5% (2018), 41.6%, (2019) with a steady 41.6% (2020).

Finally, in the socioeconomic status, in the context of Mexico, Internet users who mainly consulted government information belong to the lower middle group, with 42.2% (2018), 38.3% (2019), and 45.9% (2020). Similarly, the low socioeconomic group shows slight growth in the three years under review, going from 5.4% (2018) to 9.6% (2019) and reducing to 8.8% (2020).

The case of Spain is similar to Mexico since the lower middle socioeconomic status of Internet users is the one that primarily consults government information, with 30.8% (2018), 31.2% (2019), and 32.3% (2020). The low socioeconomic group decreased from 2018 to 2019, from 13.3% to 11.8%, respectively, and a slight increase in 2020 to 11.9%.

4.2 Download Formats

Regarding Mexico, Internet users who download government formats decreased from 26.6% (2018) to 23.9% (2019), closing with 20.3% (2020). Likewise, we observed a fluctuation, going from 44% (2018), 39.5% (2019), ending at 44.4% (2020). The behavior of this task with other variables is as follows:

The gender variable for the case of Mexico: there is a fluctuation in this segment of download government formats: 51.5% (2018), 52% (2019), and 51.9%(2020). In the case of women, the percentage was 48.5% in 2018, 48% in 2019, and 48.1% in 2020. The Spanish case also observes a fluctuation. Men went from 51 to 49.9% from 2018 to 2019, concluding at 52.5% in 2020; while women went from 49 to 50.1% from 2018 to 2019, concluding at 47.5% in 2020.

Using the age variable for the download of government forms in Mexico: the first group ages 16 to 24 years reported 31.2% (2018), 29.8% (2019), and 31.2% (2020). The second group of users (ages 65 to 74 years) reported a variation of 1.3% (2018), 0.5% (2019), and a slight growth in 2020, reaching 1.8%.

In Spain, both variables (downloaded formats and online e-government queries), the age group of 35 to 44 years old, reported a decreasing trend, going from 26.5% (2018), 25.8% (2019), and 25.5% (2020). Similarly, the second age group from 65 to 74 reported a slight growth: 4.6% (2018), 4.9% (2019), and 5.2% (2020).

The level of studies variable in Mexico: for both variables (downloaded formats and online e-government queries), the access group holds e-studies, 0.5% (2018), 0.03% (2019), and 0.04% (2020).

Both variables (downloaded formats and online e-government queries) also reported a fluctuation in Spain. The access groups hold a baccalaureate or vocational training, where a change is observed from 41.8% in (2018) to 41.1% (2019), closing with 41.4% (2020). The group with no education level showed a slight fluctuation ranging from 0.3% in 2018 to 0.2% in 2019 and 0.4% in 2020.

4.3 Socioeconomic

In Mexico, for the variable download government formats, the lower middle socioeconomic group was the most active, with 45.8% (2018), 40% (2019), and 47.2% (2020). Likewise, those in the low socioeconomic groups used the Internet the least to download government formats, with a slight rise, being 6.5% in 2018, 9.9% (2019), and 9.2% (2020).

Regarding Internet users who use it to download government formats in Spain, the situation is different since the high socioeconomic status is the one that mainly does it, with 29% in 2018, 32.8% in 2019, and 34.3% in 2020. Likewise, those Internet users from the low socioeconomic group downloaded government formats to a lesser extent, with 9.7% in 2018, 10.5% in 2019, and 10.7% in 2020.

5 FINDINGS

In sum, our data indicate that in Mexico, the most dominant e-government user characteristics related to information consultation are male, between 16 to 24 years, those with a bachelor's degree, and belong to the lower middle socioeconomic group. However, this profile shows a decreasing trend over the reviewed three years, in the first three groups, with sustained growth in women's profile, the 35 to 44 age group, attending secondary school.

On the other hand, in Mexico, the most dominant e-government user characteristics related to the downloading of government forms have the same features as in the case of information consultation. However, the 45 to 54 age group and those with a master's degree show slight sustained growth in the period under review.

In the case of Spain, the variable consultation of information, the characteristics were men, those between 35 and 44 years of age, those with a baccalaureate or vocational training, and those belonging to the lower middle socioeconomic group, the latter with a growing trend. In Spain, the profile showing an increasing trend is 45 to 54 years old and 55 to 64 years old, and those with a Ph.D.

In the case of downloading government formats in Spain, are men between 35 and 44 years and those with a baccalaureate or vocational training; belong to the high socioeconomic group. With Ph.D. as their level of schooling and belong to the lower middle socioeconomic group.

Concerning the differences between the profiles of users of e-government, Mexico and Spain should consider that (typically) user profiles are dependent on the technological level and maturity along with, e.g., social-economic, cultural, and political differences between countries.

This research aimed to understand the user profile of e-government in two countries. Data from both countries leads us to propose a common ground for user profiles. Downloaded formats indicate that the characteristics of the e-government users were male, aged between 16 and 24 years and between 35 and 44 years, who have a baccalaureate or vocational training, who have a bachelor's degree, and belong to the lower middle socioeconomic group.

Government queries, characteristics are like the male, aged between 16 and 24 years and between 35 and 44 years, who have a high school or middle-level vocational training, but with the difference of belonging to the lower-middle and upper-middle socioeconomic strata.

6 CONCLUSIONS

We can conclude that e-government users' profile during 2018-2020 is male, aged between 16 and 24 years and between 35 and 44 years, who have a high school or middle-level vocational training. The only difference with Mexico is that Spain's socioeconomic status is higher than Mexico's low income.

This paper aims to update the discussion of e-government profiles; our contribution is twofold. On one side, we explore the different e-government profiles and recommend a new profile or a supported one with empirical evidence from two national surveys. On the other side, we offer a cross-country comparison between Mexico and Spain on citizens' profiles on e-government access. This leads us to the apparent limitations regards the country's internet access, e-government development on services, and the amount of population, GDP, and geographical location. Another limitation is the three-year sample of national survey data; even though we have access to legacy data from 2015, the survey items were not comparable enough. Despite these differences, the common language - Spanish - is an essential key for government services.

Future research will be necessary for terms of the consequences of the pandemic. The synergy of e-government services due to the lockdowns seems to change the role and perspective of the citizens' profile, new research with data from the years 2021 and 2022 will produce different outcomes. Also, this profile needs to be tested with other characteristics such as government trust and government quality of services to expand the impact of the citizens' profile. Future research also includes testing our results with citizens through interviews or focused groups. This kind of qualitative research needs to be financed and supported in the future. We hope our research will help the public managers, CIOs, and CTOs design apps, websites, and e-services that consider this profiling to promote e-government access and use of online government services shortly.

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Challenges in the Transition towards a Quantum-safe Government

Ini, I, Kong
Faculty of Technology, Policy, and Management, Delft University of Technology
i.kong@tudelft.nl

Marijn, M, Janssen
Faculty of Technology, Policy, and Management, Delft University of Technology
m.f.w.h.a.janssen@tudelft.nl

Nitesh, N, Bharosa
Faculty of Technology, Policy, and Management, Delft University of Technology
n.bharosa@tudelft.nl

ABSTRACT

The computation power of quantum computers introduces new security threats in Public Key Infrastructure (PKI), a system used by many governments to secure their digital public services and communication. This calls for an inevitable need for governments to be quantum-safe (QS) by modifying their PKI systems to be resistant to the attacks of quantum computers. However, there is limited academic literature on a QS PKI system, and in this limited literature, the transition challenges are perceived as exclusively technological. This paper aims to create a structured overview of challenges when transitioning to a QS PKI system. We do this by reviewing literature and classifying the challenges using Technology-Organization-Environment (TOE) framework and using an expert workshop to explore the challenges in the context of the PKI system in the Dutch government. The main challenges in the technological context include no universal QS solution, legacy system, complex PKI interoperability, and vulnerable Root CA. The main challenges in the organizational context include knowledge gap, unclear governance, lack of urgency, and in-house management support. Furthermore, the main challenges in the environmental context include institutional void, stakeholder collaboration, lack of awareness, and policy guidance. The results indicate that the QS transition from the current PKI system is complex, and the challenges are socio-technical. For policy-makers, this implies that they should start early to prepare, whereas organizations are hardly aware of the process of QS transition and the topic of quantum computing is yet to develop the urgency in organizations.

CCS CONCEPTS

• **General and reference** → Document types; General conference proceedings.

KEYWORDS

Quantum-Safe Government, Post Quantum Cryptography, Public organization, Public Key Infrastructure transition challenges, Systematic



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1 INTRODUCTION

In the light of a rapidly developing digital society, governments increasingly provide electronic public services using a Public Key Infrastructure (PKI). Although it is not always obvious to users and policy-makers, the facilitation of electronic identification schemes and secure communication and information exchange in PKI depends on asymmetric cryptography [16, 52]. The asymmetric cryptography, also known as Public Key Cryptography (PKC), verifies digital identities for electronic government services using digital certificates and ensures confidentiality and integrity of communication by preventing unauthorized parties from accessing or manipulating the data [1]. The use of PKC schemes not only protects citizens' communication and personal data against cybercrime but also strengthens the process of managing, validating, and authenticating digital identities without requiring the physical presence of individuals [2-4].

The studies have indicated that the introduction of quantum computers will potentially break widely-used key encryption schemes (eg. using Shor's algorithm and Grover's algorithm), including previously mentioned PKI schemes [5, 6]. This means that PKI system will become obsolete and no longer provide secure electronic government services [7]. Although a large-scale quantum computer is not yet available, recent research breakthroughs published in Nature (eg. [8-10]) show that the development of quantum computers has been steadily advancing over the last decade. Notably, IBM has announced that a series of larger quantum computers will be delivered by 2023, paving the way for the real-world manufacturing and application of quantum computers [11]. In order to secure electronic services and communication against quantum computers, studies are calling attention to the risk of quantum computing and the need to become quantum-safe (QS) by modifying current PKC schemes in the PKI system [7, 12-14].

A deeper understanding of the challenges in transitioning towards a quantum-safe (QS) PKI system may provide us with important insights into QS transition. However, there is no structured overview of the challenges when transitioning from the current PKI system to the one that is quantum-safe. Prior literature on a QS PKI system largely focuses on technological challenges by addressing the limitation of a legacy system and the development of QS cryptographic algorithms [15-20]. By identifying different challenges

using Technology-Organization-Environment (TOE) framework, the paper provides an overview of complex challenges involved in the QS transition from the current PKI system. In doing so, the paper contributes in, namely, i) identifying relevant challenges that organizations may encounter and prioritize, ii) providing research and practical implication for the QS transition, and iii) suggesting areas for further research.

The structure of the paper is as follows: section two lays the foundational basis of current PKI systems and the need to move to a QS PKI system. In section three, the research methodology used in this paper is presented. This is followed by section four, which provides the list of challenges found in the literature review and examination of the results gathered from the workshop discussion. The paper is then concluded in section five with an overview of the results, limitations, and directions for future research.

2 BACKGROUND

This section highlights the foundational basis of current PKI systems and addresses the need to move to a QS PKI system to safeguard against quantum-computing-based threats.

2.1 Public Key Infrastructure (PKI)

PKI systems are widely used for securing digital services and information exchange. With a combination of hardware, software, security policies, and encryption mechanisms, the security framework of PKI generates, stores, distributes and manages digital certificate practices [2-4]. The digital certificates act as digital passports and guarantee the identity among the parties involved in the transactions over public networks, such as the Internet [14, 17].

To manage these digital certificates, there are several important components in the PKI system. The registration authority (RA) first needs to verify the identity of a certificate requester before Certificate Authority (CA) can issue and revoke the digital certificates [4, 21]. Thus, when RA successfully identifies the requesters, RA assures CA that the identity is checked and digital certificates can be issued. After the certificate is digitally signed by CA, it is issued and placed into a repository where certificate registers can access it [4, 22]. The digitally signed certificate from CA ensures authentication, integrity, and non-repudiation in the PKI system [23, 24].

The CAs in the PKI system are tied to Root Certification Authority (Root CA) which has the highest authority. In technical terms, PKI ensures the trustworthiness of all certificates that are issued from the CAs through a chain of trust [4]. In non-technical terms, CAs are chained together to form a certification path from Root CA. Several intermediate CAs can be created under the Root CA, and the following certificates that were issued by these intermediate CAs are trusted in the lower-level CA [3]. Thus, if Root CA is compromised, the entire certification path can no longer guarantee secure communication, confidentiality, authentication, and integrity of information [23].

Moreover, the digital certificates in the PKI system are created with digital signatures and Public Key Cryptography (PKC). The PKC uses a key pair, including one public key that must be verifiably authentic and one private key that must remain private [2, 24]. The large enough key sizes in encryption can differentiate the decryption time for those who have the key versus those who do not. The foundational basis of digital certificates lies in PKC, and the strength of PKC determines the secure environment of PKI. The most widely known PKC schemes are Rivest-Sharmir-Adleman (RSA), Diffie-Hellmann key exchange (DHKE), and Elliptic Curve Cryptography (ECC) [25].

2.2 Quantum Threat to PKI

With the existing traditional computers, it is under the assumption that modern PKC schemes seem to be secure [26]. As the pace of quantum research continues to accelerate, unfortunately, these are no longer safeguarded for two reasons. On the one hand, quantum computing works in a different physical mechanism that has the potential to perform computations much more quickly than classical computers. On the other hand, the threat of quantum computing can occur even today without having a large-scale quantum computer ready due to the store now-decrypt later attack [27].

To elaborate on the first point, the RSA encryption scheme uses the difficulty in factoring a key pair of a large prime number to ensure security against third parties who are unauthorized to find the secret key [3]. Although this is true for classical computers, quantum computing can bypass this time-consuming process and enable a key extraction algorithm for the decryption key using a method called Shor's Algorithm [5]. For other encryption schemes that are not prone to Shor's Algorithm, the need for an extensive brute-force search applies. However, these can still break with a different method called Grover's Algorithm. It offers a shortcut by allowing quantum computers to speed up this search process. Thus, Grover's Algorithm allows the search of a given size amounts to the time proportional to the square root of that size [6, 28].

With new advancements in quantum research, it is only a matter of time before the quantum computer becomes superior to a classical computer in one stage or another [29]. In 2019, Google and the KTH Royal Institute of Technology in Sweden further highlighted a breakthrough that it may be possible to break a 2048-bit RSA integer using a 20 million qubit computer in only 8 hours [30]. Thus, it comes with no surprise that further development will rapidly shorten the amount of time it takes to break modern PKC.

To continue on the second point, the threat of quantum computing can occur even before having a large-scale quantum computer. This is possible because any data that is under the vulnerable PKC schemes in the current PKI system can be under the attack Store Now, Decrypt Later [27]. Thus, the longer the data that needs to remain secure, the more susceptible it is to the attack because it will be exposed to the threat of getting harvested, stored, and decrypted later once the quantum computers become available. Even if the advanced quantum future may be years away, organizations need to begin the QS transition planning in current PKI systems as soon as possible [31].

2.3 Post Quantum Cryptography & Quantum Key Distribution: Two Solution Directions

There are various motivations across academia, industries, and governments to develop secure alternatives for current PKCs that are resistant to quantum attacks (for instance, from unfriendly

states and hacking groups). Two main areas for quantum-safe cryptography include (a) Post Quantum Cryptography (PQC) and (b) Quantum Key Distribution (QKD).

After its first workshop in 2015, the US National Institute of Standards and Technology (NIST) is currently working to find new cryptographic solutions and standards for QS PKI. The promising candidates of PQC are code-based cryptosystems, lattice-based encryption, and hash-based digital signatures [31, 32]. Although this paper does not specifically go in-depth in addressing the differences in each cryptography, it is worth noting that PQC already holds an advanced level of the theoretical ground, and it is known to fit well into existing IT infrastructures without making immense changes [33]. However, limitations still exist in the long key sizes, which may become a problem for providing an efficient system because it would take much processing time and high price for commercial usage [13].

On the other hand, QKD uses the rules of quantum mechanics of quantum bits, also known as qubits [34]. These have properties of superposition can that represent 0 and 1 simultaneously, and entanglement, where the state of one entangled particle can alter the state of all entangled particles [27, 35]. Thus, using the quantum properties in cryptography, it would be possible to detect whether the information has been corrupted and intercepted. However, additional research is needed to overcome research constraints in its distance, key generation rate, and practical application of QKD [26, 33]. To implement QKD, a quantum infrastructure is necessary, but it would result in high costs of delicate equipment [36, 37].

Although both solution directions hold appealing properties that are promising, different limitations exist in terms of optimization and performance [31]. Further research is taking place in order to identify many distributed computing scenarios, usage contexts, and hardware-based security schemes to better substitute existing algorithms [27, 29, 48].

2.4 Quantum-safe PKI Transition

The EU's Cybersecurity Strategy presented in 2020 aims to promote secure, trustworthy digital technologies and provide an impetus for cyber defense capabilities [38]. In addition to the development and application of new technologies, the strategy addresses a secure digitalization with solutions and standards of cybersecurity [39]. The topic of quantum computing was discussed next to AI and EU 5G, and the European Council expressed that there is a need for strong encryption to protect digital security and fundamental rights. However, the discussion at the EU level on quantum computing is only beginning to emerge and the organizations both in the public and private sectors still heavily rely on the previously constructed PKI system, which may still take several years to adopt and implement.

Moreover, for long-term information that needs to remain secure, it is crucial to assess the vulnerability by calculating the amount of time it would take to achieve quantum-resistance. According to Mosca [14], there are three factors to consider when assessing the quantum risk: X, Y, and Z. The X refer to the security of shelf-life, which is the time the information must remain confidential. The Y is the transition time, and the Z is the collapse time when the quantum computer is realized [14, 40]. If the time X and Y take longer than the time Z, the system will no longer be safeguarded and is susceptible to quantum-computing based threats (e.g., store now and decrypt later). Thus, the transition of the current PKI system to the one that is quantum-safe should be planned as soon as possible to prevent the potential damages.

In addition, determining the transition time for organizations would need to consider multiple factors, including the organization's cryptographic assets, vulnerability, crypto agility, and the transition budget [40]. However, the complexity of PKI transition is not often discussed, and it is described to be exclusively technical. The transition of a QS PKI system needs to take place in the entire organization so that organizations can implement QS cryptography as a solution. From the technical perspective, the latter may largely depend on the IT team's expertise and training, but the former is beyond what the organization's IT team can achieve.

3 RESEARCH METHOD

The following research questions have been formulated to identify and understand challenges in transiting to a QS PKI system.

Research Question 1: What challenges are mentioned in the literature in transitioning to a QS PKI system?

Research Question 2: What challenges are considered important and urgent for the Dutch government to transit to a QS PKI system?

Due to limited understanding of the challenges faced in the transition process toward a QS PKI system, the first research question is formulated to give an overview of challenges found in the literature when transitioning from the current PKI system to the one that is quantum-safe. The second research question builds up on the list of challenges found in the literature from the first research question to give a more in-depth understanding of the challenges faced by the Dutch government. We selected an example of the PKI system in the context of the Dutch government (eg. PKIoverheid) because 1. It provides an example of a public organization as a frontrunner in the PKI system 2. It facilitates the infrastructure with diverse stakeholders, including individuals, businesses, and other government agencies. 3. It is currently looking to transit towards a QS PKI system. We employed two research instruments to answer the above questions: (a) systematic literature review and (b) workshop discussion.

3.1 Systematic Literature Review

The systematic literature review (SLR) is a process-oriented research method that reviews the previous work on the relevant research topic and provides new research directions. The more literature acquired, the more imperative it is to interpret and understand the diverse findings from the literature [41].

Following the guidelines by Kitchenham and Charters [42], the systematic literature review was conducted by using keywords such as "quantum-safe PKI", "challenges", "post-quantum cryptography", and a combination of these keywords like "post-quantum cryptography challenge", "quantum-safe cryptography challenge" and "quantum-safe transition challenge". The literature was identified using search engines: Scopus, SpringerLink, ScienceDirect, Google Scholar, and Mendeley. Then, it was sorted from the year 2010 to 2021 to gather up-to-date literature on the topic of challenges associated with the transition to a QS PKI system. Since the academic

Table 1: List of Participants in the Workshop

Participant	Role	Organization
1	Manager of PKIgovernment	Government Agency
2	Consultant	Research Institution
3	PKI Expert	Tech Industry
4	Entrepreneur/ PKI Expert	Tech Industry
5	Researcher	Academic Institution
6	Researcher	Academic Institution

Table 2: Workshop Overview

Session	Duration	Theme
Introduction	3 min	-Quantum-safe PKI challenges & Workshop objectives
List of Challenges & SLR process	5 min	-24 challenges found in the literature
Part 1: Challenges & their importance	5 min	-Identifying four most important challenges in each context
Break	5 min	
Discussion	10 min	-Open discussion: list of 12 important challenges
Part 2: Challenges & their urgency	5 min	-Identifying three most urgent challenges from the list
Discussion	15 min	-Open discussion: Three challenges that are important & urgent
Closing	2 min	-Follow up

literature was not sufficiently rich, white papers, expert reports, and conference proceedings found on Mendeley were added to provide more details on this topic of research.

Overall, the literature search resulted in 2266 articles. After screening the title and abstract of each paper, 154 articles were chosen. Then 19 duplicate articles were excluded, and the remaining 135 articles were all read. Furthermore, 93 irrelevant articles were excluded with several additional criteria: (a) 23 articles were not about quantum computing, (b) 44 articles were not about QS PKI, and (c) 26 articles were not about QS PKI challenge. Thus, 42 relevant articles (including 11 academic literature and 31 grey literature) were selected for the review.

3.2 Workshop Discussion

To further refine the list of challenges found in the literature on the current PKI system, an interactive workshop was included in this paper. The workshop provides an interactive session with participants to discuss an issue or question [43]. This process allows the workshop to be optimized as a research method to collect data and create an environment for collaboration by extending the discussions outside the literature and sharing insights from the organization level. Due to the early-stage nature of the problem, the number of persons with expertise solely on QS-PKI was limited. The six participants in the workshop discussion included PKI experts, consultants, and researchers. The 50-minute workshop took place on 2-November, 2021, and the list of the six participants is shown in Table 1.

The overview of the workshop is shown in Table 2. The discussion in the workshop was supported by using an interactive tool called 'Mentimeter' (http://www.mentimeter.com).

For part 1 of the workshop, the participants used Mentimeter to rate each challenge from 1 (not important) to 5 (most important). Then, the four challenges in each context with the highest rate of importance were selected. For part 2 of the workshop, the participants used Mentimeter to choose three urgent challenges from the list of challenges developed in part 1 of the workshop and identified the challenges that are both important and urgent.

4 RESULTS

Section 4 is divided into 4.1 and 4.2. In section 4.1, we present the results of our systematic literature review. We do this by first explaining the framework used and providing a descriptive overview of the challenges found in the selected literature. In section 4.2, we present the discussion from the workshop about challenges that are considered important and urgent in the context of the PKI system in the Dutch government.

4.1 Long List of Challenges Found in Literature

To cluster the challenges found in the literature, the TOE framework was adopted. This is because TOE framework provides a multi-perspective view that focuses on technology implementation at an organizational level rather than an individual level [44]. Moreover, the inclusion of factors in technological, organizational, and environmental context bring an advantage when understanding a diverse set of challenges (technical or non-technical) that can emerge within and outside organizations.

The TOE framework shows that the implementation process of technology is influenced by three different contexts: Technological, Organizational, and Environmental [45]:

Technological Context: refers to the relevant technologies in the enterprise, including existing, company-related tools and emerging technologies.

Table 3: Overview of the challenges in Technological Context

Challenges in Technological Context	References
Incompatible Legacy System	[33], [46], [47], [48], [49], [50], [51], [52], [53]
Not-yet achieved standards from NIST	[31], [50], [52], [54], [55], [56]
No universal QS algorithm	[13], [31], [52], [53], [56], [57]
Implementation flaws and side-channel attacks	[48], [55], [54], [58]
Lack of reliability in QS cryptography	[46], [52], [53], [58], [59], [60]
Vulnerable Root CA	[46], [55], [61], [62], [58], [63]
Complex PKI system & interoperability	[31], [46], [50], [51], [52], [53], [56], [58], [64]
Cost of Transition	[40], [46], [53], [60], [61], [65], [66], [67]

Organizational Context: refers to the organizational characteristics including size, management structure complexity, quality of its human resources, and domestic slack resources.

Environmental Context: refers to the space where an organization carries out its activities, including participants and the administration. It is outside of an organization, which has restrictions and prospects for a high-tech revolution.

Technological Context: The list of challenges towards a QS PKI system from the literature is shown in Table 3.

- Incompatible Legacy system

Two main approaches to achieving QS cryptography are available: Post-quantum cryptography (PQC) and Quantum Key Distribution (QKD) [33]. In order to ensure the same level of protection in the legacy systems, however, more research is needed [48, 49]. Also, it is unclear how hardware and/ or software can be upgraded in the existing system and when these would be available for devices that have been operating with pre-quantum cryptographic algorithms [50-53]. While PQC may not need new infrastructure, QKD requires quantum infrastructure. With the latter approach, practical compatibility with legacy systems remains a bigger concern [46, 47].

- Not-yet achieved NIST standards

The standardization can bolster the use of cryptography and maximize interoperability [55]. The international standard can facilitate the widespread implementation of cryptography that is resistant to quantum-computing threats. In 2016, the National Institute for Standards and Technology (NIST) began a process to select practical standards and parameter guidelines for QS cryptography (eg. PQC) [31, 50, 54]. However, the process is not yet completed. The suitable alternatives to today's widely deployed algorithms still require further analysis, and algorithm characteristics are open to debate [52, 56].

- No Universal QS algorithm

There is relatively little chance that a single QS cryptographic algorithm will be selected as a replacement [13]. This is because different algorithms offer different trade-offs in key sizes and computing requirements which may affect compatibility in application devices and usage contexts [31, 52, 56]. Thus, NIST is looking to provide several alternatives (eg. PQC) within the new QS cryptographic standards. However, if too many protocols are accepted in QS standard, the complexity will result in slow transition, and additional interoperability challenges across organizations may arise [53, 57].

- Implementation Flaws & Side-Channel Attacks

The changes in the PKI system can lead to implementation flaws and side-channel attacks [58]. These include fault injection attacks, side-channel cryptanalysis, and physical cryptanalysis [54]. It is crucial to analyze how PQC algorithm functions in the interfaces offered by libraries, protocols, and hardware. The introduction to new patterns of memory usage, failure modes, and timing can expose vulnerabilities in addition to cryptographic weakness [48, 55]. Thus, it is crucial to maintain a controlled QS transition process in the PKI system to avoid any possible implementation flaws.

- Lack of reliability in QS cryptography

Not only is the standardization process of QS cryptographic algorithms currently being developed from NIST, it would also take years for new algorithms to be able to substitute existing algorithms [46, 60]. There is currently no widespread real-world use of QS cryptography, and it has yet to stand the test of time to prove its reliability and robustness [52]. Thus, new cryptography may still result in vulnerabilities being overlooked [53, 58]. Even if the standardization is complete, the newly introduced algorithms will need to be fully deployed into security systems and be accepted in organizations [59].

- Vulnerable Root CA

The Root CA creates a certification path for every certificate issued across the organization's environment. The transition to a QS PKI system also requires Root CA to be updated [58, 63]. For end-entities, a root certificate must guarantee the authenticity and validity of the certification. Thus, if your Root CA is compromised, your intermediate CAs and the key management of PKI are also no longer safe [55, 61, 62]. It is crucial that Root CA remains secure when migrating to a new system since it is difficult to detect malicious issuance once CA breaches occur and multiple fraudulent certificates are already issued [46].

- Complex PKI system & Interoperability

QS cryptographic algorithm cannot be replaced with a simple 'drop-in' method [31, 56]. This is because PKI systems have a chain of dependencies that extend to standards bodies, hardware providers, and third-party software, which may also include third-party component libraries [46, 50, 52, 53]. To enable secure and correct communication, changes in cryptographic algorithms must

Table 4: Overview of the challenges in Organizational Context

Challenges in Organizational Context	References
Lack of Urgency	[37], [40], [49], [53], [60]
Knowledge Gaps in quantum computing	[12], [40], [52], [54], [58], [67], [68]
No one-size-fits-all transition process	[13], [31], [40], [51], [52], [56], [63], [67], [69]
Lack of Crypto-Agility	[31], [48], [58], [60], [63], [64], [67], [70]
Lack of In-house management support	[14], [33], [52], [65], [71]
Unclear QS transition benefits & business case	[14], [29], [33], [51], [53]
No technical skills & qualified personnel	[40], [51], [65], [72]
Unclear QS governance: not knowing how to facilitate	[12], [31], [33], [47], [48], [51], [54]

be the same or compatible [51, 58]. The devices need to be upgraded accordingly; otherwise, they cannot guarantee the security of newly adopted cryptography [64].

- Cost of Transition

The new selection of QS cryptography may need changes in software, and hardware in the existing PKI system. Depending on the availability of resources and assets, the cost will also vary among organizations [40, 46, 67]. If the organization requires new software and upgrades in hardware for new standards, then it is inevitable that the transition will result in high costs [53, 65]. Moreover, In the absence of established QS alternatives, the solution may be to deploy hybrid solutions, and using hybrid certificates schemes could double the cost on the server infrastructure as it requires management of two systems and two certificates or more [61, 67].

Organizational Context: The list of challenges towards a QS PKI system from the literature is shown in Table 4.

- Lack of Urgency

Although it is estimated that a full QS transition of the current PKI system is a decade-long process, many organizations currently do not have the urgency to transit [37, 40, 49]. This is because the arrival of a large-scale quantum computer is perceived to be decades away, and many do not recognize the near-term threat of "store now and decrypt later" [60]. In addition, there is uncertainty in organizations to fully commit to the selection of QS cryptographic algorithms when standards are still being developed [53]. Without a collective sense of urgency, it is difficult to achieve inter-agency coordination and collaborations for a QS PKI system.

- Knowledge Gaps in Quantum Computing

Poorly understood quantum computing may delay organizations from transitioning to a QS PKI system [52, 54]. Quantum theory is often framed as something inexplicable and even difficult for physicists to fully grasp the concept. Thus, explaining the threat of the technology to other stakeholders who are not in the field is much more challenging [12, 58, 68]. When organizations do not have prior knowledge, they risk not taking timely action and resulting in fragmented solutions with unforeseen vulnerabilities [40, 67]..

- No One-Size-Fits-All Transition Process

The cryptographic assets and areas that will potentially be vulnerable to quantum computers need to be identified [40, 63]. The time and strategy needed to transit from the current PKI system would vary across organizations [13]. The transition process would depend on a selection of QS cryptographic algorithms, the lifespan of technology in the current PKI system, resources, and the capacity available [52, 69]. Also, different QS cryptographic algorithms will have different trade-offs in the performance outcomes [31, 56]. Thus, there is no direct one-way QS transition process, and the organizations need to review the constraints of their assets and the operational environment [51, 67].

- Lack of Crypto-Agility

Rapid adaptation of new cryptographic primitives and algorithms is difficult without making changes to the current PKI system, including key sizes, signature sizes, error handling properties, and key establishment processes [31, 58, 70]. Unfortunately, many protocols were not designed with cryptographic agility in mind. The established PKI system is rigid and resource-constrained to only support a handful of algorithms [60, 67]. It is essential to build crypto-agility so that a system becomes more flexible and scalable [48, 63, 64]. Lack of crypto-agility hinders organizations from responding and updating its system when vulnerabilities are discovered.

- Lack of In-House Management Support

The lack of drive to mitigate against quantum threats from the upper management can slow the process of QS PKI transition. Without the support of transition initiatives within the industry, it is difficult for organizations to realize the needs and requirements to change their existing infrastructure [52, 71]. It is crucial for organizations to develop a tactical roadmap and have a coherent policy that supports different teams in the organization to guide the process [33, 65]. Thus, without such a support system, it is difficult for organizations to put a high priority on driving the QS transition from the current PKI system [14].

- Unclear QS Transition Benefits & Business Case

Most people in the organization outside of the IT team are generally unaware of issues surrounding quantum computing- based-threats. The organizational leadership and budget controllers need to be first convinced that there are potential risks, and QS transition offers business benefits and opportunities [14, 51, 53]. Due to a limited use case of the QS cryptographic algorithm, organizations find it challenging to develop a business case to enter long-term QS transition commitment [29]. The activities related to QS transition may still remain in the areas of R&D programs, and its practical application will still be delayed [33].

- No Technical Skills & Qualified Personnel

Table 5: Overview of the challenges in Environmental Context

Challenges in Environmental Context	References
Low level of Investment in EU	[29], [52], [73], [74], [75]
Lack of awareness	[12], [37], [40], [53], [58], [60]
No clear ownership & operating institution	[12], [31], [49], [67], [76]
Different interpretation of QS PKI system (scenarios)	[31], [56], [68], [69], [77]
Lack of policy guidance	[33], [37], [59], [74], [75], [76], [78]
Various Stakeholders: Need for collaboration	[12], [33], [52], [53], [57], [73]
Legal Issues (eg. Laws & Legislation)	[54], [67], [69], [78]
Bureaucratic process (eg. ICT standards & regulations)	[58], [74], [76]

QS cryptographic schemes are relatively new and challenging even for cryptographic experts. To carry out a successful QS transition, educating qualified personnel and refining the relevant knowledge are crucial [40, 51]. Reportedly, most cryptographers work for the NSA, other government agencies, or in academia. There are only a few commercial cryptographers, and they are mostly employed by large multi-national corporations [65]. If organizations do not meet have the necessary expertise to fully execute the QS transition, they may only rely on external third parties or not at all.

- Unclear QS Governance: Not knowing how to facilitate

The research on QS cryptographic algorithms will need to be applied in a real-world environment outside the research labs [12]. However, there is no inventory in organizations to facilitate updates in infrastructure and related protocols to QS solutions [31, 51]. Organizations often do not know their entire cryptographic asset and vulnerabilities. Thus, it is difficult to assess where and with what priority the QS alternatives should be implemented [33, 47]. This calls for a high degree of decision-making, coordination and leadership efforts [33, 49].

Environmental Context: The list of challenges towards a QS PKI system from the literature is shown in Table 5.

- Low Level of Investment

There is no clear scope on how secure the quantum computing technology will be and when will quantum computing markets be profitable [29]. The investment returns for the technology will only be visible in the long run, and it is viewed that the development of quantum computing remains premature [74, 75]. The EU-based companies are not patenting enough and are lagging behind the global trend in capital investments in quantum technology [73]. Moreover, for the companies that require short-term security needs, it would be difficult to incentivize the early implementation of QS solutions and ensure that the investments have the desired impact [29, 52].

- Lack of Awareness

There is a lack of awareness of quantum computing and the threats associated with the technology. Without recognizing the issue, it is difficult to execute operational changes and security requirements needed for quantum protection [40]. In public, the risks surrounding quantum computing are largely ignored and mostly focused on its unique opportunities for scaling industry advantages [37, 58, 60]. It is crucial to create awareness so that organizations can draw up transition plans and recognize the amount of lead-time needed to make changes in their security products and infrastructure [53].

- No Clear Ownership & Operating Institution

The PKI system is known to be a technology used by all but owned by none. When organizations deploy PKI systems, they do not operate in isolation [12]. Under a complex system integration, any alterations in technological infrastructure would require actors to negotiate and coordinate problems [76]. Thus, the organizations do not have complete control over their PKI systems and require multiple stakeholders in the operating model. However, it is difficult to define the ownership of PKI systems, and its boundaries blur the extent to which organizations should initiate and take responsibility for facilitating the QS transition from the current PKI system [31, 49].

- Different Interpretations of QS PKI system

The emerging technology comes with great uncertainty and indeterminacy. For quantum computing technology, it makes room for multiple interpretations, measurements, and forecasts of QS solutions [77]. The current framing of quantum theory is yet to be presented with a straightforward meaning and interpretation [68]. With new, promising QS algorithms being presented every year, many competing solutions offer various trade-offs in the current PKI system. Unfortunately, multiple interpretations of what it means to be quantum-safe create too much noise when trying to find fit-for-purpose QS architectures necessary for organizations [31, 56, 77].

- Lack of Policy Guidance

The topic of quantum computing is not yet among the popular topics of discussion in the European Parliament [60]. The low awareness and magnitude of risks require an updated framework to account for quantum-computer-based threats and proactive policy-maker leadership [37, 76]. The right incentives through procurement policy or early adoption programs can help stimulate business cases, encourage QS transition and user engagement [33, 74, 78]. The lack of legislation and government regulations on quantum computing provides no compliance for organizations to enforce operational changes and security implementations to become quantum-resistant [14, 59, 75].

- Need for Collaboration: Various Stakeholders

Designing a cryptographic algorithm is very complex and requires knowledge in multiple sciences and engineering fields in

applied cryptography and system security [52, 57]. Moreover, transitioning to a QS PKI system requires collaboration on many levels [33]. There are varying interests and needs in government standards bodies, software solution providers, hardware vendors, service providers, international consortiums, and PKI users [52]. Thus, collaboration among various stakeholders is needed to establish well-coordinated contingency planning in the QS transition [53, 57, 73].

- Legal Issues

The facilitation of the PKI system requires several legal issues, including privacy legislation, regulations on qualified digital signatures, and NIS directive that ensures the security of network and information systems [75, 78]. The entities that process private data or offer qualified signatures are required by law to protect against state-of-the-art attacks [54]. Although these are not specified in the detailed procedures of the PKI system, the laws provide jurisdiction to ensure regulatory requirements and secure identity management [67]. Thus, legal issues need to be updated and comply with a QS PKI system and its new QS cryptographic algorithms [69].

- Bureaucratic Process

In the EU, governments play a greater role in the elaboration of PKI standards and regulations when compared to the U.S. [74, 76]. This makes it difficult to adapt the New Approach strategy to the development of ICT standards as the process is much slower and formal. While the laws and regulations can also be prescriptive to the technological change, these still require the process of auditing against standards and regulations, identification of risks or threats, and mitigation steps [58]. The bureaucratic process in adopting QS standards and its regulations adds an extra timeline to the transition. Any uncertainty in QS solutions would raise additional regulatory problems and delay the process [58, 76].

4.2 Workshop Discussion: Dutch PKI government

This section further discusses the challenges found in the selected literature in the context of the PKI system in the Dutch government. The public organizations that provide digital services to citizens, businesses, and government agencies are no exception to the quantum-computer-based threats.

The system of PKIoverheid, also known as PKIgovernment, is the PKI system in the Dutch government [79]. The system enables confidential electronic communications through email, websites, and secure information exchange with the use of the electronic signature and remote identification [80]. In order to transit towards a QS PKI system, the current PKIoverheid also needs to be modified, and QS transition needs to be planned. While the responsibility of the policy and strategy for PKIoverheid lies with the Ministry of the Interior and Kingdom Relations (BZK), the tactical management lies with Logius, which acts as Policy Authority (PA) [81].

For part 1 of the workshop, four challenges with the highest importance in each context were selected. For technological context, the important challenges include no universal QS solution, legacy system, complex PKI interoperability, and vulnerable Root CA. For organizational context, knowledge gap, unclear governance, lack of urgency, and in-house management support are identified as important challenges. For environmental context, the important challenges include institutional void, need for stakeholder collaboration, and lack of awareness and policy guidance.

For part 2 of the workshop, a newly selected list of 12 challenges from part 1 was used to further analyze the challenges that are considered both important and urgent in PKIoverheid. The participants each voted for three urgent challenges among 12 challenges. The three important and urgent challenges that were selected are lack of awareness, vulnerable Root CA, and unclear QS governance. The following paragraphs elaborate on these challenges in the context of PKIoverheid, and the discussion extends three policy recommendations that can be addressed in public organizations.

- Policy Recommendation 1: Boost awareness

One of the important and urgent challenges when transitioning to a QS PKI system was a lack of awareness. Although the implementation of eGovernment is a shared responsibility of all government organizations, the policy to develop and manage the information infrastructure is executed by Government ICT unit (ICTU) and Logius [81]. The discussion from the workshop indicated that the topics on quantum computing-based threats are only beginning to emerge in the public domain and the knowledge on how to transition toward a QS PKI system remains premature. Accordingly, most academic research on QS transition is mainly technical, and other non-technical challenges are often discussed by external third-party industries. The participants agreed that organizations would have difficulty realizing the urgency of the problem without being aware of the situation of what quantum computing-based threats are.

The discussion also pointed out that there is no clear set of identified risks or assessments available for Logius to measure the extent to which public organizations could be affected by quantum computing technology. Logius may need to determine its inventory and recognize its cryptographic assets and vulnerability. In addition, the general public is more steered into thinking about quantum advantages rather than focusing on issues created by quantum technology. With the perception of non-urgency regarding quantum computing technology, industries may prioritize scaling business opportunities for quantum advantage over addressing the need to achieve quantum protection. Thus, this may put the public organization in a first-mover position to create awareness for such threats associated with quantum computing technology and raise the urgency for various stakeholders.

- Policy Recommendation 2: Maintain a secure Root CA at all times

A vulnerable root CA was a second important and urgent challenge when transitioning to a QS PKI system. The workshop participants showed that the difference of PKIoverheid exists in the Root CA. Unlike other PKI systems, the Ministry of the Interior and Kingdom Relations (BZK) provides the Root of the PKIoverheid [80]. The discussion also pointed out that Logius, as Policy Authority (PA), needs to manage government-wide ICT solutions and is accountable for providing secure PKIoverheid to users, including individuals, businesses, and other government agencies. Thus, having a vulnerable Root CA is considered fatal for the continuity of many digital government services.

The discussion from the workshop indicated that the transition to a QS PKI system would be meaningless for Logius if Root CA

is compromised and no longer safe to provide root certificates to intermediate CAs and, ultimately, to end-users. The compromised PKI system will be disastrous to the entire digital services offered by public organizations, and all personal data will become vulnerable. The participants shared the view that incidents of data breaches are not only costly to fix but also would violate the promise that government holds to its citizens to regulate data protection under the Personal Data Protection Act (Wet Bescherming Persoonsgegevens, Wbp). Thus, it is crucial for the public organization to maintain secure Root CA in both tt current PKI system and during the process of QS PKI transition.

- Policy Recommendation 3: Establish a clear QS governance

Another important and urgent challnge when transitioning to a QS PKI system was an unclear QS governance. According to workshop participants, the governance in PKIoverheid is complex, and several frameworks (eg ETSI standards framework and eIDAS regulation) ensure that the digital public services operate accordingly and maintain interoperability with various devices, hardware, and software systems. Also, the Programme of Requirements (PoR) that is drawn up by Logius in consultation with the Ministry serves an important purpose for PKIoverheid. The PoR act as a basis for CA admission for external third-parties CAs in order to ensure the statement of compliance. The certificates that are issued from the qualified CAs are registered and checked by Radio Communications Agency (Agentschap Telecom) [79, 80].

The discussion pointed out that although PKIoverheid conforms to multiple standards and regulations, there is no clear governance established that can facilitate QS transition. This was considered to be problematic because the anatomy of PKIoverheid is already complex, and changes in the infrastructure would need to provide system interoperability and backward compatibility in order to function with multiple devices and applications. The participants were uncertain whether additional changes in PKIoverheid would require changes in hardware, software, and other parts of the legacy system. However, they also indicated that since Logius currently has no protocol to follow when modifying the current PKIoverheid, public organizations not only need to look at where and how to modify changes in the PKI system but also need to establish a set of guidelines with relevant stakeholders to coordinate the process of QS PKI transition.

5 CONCLUSION AND FURTHER RESEARCH

Due to the computation power of quantum computing technology and its store now, decrypt later attack, public organizations that rely on PKI systems can no longer provide electronic identification schemes and secure communication and information exchange. There is an inevitable need for public organizations to become quantum-safe by modifying their PKI systems. This paper is the first to systematically explore the challenges in transitioning to a QS PKI system that is resistant to the threats posed by quantum computing. Based on the results from a systematic literature review and workshop discussion, we present a first exploration of the challenges that may be encountered and prioritized when transitioning the current PKI system. The majority of research on the QS PKI transition is mostly taking place in industries, and academic research on the topic has only just begun.

Furthermore, the workshop discussion on PKIoverheid provides the first analysis of challenges faced by public organizations. The discussion showed that challenges in QS transition are diverse and must be tackled in concert. The modification in one part of the PKI system may require changes in other parts of the system. Thus, the challenges may need to be addressed in parallel, and the QS PKI transition requires collaboration among various stakeholders for well-coordinated and contingency planning. The main challenges in the technological context include no universal QS solution, legacy system, complex PKI interoperability, and vulnerable Root CA. In the organizational context, the lack of knowledge, unclear governance, lack of urgency, and in-house management support are identified as the main challenges. In the environmental context, the main challenges include institutional void, need for stakeholder collaboration, and lack of awareness and policy guidance.

In addition, this paper presents a call to action for policy-makers to prepare for these challenges and take part in shaping the QS PKI transition. The three important and urgent challenges for PKIoverheid are lack of awareness, vulnerable Root CA, and unclear QS governance. While public organizations must maintain the security of Root CA at all times, the urgency for quantum computing technology in organizations is yet to develop, and they are hardly aware of the process of QS transition. Thus, the results indicate that the QS transition from the current PKI system is complex, and the challenges are socio-technical. For policy-makers, this implies that they should start early to prepare for the QS transition.

5.1 Limitations and future research directions

We conclude this paper with some limitations and directions for further research. First, six participants in the workshop discussion is a small number. More participants from PKIoverheid and cryptographic experts in public organizations could have extended the knowledge with new ideas and opinions on the QS PKI transition. Second, the workshop discussion was held in the context of the PKI system in the Dutch government, and this presents a geographical limitation. Thus, examining the PKI system in a different context would provide more clarity and in-depth analysis of challenges faced in public organizations.

Moreover, the paper offers a useful starting point for future research in the development of a QS PKI system in public organizations. The topic of QS cryptographic algorithm remains a concept that is relevant to cryptographers and IT teams in the organization. However, it builds an essential foundation for our secure digital communication and information exchange. Since the topic of QS transition is relatively new, perhaps it would also be beneficial to conduct another literature review in the future to track more details on the advancement of a QS PKI system. The topic of QS PKI transition would provide vast opportunities for researchers to contribute their research in the public domain.

Despite the hype around quantum advantage, there needs to be an awareness of quantum protection. Who can raise awareness? How can such awareness be raised? Since the topic of QS transition is not yet a popular topic of discussion, the urgency of the issue has not been raised. Thus, an approach is necessary to create awareness in government, industries, and citizens. Perhaps, this may also link to future research on laws and regulations related to quantum

computing technology and how it can provide incentives to set up an environment that drives the QS PKI transition.

Public organizations need to transit from the current PKI system to one that is quantum-resistant. This brings a lot of uncertainties and issues surrounding the topic and raises questions such as what needs to be changed in the current PKI system to become quantum-resistant? Which QS solution is compatible with which PKI system? Accordingly, we need to assess the impact of quantum-computing-based risks and determine trade-offs of different QS solutions for different organizations. This requires a clear understanding of QS solutions and how the current PKI system is organized in the public domain.

Additionally, it is still unclear how the QS governance should be established. How can various stakeholders collaborate in the process of QS transition? Who needs to be included, and who makes the decision? Since the topic of QS PKI transition in academic research has just begun, there is no clear guidance available that can help facilitate the transition in public organizations. Thus, these governance challenges need to be raised in public organizations to further support the QS transition process from the current PKI system.

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E-Court System Evaluation through the User's Perspective: Applying the End-User Computing Satisfaction (EUCS) Model

Rozha K. Ahmed
Information Systems Group, Tallinn University of Technology
Tallinn, Estonia
rozha.ahmed@taltech.ee

Omer Ahmed
Judicial Council of the Kurdistan Region of Iraq
Sulaimaniyah, Iraq
omer.ahmad@sulicourt.com

Ingrid Pappel
Next Gen Digital State Research Group, Tallinn University of Technology
Tallinn, Estonia
ingrid.pappel@taltech.ee

Dirk Draheim
Information Systems Group, Tallinn University of Technology
Tallinn, Estonia
dirk.draheim@taltech.ee

ABSTRACT

The End-User Computing Satisfaction (EUCS) model by Doll and Torkzadeh has played an essential role in evaluating users' satisfaction and perspectives on change management, which will help governments in assessing the information system's success and making efficient decisions about digital transformation and improving the quality of services provided to citizens. This research uses the EUCS model to assess the end-user satisfaction with a court information system and evaluate its success from the users' viewpoint. The authors applied the EUCS model to the implemented court information system of the Sulaimaniyah Appellate Court in the Kurdistan Region of Iraq (KRI). The authors employed a quantitative approach and collected data from 66 respondents from the group of active end-users of the court systems with different roles, i.e., judges, clerks, prosecutors, judicial investigators, lawyers, police officers, and typists. The results showed that the EUCS model could be considered a reliable and valid tool for assessing the court information system. Most of the participants of the currently implemented system showed their overall satisfaction and considered it a successful system.

CCS CONCEPTS

• **Computer systems organization** → **Embedded systems**; *Redundancy*; Robotics; • **Networks** → Network reliability.

KEYWORDS

e-Court, Court Information System, EUCS, Kurdistan Region, Iraq.

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1 INTRODUCTION

Judiciaries use emerging technologies to reshape the conventional justice administration system and improve the process efficiency of courts [17]. The workflow in courts is modernized through the implementation of the court information system (CIS), which can also be referred to as the electronic court (e-court) system, to improve the efficiency and effectiveness of the court's internal daily operations in terms of extending access to the judiciary, increasing transparency, enhancing court cases' security and many more [4, 6, 13, 18, 30, 32]. This research will use the term e-court system.

Initiatives of digital transformation in the justice domain have taken place in the Kurdistan Region of Iraq (KRI) since 2014, with the implementation of the first e-court system project to digitize court processes. The system is now running in all courts under the administration of the Sulaimaniyah Appellate Court in the Sulaimaniyah City; however, the initial plan was to expand the solution to all other courts in the KRI [4, 6]. Hence, the system's success becomes a crucial factor in understanding whether to move forward with this e-court replication in other cities of the KRI or not.

Studies showed a common understanding that users play a major role in identifying the success of the implemented information system through their evaluation, satisfaction, and acceptance of the use of the available system [12, 15, 16, 21, 22, 26, 29]. Among the variety of available models and frameworks to assess the information system, user satisfaction is considered a significant success factor to rely on. Many researchers approached evaluation of user satisfaction through different measures [9, 12, 14, 16, 21, 33]. However, the End-User Computing Satisfaction (EUCS) model by Doll and Torkzadeh [16] is considered one of the significant tools in evaluating the system users' expectations of the implemented system and their satisfaction. This model has been used and validated through different information systems, including the assessment of government financial administration integrated system [31], a number of different hospital information systems [1, 19, 28, 29],

online banking system [23], online marketplace [25], others applied EUCS to different web-based academic learning environments, and library systems [7, 8, 10, 20, 24, 26, 27, 34], and data warehouse system [11]. However, the application of EUCS in the justice domain and validation of the model through e-court systems remains a research gap to be filled.

Therefore, this research measures the user satisfaction level of the implemented e-court system based on the End-User Computing Satisfaction (EUCS) model introduced by Doll and Torkzadeh [16]. The research is based on the quantitative approach, and data were collected from court users and analyzed with the SPSS application. After the validity and reliability of the tool, results showed that end-users of the court information system are satisfied with the system and confirmed the improvements in efficiency and effectiveness of their daily processes by considering the system as a successful project.

This research significantly contributes to extending the body of knowledge and literature for academic researchers, judiciaries, and practitioners concerning implementing the e-court systems. Furthermore, this study will serve the decision-makers in the Kurdistan regional government to draw an expansion plan for the e-court system implementation in other cities.

In sectin 2 we provide an overview of the e-court system in the Sulaimaniyah Appellate Court. In section 3 we present the relevant theoretical framework to assess information system success and user satisfaction level. Then, we explain our research approach and data analysis processes in section 4. In section 5 we present the results of our analysis and discuss them, and finally, we finish with our concluding statements, research limitations, and future direction in section 6.

2 DIGITAL TRANSFORMATION OF COURTS IN THE KRI

Earlier studies on the digital transformation of courts in the KRI [2–6], reported that the e-court system in the Sulaimaniyah Appellate Court in the Sulaimaniyah city was introduced as a first pilot project and planned to be extended in other cities of the KRI. The project started in 2014 in six different stages (planning, system analysis/master plan, prototyping, building infrastructure, piloting, and implementation) and launched in 2016. The system is composed of integrated subsystems that allow smooth communication and secure data exchange between different parties. Information is entered once, and processes are automated to allow system users to perform their main functions and collaborate efficiently. As shown in Figure 1, the collaborative activities are achieved successfully through a central database that allows case management through the implemented functionalities to assist court users in performing their daily judiciary tasks electronically by courts, the prosecution office, and police stations. Furthermore, outside agencies, lawyers, and case participants (citizens) can access the system through a public portal for case monitoring and status updates.

3 RELEVANT THEORETICAL MODELS

Related studies have proposed several evaluation models to assess the success of the information systems and acceptance of the technology integration into an organization's business processes.

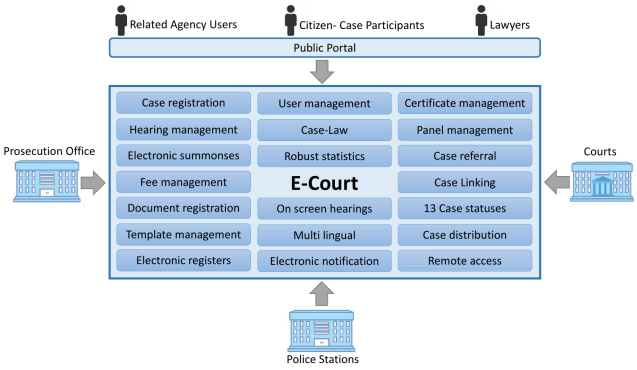


Figure 1: Sulaimaniyah Appellate Court System

Among researchers, user satisfaction has received a notable consideration as a success indicator of the information system and their acceptance of the change management. Bailey and Pearson in [9] developed an instrument for measuring and analyzing the overall computer user satisfaction, that was revised by Ives et al. in [21] and developed a user information satisfaction (UIS) model that has been accepted among researchers to assess users' view as to which extend they are satisfied with the information they get from the system if they fulfill their requirement or not, and accordingly this will examine the effectiveness of the organization. Doll and Torkzadeh in [16] designed their instrument to measure the end-user computing satisfaction (EUCS) based on the (UIS). They argued for a five-factor model composed of content, accuracy, format, ease of use, and timeliness to measure the satisfaction of end-users who are directly interacting with specific computer systems. Davis's technology acceptance model (TAM) also considered user acceptance of information technology as a measure of system success by studying perceived usefulness and ease of use in [12]. (TAM) was revised in [33] and with a unified theory of acceptance and use of technology (UTAUT) that tended to estimate and explain the usage of the information systems. Later, DeLone and McLean's model was introduced in [14], which is adopted as a model that allows us to assess the performance of an information system and considered user satisfaction as a vital variable for the system's success. User satisfaction is one of the crucial factors in understanding the user's perception of the effectiveness and efficiency of the adopted system [16, 21, 29]. Consequently, users' willingness to accept and use the system will positively affect a newly launched information system [29], as if users like the system, they use it, and in turn, higher system usage leads to higher satisfaction level [22, 26]. Therefore, to understand the success of the implemented current e-court system, we measure user satisfaction through the EUCS model.

4 RESEARCH APPROACH

This research seeks to answer the following research question; *What is the level of user satisfaction of the e-court system and its success from users' perspectives ?*

In order to answer the research question and estimate the success of the e-court system and measure the level of its user satisfaction, this study employs the quantitative approach and uses the EUCS

instrument by Doll and Torkzadeh [16] as a theoretical framework. Authors selected this model because it is widely used and accepted by researchers, is easy to use with confidence, and "has adequate reliability and validity across a variety of applications" [16]. Furthermore, this instrument can be applied to measure the success of the current system where court users work in an environment where they directly interact with the system composed of a central database and model base [16]. The EUCS model is composed of five indicators as presented in Figure 2

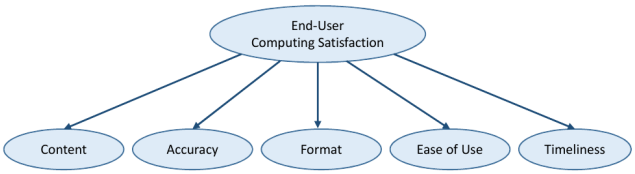


Figure 2: End-User Computing Satisfaction Model [16]

To achieve the aim of this research of answering the research question, in addition to filling the research gap, the authors set the following objectives:

- Validate the EUCS model applicability to the e-court systems.
- Understand end-users perspectives towards the system implementation in the five EUCS items.
- Identify the system's success through an end-user point of view with their acceptance of its usage and their expectation of success rate.

4.1 Data Collection

To make results more generalized, the data were collected from seven different role types using the court system to perform their daily tasks: judge, clerk, lawyer, prosecutor, judicial investigator, police officer, and typist.

The total number of active users of all the role types in the system is 875, and 66 responded to the survey. The authors considered the number of responses N= 66 as valid, presenting a confidence level of 95 % with a margin of 12 %.

4.2 Instrument

The authors designed an online survey questionnaire and sent it out to the end-users of the court system. The questionnaire was composed of 17 questions, three of them relevant to the user profile information to define the role of the participant, their computer skills, and their gender, further 12 questions were relevant to measuring content, accuracy, format, ease of use, and timeliness and the format of the standard questions of Doll and Torkzadeh were used [16]. Finally, two additional questions were posed to assess the system's success and evaluate its overall satisfaction. All questions were measured through a five-point Likert scale. A sample of the questionnaire is presented in the appendix section.

4.3 Data Analysis

IBM SPSS Statistics software was used for the data analysis phase, and for the validity and reliability test of the EUCS model. Results are presented in descriptive statics in the next sections.

5 RESULTS AND DISCUSSION

5.1 Validity and Reliability Test Results

The validity and reliability test was conducted to ensure that the EUCS model is suited for this study and can be applied to the e-court systems.

For the validity, Pearson Correlation was considered [24–26], by comparing the value of Pearson Correlation to the value obtained from r table, where the samples N = 66, and degree of freedom (df) = N-2 =64, and the significance level for two-tailed test 0.05 = 0.2423. Hence, if the item's Pearson Correlation value is > 0.2423, then the model is valid.

For the reliability, Cronbach Alpha was used as the items can be reliable if the Cronbach Alpha value is > 0.8 [23, 24].

As presented in Table. 1, results showed that across all items correlation value of r is > 0.2423, as well as Cronbach Alpha values are > 0.8. This concludes that the EUCS model can be considered a valid and reliable tool to assess user satisfaction with the e-court systems.

5.2 Descriptive Statistics Results from the EUCS Items

Our analysis showed that from the sample size of 66 participants, 51 were male, which represents (77.3 %) and 15 were female, which represents (22.7 %) of the population. Additionally, the IT skills of participants were mostly considered at a good level which was 29 participants that know fundamentals and how to use computers generally. Further, 18 of them had an intermediate level, 16 were considered their level to be advanced users, and only 3 of them clearly showed that they were at a poor level. Furthermore, results of the role analysis of respondents showed that 16 of them were judges that are the main users in the system, 14 of them were clerks that are responsible for most daily operations of the court processes, next 12 were judicial investigators that are responsible for investigation processes in the criminal courts and using the system on a daily basis, additionally, 12 lawyers responded as playing a big role in the system for their active participant in cases from all jurisdictions in all courts. Further participants are performing fewer tasks in the system; however, they are considered active users when performing specific tasks and participating in the case management process, 5 of them from prosecutors, five from typists, and the last two participated as police officers.

Regarding the results of the items analysis, the authors used a scale such as 1= Strongly Unsatisfied, 2= Unsatisfied, 3=Neutral, 4= Satisfied, and 5= Strongly Satisfied. As presented in Table. 2, results showed that end-users of the court system are satisfied with the system content and information extracted from the system, with an overall mean (3.79) that can be considered at level 4 (Satisfied). The accuracy of the data produced by the court system is also considered to be at a satisfactory level by users, with the mean of (3.66) at level 4 (Satisfied). Furthermore, the format factor indicates the provision

Table 1: Validity and reliability test of the items

Item ID	Pearson Correlation Value	r Table Value	Validity Result	Cronbach Alpha's value	Reliability Result
C1	0.697	0.2423	Valid	0.936	Reliable
C2	0.789	0.2423	Valid	0.934	Reliable
C3	0.772	0.2423	Valid	0.934	Reliable
C4	0.847	0.2423	Valid	0.932	Reliable
A1	0.774	0.2423	Valid	0.934	Reliable
A2	0.450	0.2423	Valid	0.943	Reliable
F1	0.770	0.2423	Valid	0.934	Reliable
F2	0.843	0.2423	Valid	0.932	Reliable
E1	0.748	0.2423	Valid	0.936	Reliable
E2	0.749	0.2423	Valid	0.936	Reliable
T1	0.770	0.2423	Valid	0.937	Reliable
T2	0.761	0.2423	Valid	0.936	Reliable

Table 2: Descriptive Statistics Results

Items	N	Mean	Level	Satisfaction Level
Content	66	3.79	4	Satisfied
Accuracy	66	3.66	4	Satisfied
Format	66	3.86	4	Satisfied
Ease of Use	66	4.03	4	Satisfied
Timeliness	66	2.71	3	Neutral

of information and its appearance to court users, and the results of format with a mean (3.86) means that users are satisfied with the information provided and the way they access it by level 4 (Satisfied). Moreover, the ease of use factor indicates the ability of the system to be understood and how easy to be learned and used by the end-users; as can be seen, it has got a greater number of mean is (4.03), considering that users are satisfied with the operation of the system and can learn it easily with level 4 (Satisfied). The final factor analyzed was the timeliness, which indicates the system response in terms of information updating on time and the availability of requested information on time; as can be seen from the results, users were not very much satisfied with this item and recorded the mean of (2.71) considered at level 3 (Neutral).

Table. 2 presented the results of the EUCS items analysis. It can be concluded that end-users of the court system were satisfied with the content, accuracy, format, and ease of use. However, they were not satisfied or dissatisfied with timeliness. Their responses were considered to be at level neutral, and that could be an indicator for the system improvement for future system replication regarding the system performance and time needed for previewing the court data.

5.3 Overall System Evaluation

To ensure the overall satisfaction of the system, the authors posed general questions to understand the system's success from the end-users perspective and their overall satisfaction with the daily case management processes. A similar satisfaction scale of the EUCS items was used for the overall satisfaction question with levels 1= Strongly Unsatisfied, 2= Unsatisfied, 3=Neutral, 4= Satisfied, and 5= Strongly Satisfied. While for the other question in relevance to the system success, the authors used a scale of 1= Very Unsuccessful, 2= Unsuccessful, 3=Fair, 4= Successful, and 5= Very Successful. Figure 3 shows the result of the first general question and concludes that most of the users with (48.5 %) of the population were generally satisfied with the system performance, (30.3%) of the population were strongly satisfied with the system and mainly considered it as a proper tool for processing their daily tasks. Others were (7.6%) neutral and preferred not to rate it, while only (4.5%) were unsatisfied, and (9.1%) of the population were strongly unsatisfied. It is clear that the system is becoming a necessary tool for the majority of the end-users, who are satisfied with the system performance and accept the change management in their daily tasks. On the other hand, the participants showed less satisfaction or were unsatisfied because they might have limitations or challenges when using the system or not have enough skill to use it properly. All these should be considered, and further investigation is required to understand their views.

The additional general question concerned the end-users opinion on the system's success and its stability in court. As presented in Figure 4 result of data analysis showed that the majority of the participants with (43.9%) of the population considered the system as a successful system, and (6.1%) of the population rated it as a very successful implementation, this is a significant sign for the decision-makers to plan for the future replication of the system in other cities. However, (39.4%) also considered the current e-court system a good system and rated it as a fair system. Moreover, (4.5%) rated it as an unsuccessful system, and (6.1%) considered it very unsuccessful for daily processes. It can be again concluded that further studies could be necessary to understand the reason for unhappy end-users with this e-court system.

Overall findings showed that the effort and resources put into this project by all parties are worthwhile and ensure the government that the budget allocated for this project has been appropriately utilized. Table. 3 presents the results of all items separately.

Table 3: Descriptive Statistics Results of Separate Items

Item ID	N	Mean	Std.Deviation	Level	Satisfaction Level
C1	66	3.98	0.963	4	Satisfied
C2	66	3.86	1.036	4	Satisfied
C3	66	3.62	0.989	4	Satisfied
C4	66	3.71	1.064	4	Satisfied
A1	66	3.79	1.000	4	Satisfied
A2	66	3.55	0.880	4	Satisfied
F1	66	3.97	0.976	4	Satisfied
F2	66	3.76	1.124	4	Satisfied
E1	66	4.06	0.943	4	Satisfied
E2	66	4.02	1.000	4	Satisfied
T1	66	2.74	1.460	3	Neutral
T2	66	2.70	1.358	3	Neutral
G1	66	3.86	1.175	4	Satisfied
G2	66	3.39	0.909	4	Successful

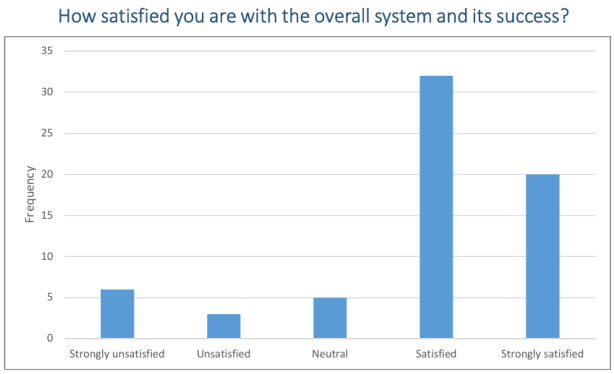


Figure 3: General Question on Overall User Satisfaction

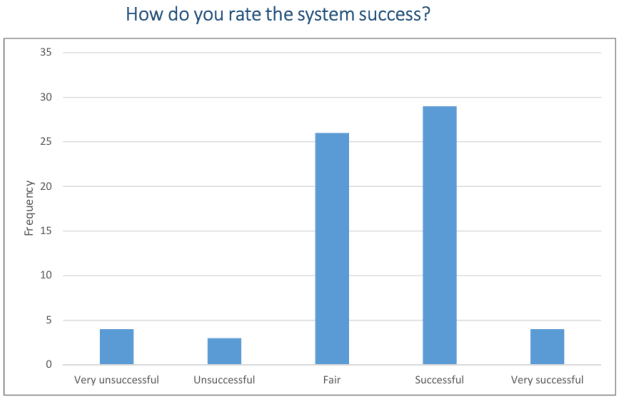


Figure 4: General Question on the System Success

6 CONCLUSION

This research tested the End-User Computing Satisfaction model on the e-court system with a survey sample of 66 respondents. Findings revealed that the main constructs of EUCS, such as content, accuracy, format, ease of use, and timeliness, are valid and reliable for measuring end-user satisfaction with the e-court systems. Further data analysis showed that end-users were mainly satisfied with the current e-court system implementation, and the majority considered it a successful system for the case management process in courts.

The presented findings aim to contribute to justice digital transformation and implementation of e-court systems. Results help to understand the users' perspective and their satisfaction with different aspects, which helps the future vision of how to design the system, for example, how users can be satisfied with the content, the format of the data to appear, how easy to be designed, and make the EUCS model relevant for the electronic court systems both practically and theoretically.

6.1 Limitation

The time limitation and low response affected the data collection phase, and it seems that initially, users were not very interested in participating in the questionnaire, mainly because of their limited time and being busy with their daily duties, or it could be due to the reason that they have participated in the different questionnaire as this project is new and researchers and practitioners are willing to investigate it with variety of research studies. Time limitation also bounded authors to not being able for detailed factor analysis between items and more investigation of the users' rate of the questions.

6.2 Future Work

Authors suggest that future direction could be towards having more sample sizes through multiple case studies that have implemented the e-court system so that results would be more generalizable. An additional wish of the authors includes further research on studying

the correlation between factors and a more detailed analysis of the user perspectives on the system.

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7 APPENDIX

Survey questions for measuring user satisfaction level of e-court system in the KRI adapted from Doll and Torkzadeh's EUCS instrument are presented in Table. 4

Table 4: Survey Questions

Item	Code	Question
PERSONAL		
		1: What is your role in the system?
		2: Please select you IT skill level.
		3: Please select you gender.
CONTENT		
	C1	4: Does the system provide the precise information you need?
	C2	5: Does the system information meet your needs?
	C3	6: Does the system provide reports that seem to be just about exactly what you need?
	C4	7: Does the system provide sufficient information?
ACCURACY		
	A1	8: Is the system accurate?
	A2	9: Are you satisfied with the accuracy of the system?
FORMAT		
	F1	10: Do you think the output is presented in a useful format?
	F2	11: Is the information clear?
EASE OF USE		
	E1	12: Is the system user friendly?
	E2	13: Is the system easy to use?
TIMELINESS		
	T1	14: Do you get the information you need in time?
	T2	15: Does the system provide up-to-date information?
GENERAL		
	G1	16: How satisfied you are with the overall system and its success?
	G2	17: How do you rate the system success?

Outsource or Invest? A Multiple Case Study of Digital Government Platform Strategies

Yiwei Gong
School of Information Management, Wuhan University, Wuhan, Hubei, China
yiweigong@whu.edu.cn

Xinyi Yang
School of Information Management, Wuhan University, Wuhan, Hubei, China
xinyi_yang@whu.edu.cn

ABSTRACT

For obtaining external resources and capabilities to improve public service delivery, involving technology and service vendors to develop digital platforms is in the consideration of many governments. However, the development of government platform is challenging, and governments often lack a clear strategic planning for their platform initiatives. This paper aims at providing insights of strategies for digital government platform development by reporting on the findings of a multiple case study in China. The strategies and outcomes of six province-level government platforms were investigated to reflect two strategic patterns, outsourcing-based or joint investment-based strategy, and their pros and cons in government platform development. The findings show that financial capacity, sensitiveness to data security, and willingness to share accountability will shape the platform strategy and result in different ways to establish platform management organizations. This study helps to understand the strategic choices for government platform initiatives and the corresponding requirements.

CCS CONCEPTS

• **Applied computing** → Computers in other domains; • **Computing in government** → E-government..

KEYWORDS

Platforms, Digital government, Outsourcing, Public-private Partnerships, Government as a platform (GaaP)

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1 INTRODUCTION

Digital platform has increasingly recognized as a strategic instrument for digital government transformation [1, 2]. A digital platform can be broadly characterized as a socio-technical assemblage encompassing extensible technical infrastructure and associated organizational processes and standards [3, 4]. With different goals and strategies, the use of digital platforms in government has been reported in many countries around the world, including Europe [e.g., 2, 5], America [e.g., 6, 7], and Asia [e.g., 8, 9].

The academic literature shows that digital platforms encourage innovation [10] and improve the efficiency of public services delivery [11]. By building digital platforms, governments have tended to emphasize the integration of private and public sectors to create seamless public services for citizens across agencies [12]. Despite the high expectation, implementing and operating a digital platform is very challenging for governments, given its large scale in terms of the number of users and the required amount of investment, as well as the needs for involving high-tech companies to complement the capability that the government might not have. Many governments are still not clear about their strategic options in digital platform development and the corresponding requirements and possible outcomes. They are confusing and hesitating whether the development of digital platforms is similar with normal software development projects in which they also involve solution vendors [13].

To understand the platform strategies and the roles that government can play in digital platform development, we conducted a multiple case study of six government platforms in China. The findings indicate two strategies: based on outsourcing or joint investment. The choice of different strategy will result in distinct relationships between governments and technology and service vendors, with different advantages and disadvantages, as well as corresponding requirements in capabilities. By understanding the possible outcomes and requirements of the two platform strategies, decision-makers could enable a clear strategic planning for their digital platform initiatives.

The paper is structured as follows. In Section 2, we briefly discuss the background of platforms in the public sector and the relationships between governments and technology vendors. Thereafter, the research method is explained in Section 3. In Section 4 we present research findings of our case study and we discuss the findings in Section 5. Section 6 contains the conclusion and future research agenda.

2 BACKGROUND

The maturing cloud computing sector provides governments with reasonable infrastructure solutions to enable the development of digital platforms. Cloud services providers such as Google, Amazon, and IBM have emerged as leading market players on the global stage. In parallel, the Chinese domestic market has seen a more rapid development in the rise of very large, domestic cloud technology vendors, such as Alibaba, Tencent, Huawei, Baidu, and others [14]. Cloud infrastructure has connected with the public sector

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platform development and smart city initiatives through the provision of large volumes of data processing, as well as communication, governance, and sensing capabilities for the implementations of cooperative networks, smart city dashboards, one-stop-shop public service delivery, and so on. In this sense, the strategy about how to develop government platforms and the respective roles between governments and different technology and service vendors in this process are critical in the digital government transformation [13].

2.1 Platforms in the Public Sector

The ability of digital platforms to generate value by reducing transaction costs or "economic friction" enthuses Management and Information Systems scholars to investigate digital platforms [15]. The platform phenomena in the private sector have stimulated increasing academic studies of platform competition [e.g., 16], platform strategy and innovation [e.g., 17], and platform ecosystems [e.g., 18]. Despite the pertinence of the findings from platform research in the private sector, this knowledge is hardly applied in the public sector [2, 6].

There are three main reasons for the public sector having litter consideration of implication from commercial platforms. First of all, platforms in the public sector prioritize public value generation upon profit and emphasize authority, accountability, transparency, citizen satisfaction over competition [1]. The public value orientation results in different roles of government in comparing with private companies as platform owners. Consequently, private companies' platform strategies might not work with governments. Second, the platform theories generated in the private sector often do not take the specific complexity of governments into account because "Government is not a single organization but a series of parallel and sometimes overlapping organisations operating in a diverse and complex range of policy, regulatory and legislative environments" [2]. Furthermore, running, for example, a smart city platform needs not only consider the cooperation between different governmental agencies, but also the cooperation between various government agencies and private companies which are often technology or solution providers with commercial interests. Finally, there are different possible roles for government to play, depending on the strategy of investment and involvement [13]. Due to those differences, governments cannot directly copy the platform strategies from the private sector for their platform development.

The digital government research on platforms often mentions Government as a Platform (GaaP) [19] as a conceptual foundation. In GaaP, a digital government platform is analogized as a marketplace with multiple providers from outside government to participate, including co-creation by citizens. A similar theoretical development is the "lean government" in which government aims at reducing the complexity of the public sector by simplifying and streamlining organizational structures and processes, at the same time at stimulating innovation by operating a platform-based environment to engage stakeholders and solve societal problems utilizing new methods, tools, practices and governance models [1]. There are many expected benefits of government platforms, including 1) the co-production and innovation of public services with external actors, helping governments to deliver more value with fewer investments, 2) reducing the complexity of the coordination of the actors in public service production and delivery, and 3) flexibility in the creation and modification of services and supporting the evolution of service delivery [5]. Despite the potential benefits of platforms in the public sector, there is a lack of clarity concerning the choices that are available to governments and how they could properly address the relationships with other parties to achieve the desired benefits. It is therefore motivating us to investigate the possible strategies in government platform development and the relationships between governments and vendors.

2.2 Relationships between Governments and Technology and Service Vendors

The public sector literature indicates multiple roles that governments can play in platform development [13]. IT outsourcing is considered as a typical way for government to obtain technologies and infrastructure that are needed to develop digital platforms. As government platform implementation is often organized in the form of large engineering projects, total outsourcing [20], i.e. with the majority of budget to be outsourced, is a typical way to build platforms. Service outsourcing could also happen in platform operation, resulting a shift of government's role from being the provider of public services to managing their provision [21]. However, literature also indicates that outsourcing of public services considers private markets which operate generally for profit motives rather than public accountability [22]. Consequently, the sharing of accountability between government and outsourcing service providers in the context of platform development remains an open question.

Public–private partnerships (PPPs), as cooperative institutional arrangements between public and private sectors, have become popular tools to deliver infrastructure and public services in the last four decades [23]. PPPs focus on long-term contract and cooperation. The private sectors in PPP project normally participate in certain phases of that project, including designing, building, operation, and maintenance, with typically large capital expenditure. Government platform phenomena are often with a long-run lifecycle and huge investment. We argue that the analysis of government platforms also falls into the conceptual field of PPPs. More specifically, the implementation and operation as two different stages in government platform development could be carried out by different actors and governments might have different actions in these stages [24]. This indicates the necessity to investigate the roles of governments and vendors in different stages of platform development. It also implies that our case study should cover both the implementation and operation stage of government platforms.

3 RESEARCH APPROACH

To understand different strategies in the development of digital government platforms, we investigated different digital government platform initiatives and their performances. This study employs a case study [25] approach to compare those initiatives to generate insights into possible strategic planning choices. This section introduces our case selection logic and data collection.

3.1 Case Selection

To compare different government platform initiatives, we selected six provincial government platforms in China, including Beijing,

Table 1: Background of the selected province-level regions and their government platforms

Province-level region	Beijing	Fujian	Guangdong	Jiangsu	Shanghai	Zhejiang
GDP per capita in 2020 (CNY)	167.64k	110.51k	96.14k	127.29k	159.39k	110.45k
Ranking in DGD						
2018	1st	6th	2nd	3rd	4th	5th
2019	4th	5th	3rd	6th	2nd	1st
2020	3rd	6th	4th	10th	1st	2nd
2021	3rd	6th	4th	10th	1st	2nd
Starting year of platform initiative	2018	2019	2018	2018	2018	2018

Fujian, Guangdong, Jiangsu, Shanghai, and Zhejiang. There are two main reasons for such a selection. On the one hand, these province-level regions are close in terms of their provincial GDP per capita, reflecting their similar levels of economic development. They are the top six province-level regions out of the 31 in the mainland of China based on the ranking by GDP per capita in the year of 2020. In other word, they are the best developed regions in the mainland of China with strong economic power for supporting their local digital government development. By selecting these top six regions, we intent to avoid the impact that might be caused by significant differences in the level of economic development. On the other hand, they are also highly ranked province-level regions in terms of the performance of digital government, based on "the research report on digital government development in China"[e.g., 26] (DGD for short) in the consecutive years from 2018 to 2021. The rankings of these provincial governments reflect that they are examples of the best practices in the mainland of China. Table 1 presents the background of the selected province-level regions and their government platforms.

We believe that the selected six cases are comparable based on the following considerations:

- They are within a similar political and institutional environment in which they are all on the province-level administrative division in the mainland of China with similar levels of complexity in public service provision and delivery;
- They are all comprehensive government platforms covering multiple but similar domains rather than those only focusing on specific domain such as taxation or water resource management.
- They are with the similar level of economic development, implying their similar levels of capability in digital government investment and financial support;
- They started their digital government platform initiatives in the similar period of time, reflecting their similar progress in platform development;
- They have different strategies in government platform development allowing the comparison of their outcomes to understand the pros and cons of their strategies.

3.2 Data Collection

To investigate the platform strategies of six province-level governments and their outcomes, we collected and use various secondary data. Besides the background information mentioned in Table 1, we also collected data to understand how the platform implementation and operation were organized, and in what relationships the governments cooperated with vendors. With these purposes, we collected government policy documents and reports, news briefings, tender invitations and result announcements, official or independent evaluation reports, and consultancy reports that are related to the government platform development of these six provincial governments.

Official governmental documents legitimize government activities and provide accountability to citizens by declaring institutional aims, plans, strategic objectives, and actions in platform development [27]. Tender invitations and result announcements provided us with information about the motivation of various engineering or operation projects and which companies were actually involved. News briefings often report to the public about the changes in organizations to support the development of government platforms, e.g. the creation of a new agency or the joint investment in an integrated corporation. Consultancy reports record the business cases about the government platform functions and services and how governments and companies cooperated to enable them.

4 FINDINGS AND ANALYSIS

Table 2 summarizes the findings from our case study. All platforms are governed by a responsible authority which is often a government department established to support the digital government transformation on the province-level. In similar, those authorities are responsible for the strategic planning and decision-making for government platform development and coordinate the actions during the implementation and operation of platforms. Consequently, those authorities are often responsible in in monitoring and supervising the platform operation and service provision. An exception is that the government platform of Zhejiang is supervised by the Information Security Department of Zhejiang rather than its responsible authority.

A management organization of a government platform is the organization responsible for the routine works in the implementation and operation of the platform. We observed two main options in the establishment of platform management organizations. The platform management organizations of Beijing, Fujian, and Jiangsu were established as a specific business unit under the platform authority (e.g., Fujian) or an independent public institution fully supported by the platform authority (e.g., Beijing and Jiangsu). In contrast, integrated corporations were established to manage the platforms

Table 2: Overview of findings in the case study

Province-level region	Beijing	Fujian	Guangdong	Jiangsu	Shanghai	Zhejiang
Responsible authority	Beijing Big Data Administration	Fujian Big Data Administration	Guangdong Government Service Data Administration	Jiangsu Big Data Management Center	Shanghai Big Data Center	Zhejiang Big Data Development Administration
Management organization	Public institution	Sub-business unit of the authority	Integrated corporation	Public institution	Integrated corporation	Integrated corporation
Public-private cooperation						
Implementation	By outsourcing	By outsourcing	By the integrated corporation	By outsourcing	By the integrated corporation	By the integrated corporation
Operation	By establishing own operation unit and outsourcing	By outsourcing	By the integrated corporation	By outsourcing	By the integrated corporation and outsourcing	By the integrated corporation
Supervisor	Beijing Big Data Administration	Fujian Big Data Administration	Guangdong Government Service Data Administration	Jiangsu Big Data Management Center	Shanghai Big Data Center	Information Security Department of Zhejiang

of the other three provinces. Those integrated corporations were jointly invested by governments (directly or indirectly) and social capital from some leading technology and service vendors such as the Alibaba group. Partners are often the substantial shareholders of the integrated corporation.

The involvement of leading companies is beneficial to the development of government platform because those companies possess strong capability for platform implementation and operation. We found that Guangdong and Zhejiang province have both the platform implementation and operation accomplished by their integrated corporations. Other provinces which insist on having fully control on their government platforms often rely on outsourcing to implement and operate the platforms. Hybrid situations were observed in Shanghai and Beijing. While Shanghai has its integrated corporation to implement and operate the platform, a part of the operation was outsourced to other companies. In the case of Beijing, outsourcing was the main instrument for platform implementation and operation, but the platform operation also involved a business unit (team) assigned by the public institution.

5 DISCUSSION

Our case study indicates two distinct government platform development strategies to obtain resources and capabilities outside. Government platforms of Beijing, Fujian, and Jiangsu mainly rely on outsourcing approach, while platforms of Guangdong, Shanghai, and Zhejiang provinces focus on jointly investing in integrated corporations. The outsourcing-based strategy enables governments to purchase services for platform development when they need, but requires they have sufficient architecting capability to design the platform by themselves. Outsourcing strategy could be implemented with total outsourcing to a company with strong capability with possibility for sub-contracting. Alternatively, the project could be broken down into a number of smaller packages and outsourced to multiple companies. In this way, governments remain flexible in contracting outsourcers without binding on certain vendors in a long run. At the same time, governments possess strong control on data and information resources, allowing specifications on the use of data in each outsourcing contract.

In comparison, joint investment-based strategy invites partners to establish integrated corporations for the implementation and operation of government platforms. The joint investment motivates partners to share their technical superiority and professional teams. Once the partnership established, governments and partner companies are bounden together in the development of government platform. Data and information resources are also shared between governments and partners. Although other companies could still participate in the platform development in small scale, the dominant of the partner companies is hard to displace.

There are both pros and cons of these two strategies. Although outsourcing-based strategy allows higher flexibility in selecting cooperative parties, it also requires the government having strong financial capacity to cover all the expense in platform development. In another word, the financial pressure will be higher for governments with an outsourcing-based strategy. In contrast, governments with the joint investment strategy allows social capital to share the investment and thus have less financial pressure, especially in the implementation stage. However, binding to specific partners also requires the government to sharing the data stewardship and accountability related to that with the partners. This could result in risk in data protection and misfeasance in public

Table 3: Comparison of two government platform development strategies

Strategy	Outsourcing-based strategy	Joint investment-based strategy
Case	Beijing, Fujian, and Jiangsu	Guangdong, Shanghai, and Zhejiang
Public-private relationship	Based on outsourcing	Based on partnership
Flexibility in contracting	High flexibility in selecting outsourcers	Binding to partners with technical advantage
Data stewardship	Governments controlling date resources	Governments sharing data resources with partners
Financial capacity	Requiring capacity to cover all the expense in platform implementation and operation, higher in financial pressure	Inviting social capital to jointly invest on the platform with governments, lower in financial pressure
Performance	Unstable performance caused by shifting outsourcers in different stages	Stable performance by having the same organization in different stages
Accountability	Government fully accountable to the services provided by the platform	Sharing accountability with partners
Applicability	Platforms with sufficient financial support in platform development and the government having sufficient architecting capability and higher requirement on data security and accountability	Platforms with large scale and investment, having sufficient trust between government and companies, and especially, with less sensitiveness to data and information security

service delivery. To reduce this risk, we observed the involvement of state-own companies together with private companies in the joint investment in all the three cases with integrated corporations. The performances of platforms in public service delivery are also different in the realization of the two strategies. Based on the DGD reports from 2018 to 2021 (in Table 1), we observed that the government platforms with joint investment strategy are slightly better and stable in the rankings. A possible explanation of this difference could be that implementing and operating the platform by the same organization allows for continuous improvements. In summary, outsourcing-based strategy is more suitable for platforms with sufficient financial support and governments having sufficient architecting capability and higher requirement on data security and accountability, while joint investment-based strategy is appropriate for government platforms with large scale and investment, having sufficient trust between government and companies to share accountability, and especially, with less sensitiveness to data and information security. Table 3 presents the comparison between the two strategies in our discussion.

This study also reflects the multiple roles for governments to play in the development of platforms. As governments do not directly participate in the implementation and operation of platform, their platform strategies decide how the platform management organization is constructed. Figure 1 presents the relationships between the governments and other parities in the implementation and operation of government platforms in the situation of adopting (a) the outsourcing-based strategy or (b) the joint investment-based strategy. In these two patterns, the responsible authority must supervise the platform to make sure that the platform will properly serve various governments, businesses, and citizens to generate public value. Based on their capabilities, governments could either authorize a sub-business unit or an independent public institution to organize the outsourcing for platform implementation and operation, or jointly invest with private or state-own companies to establish integrated corporations to develop platforms. In one way or another, governments could obtain resources and capabilities for platform development from outside, but different strategies also reflect on the consideration of whether the budget is sufficient, to what extent the data security is acceptable, and whether to share accountability with outsiders.

By observing the practices in the mainland of China, this study provides insights into the strategic options for government to plan their platform development and address their possible relationships with other parties with each strategy. Furthermore, this study enriches the knowledge of government platforms to facilitate the development of platform theory in the public sector. Specifically, we reveal that financial capacity, sensitiveness to data security, and willingness to share accountability mainly influence the choice of platform strategy.

6 CONCLUSION

The case study presents two different strategies for government platform development at the province-level by investigating the implementation and operation of six government platforms. Our findings show that the outsourcing-based strategy allows for higher flexibility in contracting outsourcers and full control on data resources, but requires the government to have sufficient financial capacity and architecting capability to develop the platform. This strategy has a disadvantage in the stability of service performance, due to the shift of outsourcers in different stages. It is suitable for platforms with high requirement on data security and governments which do not want to share accountability with other parties. In contrast, the joint investment-based strategy allows social capital to invest in the development of government platform, enables the implementation of large-scale platforms, and reduces financial pressures for the government. This strategy results in better and stable service performance so far, but requires governments to share accountability with their partners. It is suitable to platforms with less sensitiveness to data security and governments which have sufficient trust with their partners. Financial capacity, sensitiveness to data security, and willingness to share accountability are the main considerations to choose between these two strategies. This study offers several critical insights into the strategies of government

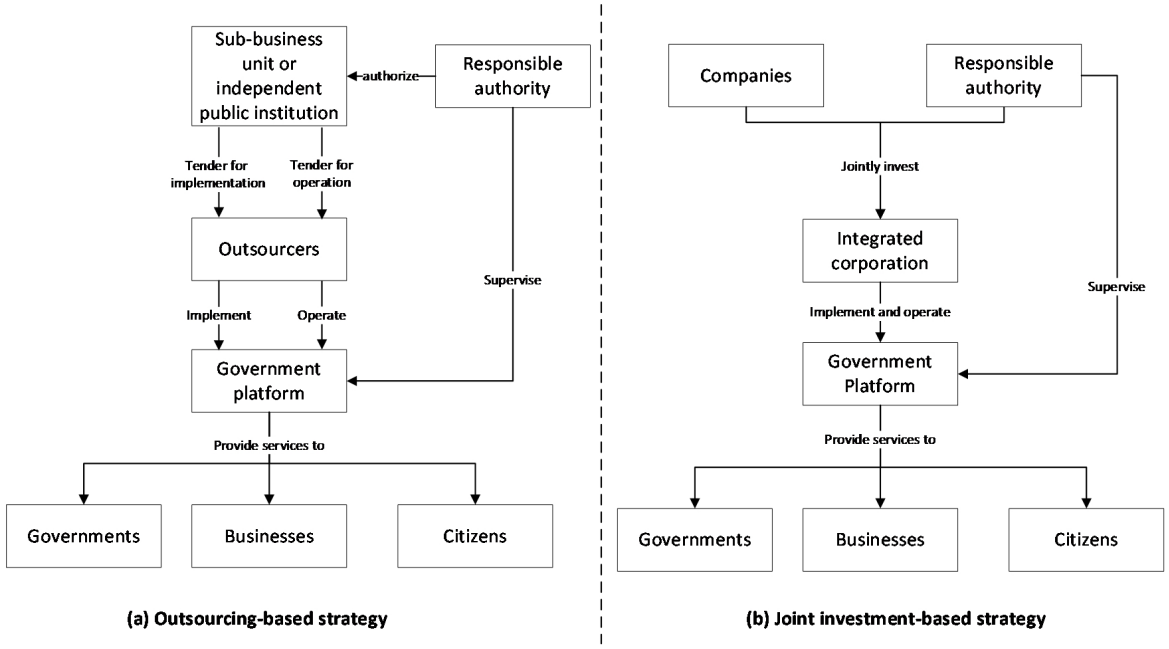


Figure 1: The roles of parties in government platform development

platform development in China and generate scientific knowledge which helps to understand the strategic choices for government platform initiatives and the needs of corresponding capabilities and actions.

Our ongoing research has its limitation in focusing on a small number of provincial government platforms in the mainland of China. As government platform development also happens on the national and municipal level, focusing on the provincial level might ignore the possible influence from other levels. Another limitation of this study is relying on secondary data to understand government platform phenomena, resulting in a risk of neglecting human factors. To overcome these limitations, future study aims at a more comprehensive understanding of digital government platform phenomena by investigating multiple administrative levels with larger number of cases and the consideration of practitioners' perception.

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Balancing the Digital Portfolio: Empirical evidence of an ambidextrous bias in digital government

Tomas Lindroth
Swedish Center for Digital Innovation, University of Gothenburg, Sweden

Johan Magnusson
Swedish Center for Digital Innovation, University of Gothenburg, Sweden; Kristiania University College, Oslo, Norway

Kristian Norling
Swedish Center for Digital Innovation, University of Gothenburg, Sweden

Jacob Torell
Swedish Center for Digital Innovation, University of Gothenburg, Sweden

ABSTRACT

The public sector is currently undergoing significant transformation in striving for digital government. With digital government involving a dilemma between continuous improvements and radical innovation, this places new demands on the manner through which digital initiatives are prioritized and managed. Previous research has called for both increased agility and adaptability in the governing of digital, yet there is to date a dearth of studies into public sector portfolio management. In this study, we address the issue of how digital initiatives are prioritized and managed in organizations, i.e., the practice of portfolio management. Through a clinical inquiry of three public sector organizations (one agency, one healthcare region, and one municipality), we analyze and compare existing portfolio management practices and portfolio compositions using previous findings from the field of organizational ambidexterity. Based on this, we identify pathologies in the current practice, elaborate on the role of balancing in portfolio management, and offer concrete recommendations to practice.

KEYWORDS

portfolio management, digital government, digital transformation, clinical inquiry, organizational ambidexterity

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1 INTRODUCTION

The public sector is currently experiencing a transformation into digital government [1]. Digital government places new demands on public sector organizations and government in general [2], demands innately associated with the digital. For instance, increased openness and transparency [3], new ways of co-creating value with citizens [4], and increased reliance on digital services [5].

Provided the current digital transformation of the public sector, research has shown that this poses significant challenges to organizations [6]. First, the organizations need to carefully balance the existing operations with new development [7]. Here, previous research has identified the tradeoffs between operations and development [8], as well as the path dependencies associated with highly institutionalized settings [9]. Second, organizations need to balance the internal (e.g., new processes for administration) and the external (e.g., new digital services for citizens) perspective in new development [7]. As noted by Gregory, Keil, Muntermann and Mähring [10] as well as Svahn, Mathiassen and Lindgren [11], balancing between often conflicting logics is a signifying mark of digital transformation.

Core to the organizations' capability of balancing are practices of governance and control. Defined along the lines of decision-rights and accountabilities [12], governance and control highlight who has the right to decide and how that decision is to be made. Previous research such as [13] has identified a pathology regarding how digital initiatives are handled in the public sector. Through constantly down-prioritizing external innovation initiatives, governance and control are geared toward the idea of "going concern", i.e., assuming plannability and the sustainability of current operations. As such, governance and control of digital initiatives may act as a deterrent to digital government, whereby new research is needed [14, 15].

When it comes to digital initiatives and how these are prioritized and governed, many organizations are employing some variant of what is commonly referred to as portfolio management [16]. In order to assure efficiency and effectiveness of an array of projects, these are managed as a portfolio where the intent of portfolio management is to assure alignment between the projects and the overarching strategic intent of the organization [17]. Despite some early examples of studies approaching the issue of portfolio management in the public sector [18-20], there is still a dearth of research [17]. On the basis of this brief rationale, we answer the following research question in this study:

How do public sector organizations prioritize digital initiatives?

In answering the research question, our objective is to contribute to the current research within digital transformation in the public sector through research calls from Mergel, Edelmann and Haug [1] on how digital transformation is enacted in the public sector,



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as well as Bryson and George [17] on the use of portfolio management in public administration. The study is operationalized through three parallel clinical inquiries [21] where the research team worked to solve practical problems through the application of scientific methods. The three organizations studied represent agencies, health-care regions and municipalities, i.e. all three layers of public administration in Sweden.

The paper is organized accordingly: After this introduction, we present the precursory findings on portfolio management and organizational ambidexterity. This is followed by the method where we expand on the clinical inquiry approach in the three settings. After this we present the results through the identified practices and balancing, which is followed by a discussion where we expand on the results and elaborate through recent findings from organizational ambidexterity, digital transformation and digital government.

2 PRECURSORY FINDINGS AND THEORETICAL FRAMING

2.1 Portfolio management of digital initiatives

According to Bryson and George [17], portfolio management is a method for strategic management where "*. . .entities of various sorts (programs, projects, products, services or, providers) are arrayed against dimensions that have some strategic importance.*". In other words, portfolio management of digital initiatives involves arraying digital initiatives against either the overarching strategic intent of the organization per se or the organization's digital transformation intent.

Portfolio management has been proposed as a solution to the problem of effectiveness and efficiency in how organizations handle multiple projects [16, 22]. With the project being the atom of initiatives in organizations, portfolio management offers support for aligning the projects with the overall intent (strategy), assuring coordination between inter-connected initiatives and balancing between existing projects [23]. Portfolio management envelops the life cycle of the project, from ex-ante to ex-post, in an attempt to usher in control over the organization's resources.

Previous research on portfolio management has primarily focused on issues related to alignment of project objectives with overarching corporate objectives [16]. Albeit a central theme in research on governance in the private sector, there is still a dearth of research on the application of portfolio management in the public sector [17]. In a study of Danish municipalities, Stentoft Arlbjørn, Freytag and Thoms [18] identify a shortcoming in prioritization procedures attributable to sub-par portfolio management and highlight the importance of improved governance. Maceta and Berssaneti [19] compare the portfolio management practices in the Brazilian public- and private sectors, with the results of the public sector showing better process documentation and lower risk awareness than the private sector. In [20] investigate how portfolio management approaches from the private sector may be implemented in the private sector. According to their findings, portfolio management needs to focus on aspects related to capabilities and past performance in delivery.

2.2 Organizational ambidexterity in the study of digital transformation

Core to the foundational literature on organizational ambidexterity is the balancing between activities of exploitation and exploration [24]. Seeing the two as mutually exclusive, the total spend in an organization will comprise of the sum of total amount of resources for exploitation and exploration. In times of dramatic changes in the environment, the literature suggests increased allocation of resources to exploration, striving for increased innovation [24]. In times of stability, the organization should strive for increased allocation to exploitation, striving for increased efficiency. As noted by Luger, Raisch and Schimmer [25] in a study of the insurance industry, this balancing is dynamic rather than stable, and organizations must continually re-allocate their resources in a balancing of exploitation and exploration to assure the optimal environmental fit. In other words, organizational ambidexterity affords an activity perspective to issues related to the long-term viability of the organization.

There have been numerous studies where organizational ambidexterity has been applied as a theoretical lens to increase our understanding of such diverse phenomenon as IT Governance [26], platforms [27], customer satisfaction [28] and R&D [29]. These applications outweigh the theoretical contributions to organizational ambidexterity itself, and several researchers have questioned the construct validity of ambidexterity as well as the claims that an organization can avoid the tradeoffs between exploitation and exploration [30].

Recent developments within organizational ambidexterity have pushed for understanding ambidexterity as a dynamic process of balancing rather than a balance [25], as historically path-dependent [31], and as a combination of enactment and design [32, 33]. We have also seen significant contributions where ambidexterity has been applied in studies of the public sector, through the aforementioned study by Cannaerts, Segers and Warsen [32] as well as Palm and Lilja [34] and Peng [35] important exploration of the transferability of organizational ambidexterity to the public sector. As noted by Smith and Umans [36], organizational ambidexterity should offer valuable conceptual support for studies of the public sector.

3 METHOD

3.1 Empirical selection and framing

The study involved three parallel clinical inquiries [21] into organizations representing all three layers of the Swedish public sector, i.e. agencies (large university, turnover € 65 Million), municipalities (large city, turnover € 4,5 Billion) and regions (large health-care region, turnover € 4,4 Billion). The combined portfolio value studied is € 35M. Building on a well-communicated previous expertise of similar studies [OMITTED], the research team was contacted by representatives from each organization with a request for a study of their digital portfolio management. The organizations were selected on the premise of them being representative of the government layer and displaying challenges related to digital portfolio management. The studies were conducted 2020-2021 and fully funded by the organizations through commissioned research.

Table 1: Overview of collected data.

Overview of collected data.			
Organization	**Steering documents**	**Management documents**	**Interviews**
Agency	10	15	18
Municipality	16	71	11
Region	15	40	23
TOTAL	*41*	*126*	*52*

Table 2: Overview of respondents.

Overview of respondents.			
Organization	**Executives/Managers**	**Non-managers**	**Total**
Agency	6	12	18
Municipality	10	1	11
Region	14	9	23
TOTAL	*16*	*13*	*52*

The clinical approach is further inspired by Ram and Goes [37] and their arguments for an increased need for high impact programmatic information systems research to tackle grand challenges. According to Ram and Goes [37], the role of research is not merely to create new theory, but rather impact as "the difference that academic research makes in the world". Theory is rather seen as a potential by-product of high-impact research, and research should strive to establish long-term programs directed at grand challenges that can envelop a multitude of different studies.

We created a research consortium for digital government in 2017 as a direct response to a clear need for supporting the digital transformation of the public sector. Since then, we have conducted a plethora of studies, each selected on the premise of the potential scalable value for practice and policy rather than research. With each study adding more and more data to our overarching quest to understand and support digital transformation in the public sector, there is an accumulative effect of the studies that now affords us to address entirely new, relevant, and impactful questions. Further, we create digital services (artefacts) that are directly used in practice, and both funnel more data to the researchers and transfer insight to practice continuously. The studies reported on in this paper will form the basis for the design of a digital service that will help practitioners in balancing their digital portfolios. We intend to release the service in the spring of 2022, whereby we will be able to further increase the depth of our analysis through scaled data collection on a national level.

3.2 Data collection

In terms of the primary data, this was comprised of 41 steering documents (strategies, policies, guidelines et cetera) as well as 126 management documents (project charters, budgets) related to the digital initiatives currently active as part of the development portfolios of the organizations (see Table 1 for details). The combined monetary value (anno 2021 or 2020) of the development portfolios was € 70M. With the organizations studied being large, we selected one of the central development portfolios for each organization. In addition to this, we conducted a total of 52 semi-structured interviews with individuals involved in the portfolio management of digital initiatives in the organizations. We used a combination of purposive sampling and snow-ball sampling [38] to identify relevant interviewees in each organization (Table 2). The interviews were conducted through Microsoft Teams, recorded and transcribed verbatim by a professional transcription service.

3.3 Method of analysis

The method for analysis consisted of two parts. First, we assessed the balance of the three organizations portfolios of digital initiatives through utilizing the method advocated by [39] with the change of instead looking for strategic-operative we categorized for internal-external in addition to the efficiency-innovation. Each digital initiative was assessed in terms of the goal(s) of the initiative. If the goal was directed toward exploitation of existing opportunities, the goal was coded as "Efficiency", whereas if the goal was directed toward exploring new opportunities, the goal was coded as "Innovation". If the benefit of the goal was directed toward internal users in the organization, the goal was coded as "Internal", whereas if the benefit of the goal was directed toward end-users outside of the organization, the goal was coded as "External". If a goal was expressed as a combination of internal-external or efficiency-innovation, it was coded as 50/50. With each project having multiple goals expressed, each goal was coded and the calculation of spend on each of the codes was done through taking the of percentage of goals with each code and multiplying this with the budget of the initiative. This resulted in a monetary assessment of resource allocation in how much each initiative was directed toward efficiency-innovation and internal-external. This method of analysis ows inspiration from Xue, Ray and Sambamurthy's [47] work on portfolio management.

Second, we assessed the practice through combining the data from the interviews, field-notes and the secondary-material in NVivo for qualitative data analysis. This involved two rounds of coding, where we first jointly engaged in thematic coding [40] to identify first-order patterns in the data for each organization (25

Table 3: Balance in terms of internal vs external (percentage).

Balance in terms of internal vs external (percentage).		
Organization	*Internal*	*External*
Agency	90	10
Municipality	84	16
Region	79	21
Average	84	16

Table 4: Balance in terms of efficiency vs innovation (percentage).

Balance in terms of efficiency vs innovation (percentage).		
Organization	*Efficiency*	*Innovation*
Agency	92	8
Municipality	99	1
Region	85	15
Average	92	8

codes). Second, we collated the coding between the three organizations, searching for second-order constructs that would help us in interpreting the data (10 codes).

4 RESULTS

4.1 The balance of digital portfolios

All three organizations share common formulations in their central steering documents as to how they strive to utilize the benefits of digitalization. According to these formulations, digitalization is seen as a method for business development through digital solutions, and there are clear directions in terms of the aspired benefits being both internal (increased efficiency) and external (increased quality of service and relevance). As seen in Table 3, there are however clear patterns of prioritization of the internal vs the external direct value of the existing initiatives in their portfolios.

Despite this clear identification of digitalization being both internally and externally poised, we see a bias regarding how the portfolios are balanced (Table 3). Digitalization in the three studied organizations is primarily introvert, targeted at changing the internal processes and activities of the organizations. In addition to this, the bulk of the internally focused projects were identified as re-investments into digital solutions that were already in place or reaching end-of-life due to technological obsoleteness. In other words, the development funds are primarily activated to maintain existing order, rather than transform operations. Regarding the externally focused initiatives, these are primarily smaller initiatives. In terms of the differences between the three layers of government, agencies have the lowest focus on external (10%), followed by municipalities (16%) and regions (21%). On average, the three layers of government spend 16% on initiatives with a direct value for the citizens as opposed to 84% with a direct value to internal operations.

In relation to the efficiency vs innovation allocations of the portfolios, this is distributed in accordance with Table 4

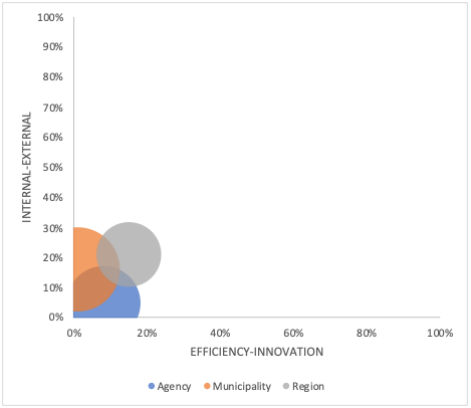


Figure 1: Overview of the direction of digital transformation strategies (size=budget).

Regarding the perspective of efficiency versus innovation, the data identifies clear patterns of bias with a primary focus on efficiency. The mean spend on Innovation is 8% in the sample, whereas the lion share of the allocated funding goes into efficiency, i.e., continued operations rather than explorative initiatives. In terms of the differences between the three layers of government, municipalities have the lowest focus on external (1%), followed by agencies (8%) and regions (15%). On average, the three layers of government spend 8% on innovation activities, as opposed to the 92% on efficiency activities, i.e., exploitation of existing opportunities.

Figure 1 contains an overview of the three portfolios positioned in the two assessed dimensions.

From Figure 1, we see the respective organizations' balancing point in the two dimensions as well as the relative size in terms of the budgets. As can be seen, the majority of resources are currently pushed toward internal efficiency rather than external innovation. Albeit differences between the three organizations, the tendency to focus on internal efficiency is commonplace. This balancing point

is interpreted as the current strategy for digital government in Sweden. Not the strategy as expressed by the government or the respective organizations, but the strategy-in-practice. This opens up for further interpretation in the Discussion.

4.2 The ambidextrous balancing of digital portfolios

All three organizations displayed a high level of formalization regarding the prioritization of digital initiatives, yet in all cases that process was the same for the traditional IT projects.

> "*Business cases are supposed to be created for these initiatives then, and that is the project owner. . . And yes, it's a usual business case that is calculated and then a prioritization is done in the development group. If you say yes to realizing something, then you need to know: 'Do we have both resources and ability in doing it?' That is a prioritization model that is in place where you value different parts and come up with a figure, and if that figure is too low or too high, then it hits different places in the prioritization and then it could also end up in some sort of initiative that may already be in place, that was last on the list and bumped out if there were no resources. That is the prioritization model." CDO, Region*

None of the organizations hence handled their digital transformation initiatives integrated in the traditional operations development processes nor separate in a new process for prioritization. Digital initiatives are in other words handled in a manner inherited from traditional IT Governance.

> *"Who owns the right to interpret what digital transformation actually means? We have not landed in that: What is digital transformation to us?" Portfolio manager, Agency.*

Central to all organizations was the description of the prioritization process as bureaucratic and alienating for operations. Through a highly formalized procedure with significant lead times, digital initiatives often end up avoiding central sanctioning under the fear of losing out on opportunities and getting stuck in the red-tape of administration.

> *"Today there is a process in [the region] called [OMITTED], and that is one way of promoting new ideas that you. . . well, to that administration called digitalization. . . If you then wish to have something implemented or developed or procured or whatever. The problem is that that process is very, very slow. . . .unfortunately, this leads to what we refer to as Shadow IT, and you realize that 'OK, we are going to have to wait for two years to even know if it is going to happen. Then it is probably better to, well, let Nisse put something together so that we at least get something."' Strategist, Region.*

All organizations displayed the same pattern of prioritization. None of the organizations displayed any procedures or methods for integrating perspectives related to anything but economic gain in their prioritization of digital initiatives. Prioritization of new initiatives was done solely on the criterion of cost, i.e. under the assumption that all potential initiatives had an equal value to the organization in its aspiration of its goals.

> *". . .the only thing [portfolio management] thinks is: As long as it is within budget, then we do not have any opinions. And then you do not govern or lead, even though this is expressed in the governance model. . .". CIO, Agency.*

No indications of strategic prioritization (i.e., ranking of initiatives on strategic criteria) nor cash-flow based characteristics (i.e., ranking of initiatives on return on investment and/or payback period) were found. Instead, the process of prioritization resembled a sliding puzzle where the prioritization group saw it as their task to optimize the total spend, i.e., assure that the allocated portfolio budget was fully utilized and there was no funding left on the table before the next round.

> *"So, we have now spent the past three meetings trying to agree on which projects to prioritize. Not once have we spoken about anything apart from cost. Not once has the notion of value been brought up. Isn't that weird?"*
>
> *"Well, you may be right. But we really need to reach a decision here, and we don't have time to start over. We can think about this for future meetings." (Discussion between Portfolio manager, adjunct member of the prioritization board and Chairman of the prioritization board (in session), Agency)*

From a portfolio management perspective, this focus on cost rather than benefits for strategic intentions illustrates a sub-utilization. None of the organizations used traditional portfolio management approaches such as matrixes or other visualization aids in their portfolio management. In other words, balancing of different perspectives such as internal-external or efficiency-innovation is non-present in the portfolio management practices in the public sector organizations studied. At the same time, the organizations have few (if any) supporting elements for safe-guarding innovation.

> *". . . the biggest problem when it comes to innovation, it is partly that we have models that benefit those that do not take any risk, plus that we love to point fingers at those who do something wrong, in worst case resulting in a dismissal." Director, municipality.*

5 DISCUSSION: THE PATHOLOGY OF DIGITAL PORTFOLIO MANAGEMENT

The digital portfolio's composition shows the intent and direction of the organizations' digital transformation, i.e., the actual digitalization strategy. From the analysis, we can see that there is a high level of isomorphism between the three organizations in terms of portfolio composition. All organizations primarily prioritize internal efficiency-oriented initiatives and discriminate against external innovation initiatives. We also identify recurring patterns that we deem detrimental to the quality of the digital portfolio management. We address each of these below.

The results show that strategic intent is not integrated into the portfolio management of the organizations studied. Instead, cost is the sole basis for prioritization decisions. This is supported by the

previous findings of Stentoft Arlbjørn, Freytag and Thoms [18] on sub-par practices in relation to prioritization, as well as perceptions of IT as primarily being a cost [41]. At the same time, this inability of balancing between the contradicting tensions associated within digital transformation [11] is indicative of shortcomings in ambidextrous capabilities when these are perceived as balancing and not a particular balance [33]. We found no evidence of mechanisms in the studied organizations that would afford sentient balancing, but instead solely mechanisms that increase the bias for internal direct value and efficiency activities [13].

Through the sole focus on cost as a basis for prioritization, this hence becomes analogous with a "sliding puzzle". Without a better basis for prioritization, portfolio management will risk misalignment, i.e., the digital initiatives will not execute strategic intent. In two of the cases (Region and Municipality) this boils down to a democratic problem since the boards of both organizations are appointed through public elections. In other words, the democratic governance of said organizations assumes that the vision and strategic intent of the organization is set by the elected officials, and that the public servants then act to realize said objectives. If there is a disconnect between the strategic intent and the manner through which digital initiatives are selected and enacted (see Magnusson, Elliot and Hagberg [42] for a parallel from the private sector). The result of this is an inability in said organizations to assure compliance with democratic processes. With the increased transformation to digital government and the accompanying increased dependency on digital initiatives this challenge is expected to increase in the future, calling for improved practices surrounding portfolio management.

The democratic problem identified above also reverberates in who is represented in the prioritization forums. As seen in the organizations studied, there is a disconnect between competence and mandate, with senior managers from primarily supporting processes (finance, HR, IT et cetera) being represented. Regarding the representation from supporting processes their over-representation delimits the impact of the core operations on prioritization decisions. Lack of representation from executives leads to decreased strategic alignment opportunities, and lack of representation from core operations leads to alienation and shadow IT [43]. In previous studies, Magnusson, Päivärinta and Koutsikouri [13] identify IT Championship as a direct deterrent to ambidextrous balancing in IT Governance, and this is supported by our findings. In all three organizations, there was a predominant representation in the prioritization board from supporting functions rather than the core operations. With the portfolio being placed under the control of the CFO or equivalent, digital initiatives were primarily seen as targeted toward the supporting functions of the organization, sub-utilizing the scope of digital solutions and delimiting it mainly to administrative solutions to decrease cost and enhance internal efficiency.

We offer two main contributions to research. First, this is, to our understanding, the first study of its kind where three different layers of government are empirically investigated and compared in relation to portfolio management. As such, the study adds to previous research through strengthening the empirical foundation of the study of portfolio management practices in the public sector. With the study being directed toward both assessing the balance of the portfolios and how said balancing is enacted, we also contribute to the study of organizational ambidexterity in the public sector [34]. Second, as we identify clear pathologies that explain the current tendency within the public sector to handle digital transformation in a reactive manner [1]. As we show, this is not a bug but rather a feature of the existing governance and control in the studied organizations. Expecting accelerated digital transformation from public sector organizations would hence be magical thinking since the system of governance and control is directly geared against it.

Our study makes two main contributions to practice. First, the method employed for assessing the balance of the digital portfolio can be directly implemented in other organizations in both the public- and private sector. As we have seen in the three clinical inquiries reported in this study, the organizations respond to the results by directly redesigning their portfolio management practices and start to realign their portfolios to their aspired digitalization strategy. From a previous study (OMITTED), we have seen the impact of this type of portfolio management approach on practice, with a significant shift in prioritization toward increased external and innovation through the motivation that this constitutes alignment. Second, with public organizations increasingly making digital government a strategic initiative and including clear goals and ambitions in their overarching strategies, the type of portfolio management utilized in this study provides the organization with increased mechanisms for aligning their digital initiatives with the overarching goals [44].

In addition to the contributions to research and practice, our study offers one main contribution to policy. Policy makers need to address the issue of governance and control being counterproductive to digital transformation. Requirements for e.g., accounting that push for risk-averse behavior are a direct deterrent to digital transformation. Here, the findings from our study along with the recent findings from De Sordi, de Paulo, Bitencourt Jorge, da Silveira, Dias and de Lima [45] on red-tape should inform policy design.

5.1 Conclusion

This study answers the question of how digital initiatives are prioritized in public sector organizations. According to the findings, there is an overall tendency to prioritize internally oriented benefits (e.g., decreased cost of operations) and efficiency-oriented activities (e.g., decreased headcount for administrative tasks), i.e., representing a bias in ambidextrous digital government. This prioritization is done at the expense of externally oriented benefits (e.g., increased access to digital welfare solutions for citizens) and innovation-oriented activities (e.g., new digital services for citizens). The three studied organizations displayed only minor tendencies for active balancing through prioritization, i.e. there is in accordance with Bryson and George [17] a sub-utilization of portfolio management. The consequence of this is that the digital transformation of the organization will suffer from what [6] refers to as doubling down on practices that are outdated rather than assuring the alignment with digital government.

This study has three major limitations. First, our empirical delineation of merely studying one (of several) development portfolios impacts negatively on the generalizability of our findings. We cannot, based on this study express how the involved organizations

balance their complete resources, but merely a sample of this. We are aware of the negative impact this has on the validity of our organization-specific findings, yet we argue that if this is the first step toward a method for a complete measurement of an organizations digital balance. Second, with the organizations studied being large (above average) in size the findings may not be transferable to smaller organizations. The pattern identified seems generalizable among large organizations, yet without additional studies we acknowledge this limitation on generalizability of our findings. Third, as noted by Bannister [46] the institutional differences between different nations public sector organizations also offers a threat to the generalizability of our findings. We hope to see additional comparative research conducted in other nations to investigate the transferability of our findings.

This study identifies three potential avenues for future studies. First, the method utilized to categorize and support prioritization of digital initiatives should be further tested not solely as a method for ex-post analysis in research but also through implementation in practice. We are currently designing a digital service which will afford organizations in the public sector to conduct the analysis of all portfolios and get an overview of the current direction of their accumulated portfolio. We are designing the solution so that the data will be available to research, whereby we will be able to have access to real-time data for continued analysis from all users of the digital service. This data will be made available to the scientific community under the FAIRE principles of open-data, and our hope is that this will inspire future research into portfolio management practices. Second, we hope to see future research on the dialogues necessary for aligning and integrating digital transformation into the political discourse. The decoupling of politics and the subsequent misalignment of the direction of digital transformation in the studied organizations constitutes a flaw in the democratic system. Provided that digital government increases in importance, said decoupling will be an increasing problem where research should contribute through both an in-depth understanding of why this happens as well as concrete design solutions for how it may be avoided.

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How Technology makes Institutions: the case of Peru

Antonio Cordella
Department of Management, The London School of Economics and Political Science
a.cordella@lse.ac.uk

Francesco Gualdi
Department of Management, The London School of Economics and Political Science
f.gualdi@lse.ac.uk

ABSTRACT

The impact of ICTs on public sector organizations and the services they produce and deliver has been widely discussed in literature. Attention has been given to how functional properties of ICTs affect efficiency and effectiveness of public services provision and delivery, as well as the impacts they have on the value these services produce. This paper complements this literature exploring how the functions designed into ICTs carry regulatory properties that trigger institutional changes that have pervasive effects on the production and provision of public services. Building on the case of the deployment of the SISFOH system in Peru, the paper discusses how changes in the functional properties of SISFOH modify the institutional arrangement underpinning the production and provision of welfare services in Peru to the point where a new Ministry (MIDIS) is created. The paper offers valuable insights to better address and discuss the complexity of the impacts of ICTs on public sector organizations and the services they provide.

CCS CONCEPTS

• **Applied computing**; • **E-government;**; • **Social and professional topics**; • **Socio-technical systems;**; • **Government Technology Policy**;

KEYWORDS

Digital Government, Technology, Public Institutions

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1 INTRODUCTION

Over the last decades, public sector has adopted Information and Communication Technology (ICT) to modernize and enhance the way by which public services have been designed and delivered. Through the deployment of ICTs in the Public Administration (PA), policymakers have enabled meaningful reforms in the public sector [1].

Scholars have accounted for the different impacts of technology on the public service provision [2, 3] and on the administrative procedures that structure the way by which PA delivers services [4, 5]. The focus on the outcomes of public administration has allowed scholars to assess both improvements [6] and distortions [7] generated by technology adoption on the public services provided to citizens. Similarly, scholars have addressed the impact of technology on public administration processes followed to produce and provide public services. For instance, technology allows innovative way to respond to citizens request [5] or to produce and deliver public services [8].

In this paper we shift the focus on the analysis of ICTs impact on the institutional configurations underpinning public sector organizations and actions. The research aims at shedding light on how ICT institutionalizes specific organization configurations that redefine how public policies are framed and delivered. The adoption of ICTs in public organizations has transformed the configuration and governance of public sector organization. The more public sector organizations rely on technology to perform their functions, the more technology becomes an institutional actor [9] that shapes public sector transformation. By so doing, technology entangles with existing elements in organizations – such as laws, norms, and practices – to create new organizational configurations.

Building on the techno-institutional theory [10] we shed light on how techno-institutional redefine the domain of action of public institutions. Through the analysis of a case study of the Peruvian public administration, we show that technology can foster the creation of new public sector institutions. The outcome of this transformation might produce meaningful consequences in the public administration activity of service provision.

The paper is structured as follow: section two sheds lights on the academic literature that focuses on the impact of technology on institutions. Section three introduces the theoretical framework that describes the regulative properties of technology. Section four illustrates the methodology followed in the research. Section five illustrates the case study of the Peruvian Households Targeting System (*Sistema de Focalización de Hogares* – SISFOH). Section six elaborates the findings in the light of theory and offers a theoretical contribution. Section seven provide the conclusions of the paper.

2 BACKGROUND

There is an established body of literature investigating how technology transforms the public sector. These transformations have been either studied looking at how ICT changes the policies or the processes of the public organizations. Both streams of research consider ICTs carriers of political and social values that reflect the way in which technology has been designed [11, 12].

The literature that focuses on the impact of technology on public organizations' policies discusses how the adoption of specific

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ICTs affects the services delivered by the public administration [3, 13]. Although technology has been often deployed to increase efficiency and effectiveness of the public administration, scholars have highlighted that ICTs also create distortions and unexpected consequences in the specific public service provision. Relevant examples include judicial systems [14, 15]; the healthcare sector [16, 17]; information provision to citizens [18], welfare programs inclusion [19]. This research offers a granular view of how technology shapes the policies it informs. ICT-mediated policies cannot rely only on administrative and legal acts: rather, they must accommodate technological standards to deliver services. Hence, when public sector adopts ICTs, the outcome of ICT-mediated policies might deliver unexpected outcomes. This stream of research is relevant because it shows that often ICTs change and transforms the policies they mediate.

The second stream of literature focuses on ICTs impacts public sector organizations' processes used to produce and deliver public policies. Scholars investigate how the adoption of ICTs to support decision-making activities structures and hence redefines roles and functions of those involved in the decision-making processes. Examples of this stream of literature are the studies that focus on back-office and front-office automations [5, 20]. The widespread adoption of technologies to support the decision-making in public sector organizations generate complex outcomes. Decision-making is constrained by technology [4, 21], redefining the accountability, fairness and transparency of the ICT-mediated decision-making process. Accordingly, scholars have shown that in many cases the deployment of technological systems or tools to improve the decision-making processes have a profound impact on the quality of the decision-making itself [21]. Technology can change the boundaries of the decision-making domain, challenging democratic and constitutional prerogatives of public decision-making [4]. In this perspective, the key takeaway is that technology has the potential to directly impact the processes: it alters the way in which key decisions are taken in the public sector. By so doing, technology becomes itself an actor in the policymaking process [22].

These two streams of research account for the impact of technology on policies and processes mediated by public sector organizations. They are complementary to account for and analyze how ICT redefine public sector policies and the service they mediate. However, although valuable, these works do not account for the direct institutional transformations triggered by ICTs adoptions in the public sector arrangements they mediate. Beyond impacts on policies and processes, we discuss that technology plays a fundamental role in the evolution of public institutions which are designed and structured to adapt to the technological formal standards and requirements. This phenomenon needs a nuanced account since the adapting of institutions to technology might produce relevant consequences in terms of public service provision.

3 THEORETICAL FRAMEWORK

To analyze how ICTs shape the evolution of public institutions, we build on Lanzara's [10] techno-institutional theory. The theory draws on social systems [23] and neo-institutional [24] theories to shed light on how the adoption of ICTs in (public) organizations generates institutional dynamics [10]. The scripts and codes [25, 26] designed in ICTs institutionalize specific values and norms translating the institutional norms, code, values, etc., into the technological properties of the ICT system [10]. The scripts and codes determine how specific organization's functions, decision-making and workflow processes are structured and executed in the organization. Consequently, the adoption of ICTs constraints organization's functions and processes in what has been designed into the technology [25]. When using a chosen ICT, organizations accommodate (align) their rules and norms with those designed in the technology. Therefore, the organization's existing institutional norms, activities and practices are redesigned to become compatible and hence aligned with the technological functional properties [25]. Hence ICTs' functional properties shape and modify existing institutional arrangements conferring to technology authority and potential to regulate patterns of behaviors within organizations [10]. The functional properties of ICTs act as a regulatory regime that structures organization's practices and processes in a rigid and normative manner [10].

These regulatory regimes are designed into ICT's functional properties which carry institutional agency. When ICTs are deployed in organizations the regulatory regimes designed into the functional properties of technology carry institutional agency which negotiate with other regulatory regimes structured in norms, regulation and values institutionalized in organizations. When deployed in organizations, the institutional agency carried by ICTs regulatory regimes always negotiate with already existing regulatory regimes carried by systems of values, cultural norms, interests at stake, etc. institutionalized in organizational configurations and practices [10]. These negotiations result in techno-institutional dynamics where institutional agency carried by ICTs triggers innovative organization practices that in turn will enable further institutional changes. When ICTs are deployed in organizations, the institutional codes and norms that regulate how the organization operates need to find a way to constantly mediate with the institutional arrangements designed into the ICTs. Yet, since technology develops very rapidly, the alignment between ICT and institution codes and norms is never permanent. On the contrary, it is unstable and evolving: this means that an institution must continuously adapt to technological standards and features. By so doing, the institution is forced to follow the technological evolution to accommodate with its characteristics: institution becomes itself "a technology of regulation" [10]. Lanzara's work on the regulatory properties of technology is valuable to understand "what technology *does* to institutional and normative frameworks" [10] (p.14, italics in original). Technology acting as a regulatory regime means that it has the power to restructure the interdependences within the institution and across different institutions. The emergence of specific ICT systems adopted within institutions set standards and create possible patterns of evolution of the institutions themselves: different hierarchies rise, boundaries span and new configurations replace the old ones. Technological regulatory regime theory offers a valuable lens to depict what is the effect of technology in the making and unmaking of public institutions.

Table 1: List of documents and sources consulted

Document name	Document type	Source	Date(s)
Laws: 29792-2011, 30435-2016	Primary Legislation	Peru Congress	
Decrees: 001-2012, 007-2016	Primary Legislation	Presidency of the Republic	
Ministerial Resolutions: 399-2004, 400-2004, 372-2005, 320-2010	Secondary legislation	Presidency of the Council of Ministers (PCM)	
Ministerial Resolutions: 023-2015, 257-2015, 277-2014, 107-2015, 03-2016, 052-2016, 151-2016, 070-2017, 184-2019	Secondary legislation	Ministry of Inclusion and Social Development (MIDIS)	
National Report on National Targeting System (SINAFO)	Government report	Directorate-General for Targeting and Social Information	March 2020
Assessment Report: SISFOH	Government Report	Ministry of Inclusion and Social Development (MIDIS)	July 2017
Control Report 019-2020	Legal assessment	Peruvian General Comptroller	June 2020
Legal Opinion 030-2020	Legal opinion	Ministry of Inclusion and Social Development (MIDIS)	October 2020

4 METHODOLOGY AND DATA COLLECTION

To illustrate how technology impacts on public institutions, we have selected a case from the Peruvian public sector. We find that to proper shed light on the phenomenon, the latter needs to be investigated within its context. Hence, we adopt a qualitative case study research approach, as per Yin [27]. Specifically, we believe that exploratory case study [27] better fits with the purpose of investigating contexts where there aren't clear and single set of outcomes [27]. Moreover, exploratory case study approach allows us to better understand the impact of a single factor over a process. In this case, the single factor is the deployment of technology, and the process is the institutional dynamics triggered by the technology. Data collection includes secondary sources, such as: (i) official reports and analysis from the Peruvian Government and Parliament bodies; (ii) primary sources of law (bills, decrees); (iii) secondary sources of law (Ministerial documents, technical specifications); (iv) official legal opinions produced by experts and committees. Table 1 illustrates the documents consulted.

5 CASE STUDY

Since the mid of the 1990s the provision of most welfare services in Peru was driven by an on-demand and targeting logic [28]. This choice was driven by the need to make the most efficient use of limited resources available to serve those in needs. To pursue this policy goals the government of Peru has adopted strategies to "establish criteria of eligibility and prioritization of the target population" to access welfare measures [29]. Also, many ICTs have been deployed to support and improve the efficiency and effectiveness of these polices. The Households Targeting System (*Sistema de Focalización de Hogares* – SISFOH) provides the core socio-economic information about potential users and beneficiaries of welfare measures.

5.1 SISFOH

The fundamental purpose of SISFOH is to produce a Socio-Economic Classification (SEC) of citizens based on their level of poverty. In line with the on-demand logic at the core of the welfare provision policy, the classification only processes information of those who proactively apply for welfare services. The SEC constitutes of multiple steps and involves many actors. The determination of the SEC works as follows:

i. Citizens reach public agencies at local level (such as municipalities) and they apply for the SEC. Citizens must provide specific information about their households living condition by filling a survey (S-100). Public officers from ULEs register the application.
ii. Public officers from ULEs check the correctness of the information provided through in-person visits [30]. Once the information is verified at local level, ULEs staff sends it to the Directorate-General of Targeting Operations (DGFO) that will process data at central level.
iii. The DGFO cross-checks the information provided by citizens with existing administrative databases, and then runs an algorithm which determines the SEC. SEC's outcome can be "very poor", "poor" or "not poor".
iv. The outcome of SEC is registered in the General Households Registry (*Padron General de Hogares*, PGH) and becomes available for social programmes delivery.

Over the years, different SISFOH's functions have s changed and transformed. However, while changes to data collection and verification – phases i), ii) and iv) – have not substantially modified the outcome of the process, the evolution of the algorithm has generated more substantial impact.

Table 2: Evolution of the algorithm

Year	Filters	Administrative databases to verify filters	Geographic clusters	Variables to calculate the IFH
2004	No	No	No	Demographic, housing, and asset tenure indicators
2010	Individual income	Public and Private payslips registry (MEF databases)	No	Not available
	Water and electricity consumption	Water and electricity consumption databases		
2015	Household Aggregate income	Public and Private payslips registry (MEF databases)	3 regional clusters applied to the first 2 filters.	17 variables for the urban areas.
	Electricity consumption	Water and electricity consumption databases	15 conglomerates for the IFH calculation	15 variables for the rural areas
2016	Private health insurance subscription	Databases from Seguros Privado de Salud (SPS) or Empresas Prestadores de Salud (EPS) – SUSALUD	3 regional clusters applied to the first 4 steps.	17 variables for urban areas 22 variables for the rural areas.
	Possession of car/van	Databases from Superintendencia Nacional de Registros Publicos (SUNARP)	8 geographical conglomerates for the IFH calculation.	
	Income	Public and Private payslips registry (MEF).		
	Electricity consumption	Databases from Superintendencia Nacional de Administracion Tributaria (SUNAT).		
		Databases from the Organismo Supervisor de la Inversion en Energia (OSINERGMIN).		

5.2 SISFOH's algorithm evolution

SISFOH's algorithm is designed following very clear guidelines specified in the government methodological document approved by a Ministerial Resolution (*Resolucion Ministerial*, RM). The methodological document is periodically revised to respond to changing political or social needs. To date, four methodologies have succeeded and triggered changes in the algorithm: Methodology 2004, 2010, 2015 and 2016 [31]. The algorithm is a combination of filters built on administrative databases and a Household Targeting Index (*Indice de Focalizacion de Hogares*, IFH) which determines the SEC variables and their respective weight. Over the years, the Ministry choose different filters and selected multiple variables (and their weights) to account for the socio-demographic transformations of Peru [31]. Indicators to determine poverty thresholds have been updated over the years according to the ENAHO statistical and demographic analysis: Methodologies 2004, 2010, 2014, 2016, 2019 relied respectively on 2003, 2009, 2012, 2015 and 2018 ENAHO data. Table 2 shows the evolution of the algorithm.

The changes are reflected in the evolution of the algorithm functions over the years. Specifically, the algorithm changed to reflect the government needs to define more precise criteria to establish the SEC of a household. The original algorithm had no filters and no geographical clustering. In 2010, MEF radically transformed the algorithm to include nation-wide filters (individual income, and water and electricity consumption), however the SEC was not linked to local variables. In 2015, geographic clustering was adopted: filters were introduced, and variables were weighted differently (Lima metropolitan, Urban, and Rural areas) to provide a more accurate estimate of the households SEC. In 2016, with the aim to produce an even more precise and accurate SEC, four new filters, geographic clustering, and more variables were added to determine the Household Targeting Index.

5.3 SISFOH governance

SISFOH is an inter-sectoral and inter-governmental system, created in 2004 by the Presidency of the Council of Ministers (PCM) of Peru. SISFOH has a centralized architecture: it is managed at central level by Ministries' Directorates-General, that coordinates SISFOH operativity and ultimately bear the responsibility for the operations. However, SISFOH relies on decentralised data collection and data production that involve multiple levels of local governments responsible to liaise with and reach out to population.

Since its deployment in 2004, SISFOH's structure and governance have been modified multiple times to reflect the increased importance of SISFHO in the provision of welfare services.

For SISFOH's governance evolution, key events are:

Table 3: Evolution of SISFOH governance

Year	Event	SISFOH Ownership	SISFOH governance and changes	Source of law
2004	Creation of SISFOH	Presidency of the Council of Ministers (PCM)	The Interministerial Commission on Social Affairs (CIAS) and its Multisectoral Social Technical Committee The Central Focus Unit (UCF) Municipalities and their corresponding Local Focus Units (ULF) Social Programs	Resolucion Ministerial (RM) 399-2004-PCM
2005	SISFOH moves from PCM to the MEF	Ministry of Economy and Finance (MEF)	UCF reports to the Directorate-General for Economic and Social Affairs (DGAES), that becomes the driving unity of SISFOH	RM 372-2005-PCM
2011	SISFOH moves back from MEF to PCM	PCM	While the new Ministry for Inclusion and Social Development (MIDIS) is created, PCM owns temporarily SISFOH	Law 29792
2012	SISFOH moves from PCM to MIDIS	MIDIS	MIDIS through the Directorate-General for the Management of Users (DGGU) and UCF ULEs (former ULFs) Social Programmes UCF holds the control of SISFOH operativity	Decree 001-2021
2016	Creation of SINAFO	MIDIS	Change in the whole architecture of the targeting system. SISFOH becomes a part of SINAFO, which is now the centre of social policies.	Law 30435, then approved by Decree 007-2016-MIDIS
2017	New governance of SISFOH	MIDIS	MIDIS through the Directorate-General for Targeting (DGFO) Local governments Local governments' ULEs Entities in charge of Public targeted interventions (social programmes)	Directive 006-2017-MIDIS (then approved by RM 070-2017-MIDIS)

- The move from PCM to MEF, which developed the early version of the system in 2005;
- The creation of Ministry for Inclusion and Social Development (MIDIS) that in 2012 enabled key transformations of SISFOH;
- The creation of SINAFO (Sistema Nacional de Focalizacion – National Targeting System) framework in 2016. SINAFO is to date the key framework for the targeting and classification of citizens eligible for social policies.

The changes in SISFOH's governance reflect how the role of SISFHO changed over the years. In the first phase (2004-12), when under PCM/MEF governance SISFOH was designed, its purpose was confined to activities of allocating resources and identifying areas in need of social intervention [31]. In the second phase, MIDIS phase (2012-16), SISFOH became the foundation of the newly created MIDIS established to better handle the development and the refinement of the technology, which had become the backbone of the process of welfare measures targeting. The choice to move SISFOH from MEF to MIDIS reflects the impact that the transformation of SISFOH from a tool to support decentralised decision-making processes into the main driver and the central architecture driving decisions had on the organisation, structures, and responsibilities of government's decisions on welfare services provision. SISFOH had a foundation role in the building of the new Ministry and of its role and responsibilities in enhancing the quality of data processed on how "the targeting system was framed into a national targeting policy" [31] (p.46) whose implementation was delegated to MIDIS. Finally, in the SINAFO phase (2016-to date), SISFOH acquired a new role as it is enclosed in the SINAFO framework. SINAFO, building on SISFOH, becomes the key actor of the Peruvian social policy design and implementation. SISFOH's organizational structure is improved and better connected with different levels of governance, from the central one to local and regional ones. Currently, SISFOH is the backbone of the provision of information to ten different Peruvian social programmes [29]. Table 3 illustrates the main transformations of SISFOH.

6 DISCUSSION

SISFOH provides a good example of how changes in the functional properties designed into an ICT impact on the regulatory properties which negotiate the techno-institutional configuration reflected in the organizational configurations of public institutions.

The Peruvian welfare state is structured around the logic of targeting citizens eligible to receive welfare measures within those who apply for welfare support. Over the years, the Peruvian government adopted and updated ICT resources to improve the welfare

targeting capacity and accuracy. To improve the targeting accuracy and efficacy, new functional properties were designed in the SISFOH system.

During the initial deployment phase, SISFOH functional properties only consisted in simple algorithmic functions able to provide basic input to the welfare allocation decision-making process. SISFOH calculated the Household Targeting Index using a limited set of indicators (early version of the system, 2004). In this phase, the function of the technology was ancillary to the improvement of organizational activities concerning the collection of information and the streamlining of basic decision-making processes.

In this phase SISFOH functional properties did not have a profound impact on the institutional arrangements underpinning the provision of welfare service in Peru. However, SISFOH played an important role in the provision of welfare services: without the output released by SISFOH's algorithm, it was not possible to assess a citizen's socio-economic condition (SEC). However, the functional properties of the system (data collection and basic computational analysis) did not carry regulatory properties able to impact and transform the institutional arrangements underpinning the provision of welfare services, which remained decentralized and scattered among different ministries and departments. When designers included additional variables to determine SEC – such as water and electricity consumption – they also allowed integration of SISFOH with existing databases to fetch information. Moreover, SISFOH was granted access to MEF databases to gather information about citizens' payslips to better determine eligibility for welfare measures.

The design of these new technical functionalities transformed the role of SISFOH in the process of welfare services provision. SISFOH did not only support decision-making processes of different ministries or departments: it centralized these decisions providing uniformed data to the different organizations and departments. In other words, SISFOH standardized parts of the decision-making processes. Hence, providing rapid and reliable provision of key information and integrating with existing databases owned by different public bodies, SISFOH became the backbone of the whole decision-making process on the provision of welfare services. Because of this design, the welfare provision in Peru was restructured according to a uniform targeting logic which was designed into SISFOH's functional properties. These functional properties imposed a new regulatory regime on the multiple agencies participating in the provision of welfare services. The regulatory regime of technology imposed the decision-making logic designed into SISFOH on existing institutional norms, activities, and organizational practices followed by different organizations to take decisions on welfare provisions.

Peruvian policymakers acknowledged the emerging centrality of SISFOH in the provision and production of welfare services. De facto, SISFOH created a new centralized approach to decision-making on welfare provision which was not reflected in the organizations' structures and processes underpinning the decisions on welfare. To address this transformation imposed by the functional properties of SISFOH, the government created a new ministry: the Ministry for Inclusion and Social Development, MIDIS.

MIDIS reflects the institutionalization of the SISFOH functional properties in Peruvian government's welfare provision structures and processes. Within MIDIS, a single, dedicated unity – the UCF – was created to improve SISFOH operativity and help MIDIS to better deliver the national targeting policy now under its remit. UCF helped designing new technical standards – more precise variables and filters to produce better outputs – which reinforced the key role of SISFOH in welfare provision. As a result, SISFOH became core in the delivery of key ten different social programs currently delivered in Peru.

The centrality of SISFOH in the Peruvian welfare provision was further reinforced by UCF when the system was integrated with additional databases maintained by six different public bodies.

In the MIDIS phase the entanglement of the technology with the institution became stronger and it produced consequences on the institutional architecture of Peruvian public sector. The diffusion of SISFOH triggered innovative practices in the ways by which targeting and streamlining tasks were performed in the welfare services provision and productions, and it called for the development of a centralized approach which triggered the creation of MIDIS. The emergence of SISFOH as key actor in the process forced the diffusion of SISFOH technical standards and decision-making process across the Peruvian public administration. This triggered the need to redesign the institutional arrangement which governed the provision of welfare services. The provision of welfare services moved form a decentralized multi-ministerial approach to a centralized and unified structure under the MIDIS. The Peru case shows that the regulatory properties of a single technology have the power to generate new interdependences across different institutions to the point where a new institution – MIDIS – must be created to respond to the changes imposed by the functional properties of ICT. SISFOH became so central in the processes it mediates that it engendered innovative institutional dynamics.

The SISFOH case reveals that it is not always possible to align existing institutional arrangements with the regulatory regimes carried by ICTs. New institutional arrangements, such as the MIDIS ministry, can emerge out of the techno-institutional negotiations that emerge when different regulatory regimes encounter. It is notable that the evolution of the technological standards of SISFOH continues to inform the dynamics of the institutional architecture of Peruvian public sector. The patterns created by the regulatory regime of the technology impacted also on the most recent transformation in the institutional arrangement underpinning the provision of welfare services. In 2016, SISFOH was placed at the hearth of the new National Targeting System, SINAFO: the latter has the purpose to better align the different policies (central, regional, and local) that deliver social policies. SINAFO is managed by MIDIS, and by leveraging on SISFOH it orchestrates the provision of information that structures the delivery of welfare services of ten different welfare programs.

7 CONCLUSIONS

Literature has widely discussed the impact of technology on public service provision and production, and on procedures that define the ways by which public organizations deliver services. This research has shed light on how the functional properties designed

into technologies become the regulatory regimes that can potentially transform the institutional arrangement underpinning public sector organizations.

The paper makes the case that the adoption of ICTs in public sector triggers dynamics that have relevant institutional impacts. The case study of the Peruvian welfare system illustrates that the regulatory regime designed into the scripts and codes that constitute SISFOH produces meaningful alterations to the evolution of the public institutions. Technology carries institutional agency that has the power to redefine interdependences across public institutions, and to force the building of new institutions to better accommodate the new standards and requirements generated by technological properties. Hence, technology plays a direct role in the making and unmaking of public institutions.

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Challenges and Opportunities for ICT in Co-production: A Case Study of Public Service Innovation in an Italian Municipality

Chiara Leonardi
Fondazione Bruno Kessler
cleonardi@fbk.eu

Elena Not
Fondazione Bruno Kessler
not@fbk.eu

ABSTRACT

This paper contributes to the ongoing debate on how ICTs can be exploited to support the co-production of public services by exploring the case study of an Italian municipality that is experimenting new forms of governance and co-production practices. We examined the process followed by a network of stakeholders for the co-design and co-delivery of a digital portal for citizens, a single access point to online services, trying to depict the organizational model, the dynamics among the network participants and the opportunities and barriers offered by ICTs to co-production. We identify specific areas in which pitfalls and shortcomings related to the actual achievement of co-production might be practically overcome through digital technology, addressing in particular: capacity building, step-by-step guidance, simplification of handovers, transparency of network status and process accountability, lowering the costs of citizens engagement, continuous evaluation, and sustainability by design.

CCS CONCEPTS

• **Human-centered computing** → Collaborative and social computing; Collaborative and social computing theory, concepts and paradigms; Computer supported cooperative work; • **Information systems** → Information systems applications; Collaborative and social computing systems and tools.

KEYWORDS

ICT-enabled co-production, Digital collaborative environment, Digital public services, Digital platforms design

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1 INTRODUCTION

New paradigms and governance models that foster participatory practices and leverage networks of public organizations, companies and citizens are being experimented to improve the quality of public services and guarantee their effectiveness and sustainability [3, 12]. Within this landscape, the paradigm of co-production is gaining more and more centrality, as a form of governance that involves the contribution of multiple actors to public services design and delivery [17] and that could greatly benefit from information and communication technologies (ICTs). Communication and sensing technologies and social platforms, for instance, are promising to bring positive outcomes on public service provision and citizen engagement, to make collaborative processes more efficient and to empower individuals and collectives [11]. Yet the effectiveness of introducing ICTs to foster these practices strongly depends on factors both inside and outside government organizations [21], among these, cultural and organizational factors, shortage of technical skills and financial capabilities [1, 9, 17].

This paper intends to contribute to the ongoing debate on ICT-enabled co-production by exploring through a case study how local administrations are experimenting new forms of governance and co-production practices, and which pitfalls and shortcomings can be practically overcome through digital technology. The aim of our work is to distill implications and requirements for a digital platform providing an overarching support to the co-production process, which is rarely considered in its whole, from the initial step of launching the initiative, to the moment in which the public service is designed, developed, and delivered in collaboration with private stakeholders and citizens, and sustained in the long term. We selected the Italian municipality of Reggio Emilia as a very informative case study, due to their consolidated experience with participatory initiatives of co-produced public services. We explored the process they followed for the co-design and co-delivery of a digital portal for citizens, a single access point to online services, trying to depict the organizational model, the dynamics among network participants, and the opportunities and barriers offered by ICTs. The emerged findings call for innovative digital tools that support capacity building, step-by-step guidance, simplification of handovers, transparency of network status and process accountability, lowering the costs of citizens engagement, continuous evaluation, and sustainability by design.

Our discussion will start from a review of related work on public service co-production and on applications of ICT in this domain. Section 3 will then introduce the Reggio Emilia case study and the methodology used to collect the results presented in Section 4. Several interesting implications for the design of ICT platforms supporting co-production are then discussed in Section 5, before drawing final conclusions.

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2 RELATED WORK

2.1 New governance models and co-production

New paradigms for governance are changing the boundaries between government, citizens and various other actors. Several models stress the need to involve citizens and private actors (including non-governmental and civil society organizations) in the whole administration process [2, 20] as a consequence of the failure of the traditional "statist" system for providing public goods and services [7]. Private participation is a necessity also connected to the recent socio-economic crisis and the related challenges public services are facing, among others increased demand, rising expectations and, in many cases, reduced budgets [5]. These participatory approaches have recently gained popularity, so much so that the partnership between citizens, private organizations, and public administrations (PAs) is at the core of the European Digital Agenda [6].

In particular, co-production of services is a new and more inclusive way of developing and delivering public goods and services, a collaborative form of governance in which citizens are involved in the creation of public policies and services and possibly in their implementation and long-term sustainability [17].

Despite the growing recognition of the benefits of co-production, several issues and drawbacks exist to effectively carry-out initiatives able to impact policy and public services delivery. Among these, the lack of clear responsibilities and accountability, high transaction costs, including costs related to information seeking and sharing, and paradoxically a too strong institutionalization of users' involvement [18]. Besides, studies demonstrated that an effective co-production process needs to develop the right organizational structures and culture, requires adequate operational and political support [1] and should be characterized by low centralization and high connectedness. Howlett and Ramesh [9] pointed out that three types of resources and capabilities are crucial to carry out successful co-production initiatives: i) analytical resources to ensure policy action, ii) operational resources to mobilize and deploy means, to carry out coordinated actions, and engage policy networks, communities, and individuals; and iii) political resources to ensure political legitimacy and a two-way communication with non-state actors.

2.2 ICTs and co-production

Several studies are being conducted on how technology may foster co-production practices and promote citizens engagement [11, 12, 16]. "ICT-enabled co-production" is the term used to refer to the use of ICTs to support engagement in the co-production of public services [8]. ICT can encourage co-production in different ways, for instance facilitating new connections within the community, establishing relationships that were not possible before by overcoming problems of geographical dispersion of users, or empowering citizens by sharing sovereignty and responsibilities in relation to service co-design [16]. According to Meijer [14], the role of ICT in co-production matters in both instrumental and institutional terms: technology facilitates new practices of co-production and could, for instance, help cut costs. On the other side, technology transforms these practices into more social and 'playful' interactions. The role of ICT also depends on the policy domain, institutional situation, and existence of citizen communities. Lember et al. [11] propose an analytical framework to account for the conditions in which digital technologies impact on various elements of co-production, starting from the assumption that four elements can be identified: establishing interaction, motivating the people involved, bringing resources, and sharing decision-making.

Besides the body of studies that analyze the role that ICT could play in supporting co-production initiatives, other studies explored the barriers that prevent PAs, companies, and citizens from fully exploiting the potential of ICT to co-produce and co-deliver services. Clifton et al. [8] identified limits such as the shortage of financial resources required to set-up and maintain an ICT-enabled co-production initiative, and the lack of skilled workforce able to coordinate and execute related activities. Other barriers are related to the lack of planning for the day-to-day ICT use, and to the complexity of legal regulations that can prevent governments from adopting ICTs and can cause delays in the deployment of solutions. Finally, the lack of technical skills along with cultural barriers - like a negative attitude toward ICTs - could lead to a scarce participation of both citizens and government staff: while government staff may perceive ICTs as potentially controlling and intrusive, introducing too much rigidity to the organization, citizens might fear that ICTs may invade their privacy [8].

Other barriers toward ICT-enabled co-production identified by Sorrentino et al. [17] are related to the often informal and experimental nature of most co-production initiatives "and in the difficult scaling up and dissemination of the experiences". The authors also stress potential negative effects of ICT-enabled co-production: for instance, equity and accessibility could be an issue, in particular for disadvantaged people and minorities. As stressed also in [8], demographic factors should be considered to avoid digital divide, the gap that exists between people with and without technology skills, which excludes certain social groups from active participation.

What seem to emerge from the literature is the need for new types of digital collaborative platforms that support co-production practices in a more holistic way, by providing both (i) enablers to create healthy and sustainable partnerships and joint action as well as (ii) the pre-conditions to overcome barriers, by lowering the costs of ICT take-up in public services, by building capacity, trust, legitimacy, and reusable resources. To extend our understanding on opportunities offered by digital platforms, empirical research should take a holistic stance in the investigation of current practices and the related barriers to successful co-production.

3 THE REGGIO EMILIA CASE STUDY

The case study presented in this paper was conducted as part of a larger EU-funded project – INTERLINK – that aims at developing and testing an ICT-based platform that facilitates co-production processes between public organizations and private stakeholders and that provides tools to guide and monitor public service customization and delivery. To this aim, different requirements and constraints should be carefully taken into account, considering that different users (i.e., public governments, companies, citizens) will weigh criteria differently and might have different needs that are related to the final acceptability, and hence adoption, of a digital solution. The adoption of a new technology by public organizations

is affected by many factors. Usability, accuracy, price, security, interoperability, and robustness are all independent factors affecting user acceptance [10].

As a first step in the elicitation of requirements for the development of the INTERLINK ICT platform, public organizations at the national and local level interested in co-production practices have been involved in our research activities. In particular, an Italian local public administration - the Municipality of Reggio Emilia - has been involved because of its long-term commitment and experience with participatory processes and initiatives of co-produced public services.

3.1 Reggio Emilia participatory governance model

The city of Reggio Emilia (Italy) is known for its long history of resistance to social injustice and for its cultural traditions of service innovation and collaboration [15]. One of the main challenges that the city is trying to address is to change the traditional role of the public administration and its relationship with citizens, promoting a cultural and structural change that fosters the role of public administration as an enabler for participatory paths and practices, bringing citizens at the center of the decision-making process.

The governance model followed by Reggio Emilia Municipality is based on three main pillars, that are strictly connected with INTERLINK goals and mission: (i) *Participatory governance,* to promote stakeholder involvement and to ensure that everyone contributes with their own ideas, skills and solutions; (ii) *Transparency*, to make decisions transparent and open to the participation of citizens, organizations and businesses (e.g. openness and publication of data and procedures); (iii) *Sustainability* to rationalize processes and plan initiatives that will be integrated into normal operational flows and organizational structures, so as to ensure continuity and allow for a medium-long term horizon.

The Reggio Emilia Municipality implements its participative governance model within the “Smart City protocol”, a formal framework to boost strategic initiatives for digital and social innovation. Launched in 2017, the protocol has already involved 36 local organizations to design and implement joint initiatives which, through collaborations and sharing of working methods, solutions, and skills, allow subscribers to promote innovation and development of the territory and thus improve the quality of life and services.

3.2 Workshop on co-production practices and barriers

Representatives of the Reggio Emilia Municipality were engaged in preliminary meetings to negotiate their role in the INTERLINK research project, to investigate their ongoing collaborative initiatives and their interest toward exploring the opportunities offered by ICTs to enhance co-production practices. After these preliminary discussions, a structured workshop was organized with the goals to depict the organizational model behind their co-production processes, identify barriers and reflect about the type of support they might need to improve the process performance and quality, and hence envisage functional requirements for a digital platform to facilitate co-production.

The workshop was organized online in July 2021 and it involved two representatives of the Municipality: the general manager coordinating both the information systems of the public organization as well as the technologies offered to citizens and an IT officer, coordinating digital transformation and smart city projects. The research team was complemented by two researchers in service design and user-centered ICT, a software developer with experience in applications for social innovation, and three project managers of a software company providing digital services to public administrations. To bootstrap the discussion, the two representatives of the Municipality were asked to select a service co-designed and co-delivered within the Reggio Emilia Smart City protocol.

The service selected for further analysis was “MySpace[1], an integrated single access point to online services where citizens can find online services and information resources, such as those required to print a certificate, enroll children in preschools, etc. By logging in with the same credentials, citizens can access the on-line services of the Municipality of Reggio Emilia, as well as of other private and public parties. The representatives of the municipality were invited to reconstruct the different phases of the co-production process for "MySpace". For each of the mentioned phases, we investigated the following dimensions:

- Actors involved, their role in the process, relationships among them;
- Procedures followed to manage the different phases of the process;
- Coordination, communication, and information sharing within and outside the network: online and digital tools used and related barriers;
- Decision-making process, transparency.

4 RESULTS

4.1 The different phases of the co-production process

During the workshop, the information and the reflections emerged in the discussion were summarized in post-it notes attached to an online board. Statements that pertained to the same process phase were grouped together, to visually render the different co-production steps and solicit further analysis. In the following, a summary of the co-production phases emerged, along with the characteristics of each phase, are described.

Project launch. The idea of an integrated single access point to online public services emerged internally to the Municipality, which started collaborating with some selected external stakeholders such as subsidiary companies, well before the creation of the institutional framework “Smart City Protocol”. The first phase was hence very explorative: a pioneering phase started in 2012 when a restricted team started planning and refining the first service idea. Actors involved were the "technical" staff of the Municipality and technical employees of the subsidiary companies (e.g., companies which deal with the waste tax, the mobility agency that deals with school transport, etc).

[1]https://openapps.comune.re.it/cruscottocittadino/public/cruscotto.jsf”

Engagement phase. The informal network was then institutionalized as a consequence of the official appointment of the "digital councilor" of the Municipality, who played a crucial role in upholding the importance of digitalization at the political level. The digital councilor strengthened the strategic nature of digital projects, giving more external visibility to initiatives, both towards companies and citizens. This step enabled the formalization of the collaboration and the network enlargement. A memorandum of understanding was signed by the organizations interested in participating in the working group. This list of organizations committed to develop collaborative projects and to boost strategic initiatives for digital and social innovation. The list of signatories of the memorandum includes various types of businesses, trade associations, cultural and civil associations and has reached more than 30 signatory organizations.

Feasibility check of the service. The feasibility of the service was further analyzed by the Municipality with a restricted network of organizations, to understand how a selected number of existing online services supplied by different service providers could be offered to citizens from a single access point. At this stage of the process, information was collected through a direct dialogue with the technical representatives of the subsidiaries involved.

Design phase. After the technical check, the extended group of stakeholders was activated to collect information for the overall design of the citizens' portal. All the signatories of the protocol were involved. Organizations were asked to identify an internal contact to participate in the design activities that were performed through two subphases:

- *Consultation of the network*. In this enlarged collaborative phase, information was collected during an assembly: a guided discussion was organized, followed by the distribution of a form designed to collect information about the online services that organizations already offer to citizens and customers, their interest to bring their online service within the citizens' portal and their ideas about the design of a centralized service. A structured discussion followed in which participants brought their experience with online services and their perspective on a single access portal.
- *Sharing of results.* The outcome of the consultation activity was elaborated by the Municipality: emerged ideas and other relevant information were organized in a PowerPoint presentation and published in a folder of a content management platform dedicated to the initiative, a sort of shared repository accessible only by participants and stakeholders involved.

Development phase. In this phase, the online portal was developed by a restricted technical team. Small sub teams of technical actors proceeded in parallel on the development of different features of the digital solution. In this phase, direct communication among actors took place.

Evaluation phase. Throughout the process, periodic internal evaluations were performed, in the form of self-reflection with stakeholders to adjust the process and refine the understanding of the ICT solution to be released. Informal methods were used to manage the internal assessment. The developed service was evaluated between the 1st and 2nd cycle to lay the foundations for the second edition. A survey was administered to citizens to evaluate the relevance and effectiveness of the services provided by the Municipality. The Municipality was supported by the Bocconi University to define, administer, and analyze the survey data. The results emerged from the survey were presented and discussed within the extended network of stakeholders.

4.2 Organizational factors and barriers of the Reggio Emilia Municipality co-production process

After having depicted the main phases of the co-production process for the development of "MySpace", a more focused analysis was performed according to the investigation dimensions described in Section 3.2 above.

Stakeholders' network evolution, iterative redefinition of teams and problematic handovers. The experience of the co-production of "MySpace" shows that the network of stakeholders is not a stable entity but it evolves over time. In our case study, involved actors changed according to the different phases of the process and to the different skills needed for addressing the several emerging challenges (e.g., information collection versus technical development of the platform). Moreover, the level of institutionalization of the initiative evolved over time in relation to the changes in the political landscape, that entailed the reconfiguration of the network as well as the internal decision-making structure. The arrangement and the size of the network also evolved: specific phases in which the extended group of stakeholders was involved alternated with phases in which only a restricted and focused team was active (or several small groups worked in parallel). The handovers between participants emerged as particularly critical. In some cases, representatives of organizations that participated in the first phases delegated to colleagues the participation to successive phases, and some information was lost in between. As voiced during the workshop, to support continuity of joint action, tools for team management would be highly appreciated to offer communication archives, work plan visualization, and task assignment, in addition to mere document storage.

Use of ICT throughout the collaborative process. The Reggio Emilia Municipality promoted the use of a collaborative platform - Alfresco Share[2] - to encourage collaboration and communication among participants. Yet the platform was mainly used as a shared archive where to store project documents. The reasons behind the poor use of the platform are mainly related to the fact that online interaction within a collaborative environment should be encouraged and sustained over time but there was a shortage of (human) resources and expertise to guarantee lively community interaction and engagement. Another reason is that for the technical partners involved in the operational/development phase more direct and fast communication channels were preferred. These findings confirm the barrier identified by [8] related to the shortage of financial resources required to set-up and maintain an ICT-enabled co-production initiative and the lack of skilled workforce able to coordinate ICT-based activities.

Need for process transparency. The improvement of communication with and between stakeholders emerged as a critical

[2]https://docs.alfresco.com/content-services/6.0/using/share/

issue for Reggio Emilia Municipality. Informal and collaborative channels for exchanging information, keeping everyone up-to-date, and motivating participation were needed to establish a process that is transparent and accountable. To overcome the currently perceived lack of awareness about how the collaborative process proceeds, it emerged that a digital dashboard would be useful to show statistics and insights on the collaborative process itself, to foster self-reflection and co-evaluation for an internal assessment of the co-production initiative. Information regarding which participants contribute most to the planned actions and decisions, and how interaction revolves between members of the network, may reveal whether co-production is fair and inclusive and whether it fosters durable ties and synergies. The initial agreement of key performance indicators and their monitoring over time is considered a significant added value that ICT could facilitate.

Enhanced citizens involvement. As already reported in several studies [4, 8, 19], also for the Municipality representatives, the engagement of citizens is considered complex and time consuming. They recognized that more citizen engagement would be fruitful for the successful co-delivery of services. Yet, the costs related to effective communication and community engagement are evaluated too high for the resources available and for the expected outcome. Despite these perceived difficulties, citizens were engaged during the evaluation phase, considered as crucial to assess the quality of the co-delivered service. As periodic service co-evaluation with citizens becomes the norm, the local administration would benefit from guidelines and templates for administering surveys, coupled with software that facilitates data collection, analysis, and results reporting.

Lack of standardized procedures and best practices. As in most co-production initiatives [17], also the coordination and the management of the co-production process explored in this paper was characterized by an experimental nature. This required the administration to proceed through trials and errors and to continuously stop and reflect on the next steps. Moreover, the long-term nature and complexity of the collaborative process made it difficult - as discussed in previous studies [17] - to assess the quality of the process and understand, for instance, how the network was performing, which actors were actively engaged and hence, how to put in place corrective measures to foster the network participation. What emerged as very important to nurture a virtuous cycle that consolidates social innovation is the availability of standardized and reusable procedures and mechanisms that facilitate the sharing of lessons learned. In particular, mechanisms that guarantee that results and lessons learned (i) are appropriately communicated to stimulate the enlargement of the network and its objectives, (ii) are disseminated to build consensus at the political level and at the societal level, (iii) are shared as good practices to inspire other public bodies and co-production initiatives or to publish reusable tools (e.g. strategies for communication campaigns that have proved effective, means to manage open data made available by multiple stakeholders).

5 DISCUSSION

Several interesting implications for the design of ICT platforms supporting co-production can be derived by reflecting on the results emerged from the case study investigation.

Build capacity in co-production. First, co-production is a broad concept: the spectrum of public service delivery is defined by a number of variables, like the level of citizens participation, the spectrum of government-entrepreneurs-citizen relationships, the type of service, sustainability models [12]. Public administrations need to be guided in establishing and managing a co-production process that fits their context and takes advantage of standardized procedures. The first step is to develop awareness about the different types of co-production and co-business models. For instance, co-producing a public digital service (e.g. activating an online service like "MySpace") requires different tools, expertise and a different organization of the collaborative work than to co-produce a more traditional service (e.g. setting-up a new educational program). ICT may greatly facilitate capacity building, not only by offering learning material and examples, but also by offering step-by-step guidance to support actors in choosing different co-production paths and in coping with the different phases and challenges of collaboration. However, this points to a need for research to fill the existing knowledge gap on how co-production processes vary according to different governance models.

Consider the heterogeneity of actors involved and the evolving structure of the collaborative network. There is a continuous redefinition of the teams engaged in the different tasks and phases of the process. Furthermore, co-production involves different stakeholders with different ICT skills, backgrounds, competences in relation to eGovernance and, finally, with different motivations to participate in the process. Collaboration might create a strong tension between the rigidity and division that characterize the public administration functioning and the strong flexibility and interconnectedness typical of complex collaborative initiatives. Digital collaborative environments should provide flexible and adaptable solutions that do not introduce additional bureaucracy to processes. They may be helpful in accommodating the needs and expectations of a variety of stakeholders, as user interfaces and available functionalities can be flexibly personalized according to different user profiles, so to soften the cultural and organizational barriers [8]. Simplification of handovers, transparency of network status and accountability of process advancement are additional important benefits. Recent research advances in social coins and serious games [13] show how digital platforms can incorporate mechanisms for incentives and rewards to encourage the participation of different target groups (e.g., citizens).

Lower the costs for citizen engagement. Considering the issue of citizen engagement, our study confirms the difficulty for public administrations to set up, manage and sustain bottom-up processes because of the perception of the high costs required to properly manage engagement and communication tasks. This issue - largely discussed in the literature [4, 19] - opens several opportunities for ICT. As suggested by the stakeholders in our case study, digital platforms for co-production should support the sharing and re-use of protocols, templates and successful strategies among PAs,

this way improving the know-how and the capacity of public bodies to engage the civil society in the co-delivery of public services.

Increase support for evaluation and sustainability. ICT-enabled collaborative environments should provide PAs and other actors guidance and automatic mechanisms to evaluate and monitor the availability of needed analytical and operational resources [9]. As confirmed by Reggio Emilia practices, periodic stop points should be scheduled to encourage the co-production team in reflecting and assessing under what conditions and constraints the initiative is likely to succeed or fail. On the other hand, digital platforms, as sorts of one-stop shops for governance innovation, can facilitate the finding of appropriate resources to cope with the challenges related to the co-production of services (available human expertise, best practices, templates for co-production activities, reusable software components) as well as with the challenges related to sustainability (business models, regulatory frameworks, ICT maintenance checklists).

6 CONCLUSIONS

Our case study was based on the analysis of a co-production initiative implemented by the Italian Municipality of Reggio Emilia to co-design and co-deliver a digital portal for citizens. This initiative is part of a wider commitment of the Municipality that pursues service innovation through new governance models based on strong and long-lasting partnerships with other local and national public bodies, companies, and citizens. Building on previous studies that examine opportunities and shortcomings of ICT-enabled co-production initiatives, our work paper explored the organizational model behind Reggio Emilia co-production processes and sheds light on a number of themes that should be considered for the development of digital platforms that meet public administrations requirements for service co-design and co-delivery.

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Safe return to the workplace: Perceived opportunities and threats in the use of health surveillance technologies in public administrations

Stefan Stepanovic
Swiss Graduate School of Public Administration,
University of Lausanne
stefan.stepanovic@unil.ch

Tobias Mettler
Swiss Graduate School of Public Administration,
University of Lausanne
tobias.mettler@unil.ch

ABSTRACT

The digitalization in public administrations has seen, through the COVID-19 pandemic, the appearance of health surveillance technologies at the workplace. Wearable health devices, such as physiolytics, may then have an increasing role in the management of public agents. Still, little is known about the use of these systems in work settings, as research is mainly oriented towards ethical debates or legal considerations. Accordingly, we propose to consider a concrete case of implementation of physiolytics in a Swiss public administration. We particularly investigate employees' use rates as well as the perceived opportunities and threats that are linked to physiolytics and health surveillance technologies. This is done through an action design research perspective, where we search to extract from the field guidelines and knowledge for practitioners. We especially highlight that physiolytics' use steadily decline after the first weeks, due to the design of such devices, the fear of surveillance, and the impression of competition that these systems bring into the workplace. It is therefore vital for public managers to introduce interventions, such as regular feedback, gamification, or nudging to support the engagement of public agents and ensure the viability of such novel health initiatives.

CCS CONCEPTS

• **Social and professional topics/Computing/technology policy/Surveillance**; • **Human-centered computing/Collaborative and social computing/Empirical studies in collaborative and social computing**;

KEYWORDS

Health surveillance technologies, physiolytics, case study, action design research, public administrations

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1 INTRODUCTION

The COVID-19 crisis has phenomenally accelerated the digitalization of Public Administrations (PA) and their workspaces: public managers in organizations had to look to new ways to effectively monitor their employees stuck at home. The notions of task automation, digitalization of information or dematerialization of the workplace have consequently become familiar to many. Yet, rather than an epiphenomenon, the increasing weight of digital instruments in the management of PA has been observable over the past decade [1]. Information systems (IS), that are able to both (a) collect/analyze data, and (b) offer an interconnected communication framework, were progressively implemented in public services, making work more connected, personalized and flexible [2, 3].

However, during this pandemic, a particular concept linked to digitalization has spread within in the media and the public debate: health surveillance technologies [4]. The idea of monitoring individual health data through digital tracing has been promoted as a way out of crisis. Asian countries, such as Taiwan and South Korea, which have been able to initiate a comprehensive digital tracing based on big data, quickly became examples to follow for western societies. Still, the use of health surveillance technologies in western PA remains rather infinitesimal and mirrors the use of other big data technologies, which are still in a very early stage in western PA [1, 5]. Accordingly, there is a big gap between the demand or interest for these technologies and the available knowledge on this subject. In fact, most of the research in the PA domain is concentrating on legal and on privacy concerns regarding the use of health surveillance technologies [6] and little is known regarding practical and organizational that can arise with the implementation and use of such innovative systems in PA.

In this paper, we therefore propose to study a concrete case of implementation of a health surveillance technology in a PA. More precisely, we focus on physiolytics [7], which are connected health wearables that offer individualized algorithms-based feedback. We organize the introduction of physiolytics as part of an occupational health program in a PA of a Swiss municipality with a population of roughly 15'000 inhabitants. Through an interpretative case study, based on focus groups done before, during and after the introduction of physiolytics as well as on the effective use time of physiolytics, we pragmatically outline structural opportunities and threats regarding the use of such a technology on a day-to day basis. We notably (a) examine if participants use the devices in a regular

and continuous manner, and (b) detail perceived opportunities and threats that influence the consistent use of physiolytics in PA.

By doing so, our objective is to offer public managers a more pragmatic perspective on the practical issues related to the implementation of health surveillance technologies in public organizations. As mentioned above, physiolytics technologies are emblematic of a possible digital transformation of PA. They demonstrate a massive data collection capacity, a large storage capacity and a complex analysis system [8, 9]. Acquiring applied knowledge on this topic, in the form of opportunities and threats directly identified by public agents, therefore makes it possible to complete the ethical, legal, or technical perspectives. It thus enables the actors in the digital transformation of public organizations to deal with these emerging technologies and to position themselves, increasingly, in anticipating the challenges of digital evolution rather than in reacting to them.

This papers structures as follows. First, we briefly present physiolytics. We then describe the case study methodology and discuss our results and implications. We finally end by stating the limitations of this work and indicating avenues for future research.

2 BACKGROUND

Physiolytics are wearable devices with sensors (smartwatches, connected wristbands) that use physical and biological data to advise individuals about their physiological state (typically their stress level). This data can also be used, in an anonymous and aggregated manner, to produce dashboards, alerting all employees to collective levels of physical activity or different peaks of stress [10]. Before the COVID-19 pandemic, physiolytics were increasingly distributed by employers as part of (voluntary) health promotion programs within companies, but also for the purpose of occupational safety or performance optimization [11]. Estimations indicated that 75 million physiolytics devices were used within the workplace by 2020, with many large corporations (such as IBM or SAP) including these systems in their occupational health programs. The COVID-19 situation assuredly created a new dynamic regarding these technologies, and raised the predictions for their dissemination in work settings [12].

For physiolytics, early evidence suggests that organizations typically put a substantial effort in the early phases of implementation to address eventual privacy concerns that employees may have. Due to the collection of personal health data that is potentially sensitive, there are personal data protection laws that impede organizations to establish a mandated use [13-15]. Consistent with this, most of the research has been oriented towards factors influencing adoption and, more generally, adoption behaviors regarding physiolytics at work. In particular, scholars have investigated expectations and experiences linked to the introduction of physiolytics in organizational settings [16]; privacy perceptions and mental pressure [15, 17, 18]; acceptability and scalability [19]; mental models of employees who are faced with the introduction of physiolytics [11]; social implications [20]; perception of barriers to the adoption of such technology at work [21] as well as defined design principles to reduce the social tensions caused by the adoption of physiolytics in the workplace [22] and resistance in PA [23, 24]. Yet, early evidence also suggests that organizations are good at motivating (or pressuring) employees to engage in such occupational health programs [21, 25-27]. What is certain is that, for both employees and organizations, physiolytics have value as long as participants engage in the use, so that health data is gathered over time to (1) ensure that relevant information and feedback is presented; (2) eventually increase employees' consciousness of possible health and safety threats (e.g. elevated stress levels or sedentary behaviors) and, in fine, (3) nudge them to engage towards better health behaviors and attitudes [28].

3 RESEARCH METHOD

To provide explicit prescriptions for the use of health surveillance technology in PA, we have followed a pragmatic research epistemology, called Action Design Research [29]. Action Design Research (ADR) is a problem-driven process that aims, through iterative cycles, to solve a practical problem in a concrete and systematic way. This process can be outlined in 4 main stages: *problem formulation*; *building, intervention, and evaluation*; *reflection and learning;* and *formalization of learning* (see Figure 1).

ADR is a validated IS method for generating prescriptive knowledge through building and evaluating IS artifacts in organizational settings. It holds the particularity that the researchers and participants of the experiment are cooperating to actively find innovative solutions in real-life conditions [30]. This is much needed in the PA context, where public entities often struggle to find novel solutions to complex problems [31]. Therefore, this paper presents, starting from an identified problem (i.e., lack of knowledge regarding an actual use of surveillance health technologies in PA), main learnings from a first design iteration.

Concretely, for the intervention, we created with a partner medium-sized municipality in Switzerland a new occupational health program based on physiolytics. The selected system was a CE class IIa device (see Figure 2), able to monitor a large panel of biological parameters such as blood pulse wave, blood oxygenation, skin blood perfusion, skin temperature, respiration rate and heart rate variability. This device was paired with an app, so that participants could consult visualizations of their own health parameters (e.g., stress levels, which were algorithmically calculated and displayed). In an introductory session, we made sure to inform all public agents about data privacy, security and functioning of these systems. Participation for public agents was completely voluntary. After the introduction process, slightly more than half of the approached employees confirmed their participation (19 out of 32 individuals, spread over four partner departments: tax administration, building management, social service, and chancellery). We let participants freely use the devices for 6 weeks.

In terms of data collection, a mixed approach (qualitative/quantitative) was used. For the qualitative part, we conducted focus groups before, during and after the introduction of physiolytics to identify the opportunities and threats perceived by the participants regarding this technology. To complete this perspective, we also integrated quantitative data, through the time of actual use of the devices by the participants. In this way, we were able to assess not only the determinants of the employees' use, but also the materialization of this use over time.

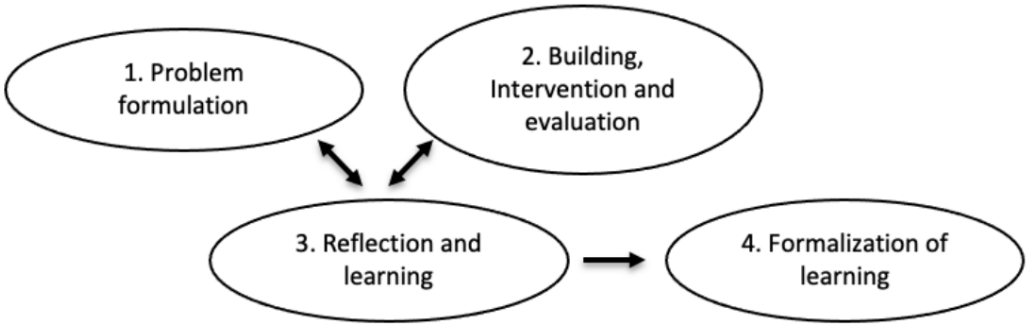


Figure 1: Action Design Research (ADR) process



Figure 2: Physiolytics used in our study and visualizations of stress levels

4 FINDINGS

The dynamics of device use indicates a significant and steady decline in the number of active participants over six weeks (see Figure 3).

This is in line with early evidence on the use of physiolytics in work settings, as surveys suggest that roughly half of participating employees lose interest in wearables within the first months of use [32-34], possibly leaving this fast-growing technology without expressing its full potential. Achieving a continuous use, when implementing such an occupational health program, is certainly a major milestone to get for organizations. In fact, the introduction of a tracking technology may only be considered successful when a significant quantity of employees move beyond the initial adoption stage, and use the devices on a continued basis [35]. To better understand the factors that may impact physiolytics use over time, we grouped, under main themes, perceived opportunities (see Figure 4) and perceived threats (see Figure 5) regarding the use of such surveillance technology.

4.1 Opportunities

Increase of information. Health big data analytics offer the opportunity for participants to quantify their health levels and represent an approach to objectively address health in the workplace. This particularly applies to stress, which is defined by a lack of consistency and thoroughness in the measurement [36]. In fact, stress is experienced by individuals in various forms (i.e. social, psychological or physiological manifestations) making it complex to measure. For that matter, Spath [37] indicates that finding a proxy for determining and quantifying stress is one of the most efficient ways to push individuals to act towards it, as their perceptions become apparent. Individuals are thus in a position to define levers for action and mobilize the resources that they need.

> [P4] “For me the experience with the sensor was a confirmation of my gut feelings. For example, the December 7 was the local council, the worst day of the year; the sensor accurately showed my “felt” stress level.”

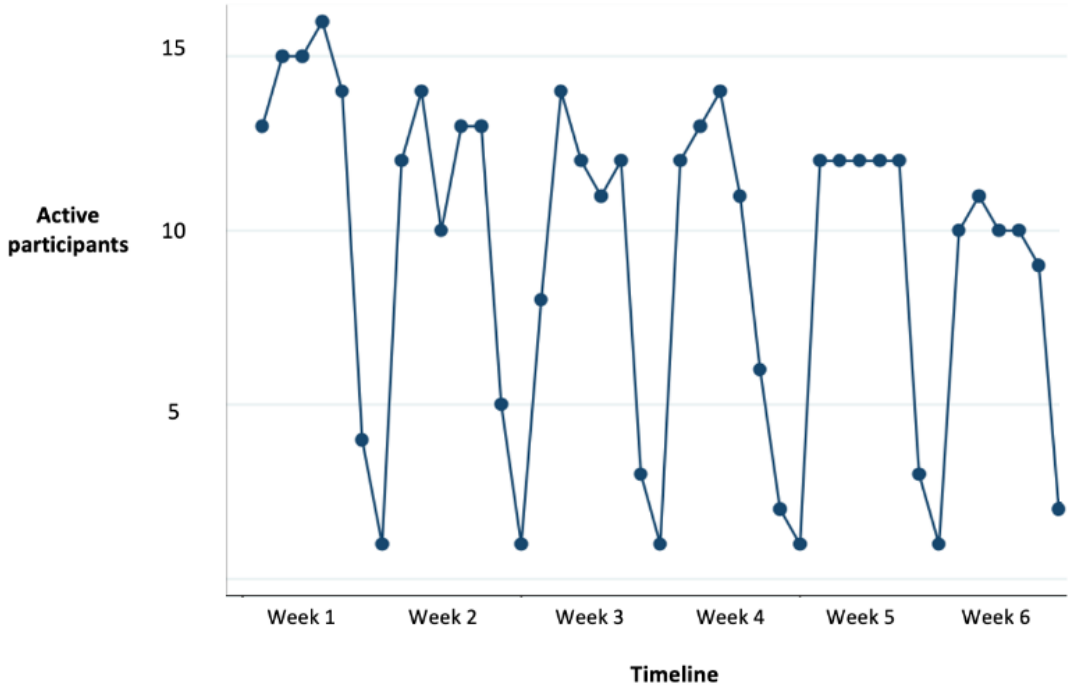


Figure 3: Overall use dynamics of the 6-weeks field experiment in a medium-sized Swiss municipality

Participants in our study were particularly sensitive to the display of their personal information through visualizations. For that matter, research shows that data visualizations have a particular agentive force: they drive individuals to reflect and eventually act in response to the represented data [38]. By translating sensor data into comprehensible visual representations, issues with health and well-being become more legible, accessible and foreseeable [39]. Therefore, they may help users to perform more punctuated health behavior changes because the action is based on informed insights of individual lifestyle issues rather than on subjective experiences [40]. In short, visual representations are critical to our ability to process complex sensor data and to build better intuitions as to what aspects improve and what worsens health [41].

Call to action. On the same note, quantification of work created a spontaneous coordination of people. Participants reported moments of increased group cohesion where the workload was balanced between collaborators, so as to better deal with stress peaks.

> [P12] "We found it a funny experience. Every time a citizen came to our clerk, the stress indicators went up; we used these indications to distribute/assign the "counter service" within our team. We started to think about measures to prevent the situation that the stress indicator goes up."

This resource and work allocation is in line with the growing importance of big data in orienting the management inside organizations: fields services such as schedule management, client interaction, real-time analytics are more and more rearranged according to numbers and algorithms [42]. This also pertains to other studies on physiolytics that underline the capacity of these systems to offer concrete guidelines and prescriptions for health at work [19, 34, 43]. For instance, the retailer Tesco exploit physiolytics on a large scale in its distribution centers: following this technology, employees are coordinated (in function of their position and location) to ease the fulfilling of the orders [7].

Playfulness. Participants highlighted the fun dimension that personal quantification was bringing to their workspace, as physiolytics added variety to their daily routine at work. In that regard, studies show that playful experiences are important for health behavior change initiatives. In fact, they serve to recognize and reward an effort that is identified as positive [44]. Thus, they create new social situations, practices and meanings around the use of the devices, conditioning their potential to be used in a continuous manner [45].

4.2 Threats

Surveillance. The abundance of health information may also represent a challenge because physiolytics allow to precisely monitor individuals. Some participants said that in the long run, the collection of large amounts of data could be problematic.

> [P8] "I will not use physiolytics for a longer period of time (. . .) after a period, I do not see the same utility for me from the device."

In this sense, research shows the necessity to have clear and distinct protocols regarding the use of physiolytics at work, so that individuals feel that physiolytics represent reliable and important resources, which assist them in improving their health levels [46].

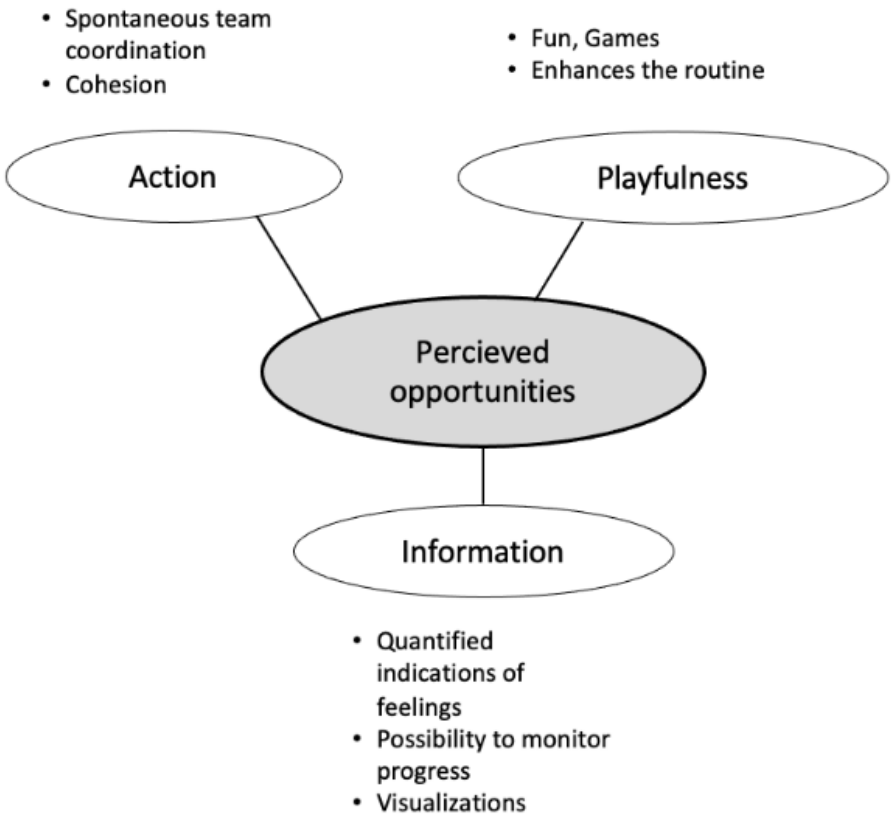


Figure 4: Perceived opportunities regarding the use of physiolytics

In particular, employees must know the limits of the use of collected data in order to build a trust relationship with the PA [47]. It has been shown that this trust relationship is the most important factor in the success of a program based on big data analytics, for both participants and organizations [48].

Competition. Public agents reported that in some instances a form of competition arose between participants. This led to comparisons between public agents based on health indicators, which was perceived as a negative aspect by some participants. Following Türken, Nafstad, Blakar and Roen [49], such phenomenon is the reflection of a neoliberal climate that is promoted at the workplace, as every form of competition is seen as a beneficial for individual growth and development. Health is in this sense objectified, with health indicators (obtained from physiolytics) serving to evaluate movement, exercise or health levels [50]. This adds up to the prevalent moral obligation in western society to maintain a good general health condition, as people with poor physical health and lifestyle are often viewed as burden for the society [51].

Decrease in interest. A frequent occurrence linked to the use of self-tracing technologies is that people tend to try physiolytics out of curiosity [28, 43, 52]. This means that the device is often seen as a gadget more than a health promotion tool. The consequences are that the general population (in opposition to a small number of tech savvy individuals) frequently lose interest in physiolytics once this initial phase, fueled by the sentiment of novelty, fades.

> [P3] "I think that I would perhaps use the sensor on a temporary basis only, like 3 months. It's good to get an impression about one's personal health status."
>
> [P5] "I would be less likely to use it during work, but rather for sport and leisure activities."

Design. Finally, our results show the prominence of design considerations in the use of the system.

> [P15] "At the beginning, one feels the squeeze of the sensor; after a while it becomes like a regular wearable but I'm aware of the fact that it measures with much more precision."
>
> [P18] "The longer the day, the more I noticed the sensor. In the morning, one is not aware of the sensor, but towards the knock-off time the sensor becomes irritating and painful, particularly when one wears it always on the same arm."

Of course, public organizations might not have direct impact on this; but they should certainly select with caution health surveillance technologies that they aim to implement. This goes notably by assessing the needs and expectations of public agents. In the same vein, PA should pay attention to the chose a system that is satisfactory in terms of portability, comfortability, ease of use, autonomy and unobtrusiveness [53, 54].

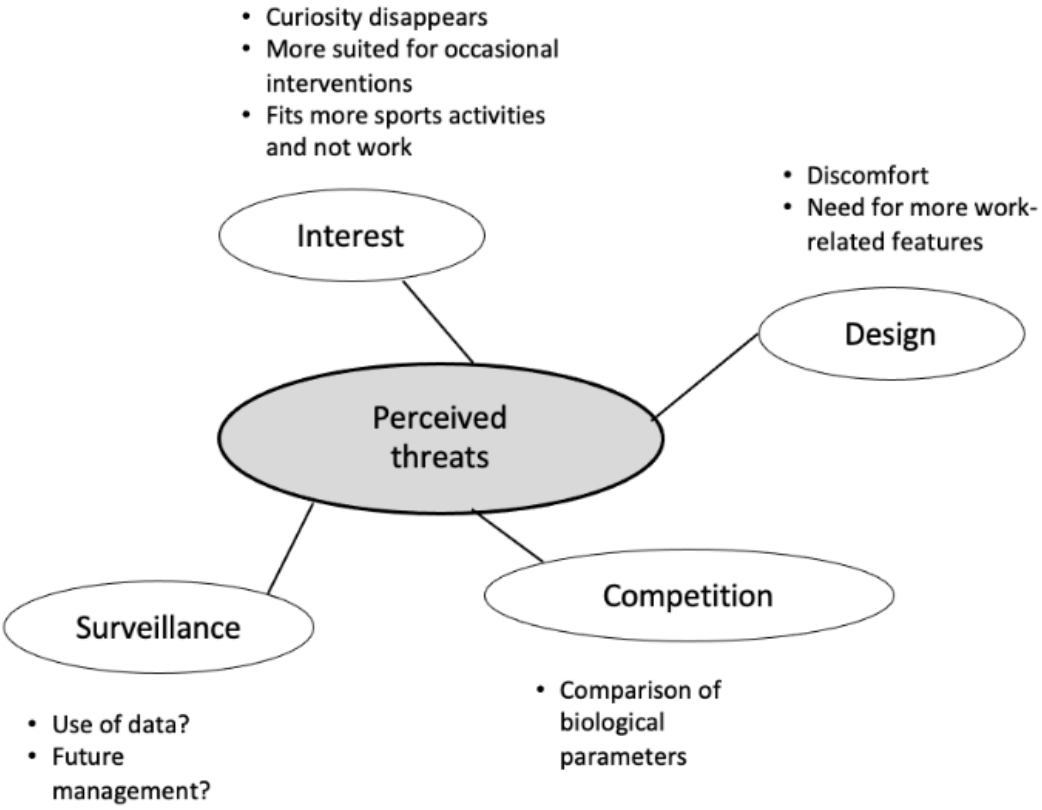


Figure 5: Perceived threats regarding the use of physiolytics

5 IMPLICATIONS

This work offers several learnings. It first sheds some light on new challenges relating to digitalization in PA, which is defined by the growth of decentralized systems that enhance information flow (e.g. through synchronization or their capacity to dialogue) to assist public agents in work settings [55]. Through physiolytics, we particularly show the importance for PA to proactively manage the use of these complex systems rather than risk implementation failures. Our results clearly show that physiolytics' use decreases with time. Even if the disengagement may be temporary -because it is linked to a brief loss of motivation or to external factors [56]- it seems critical for public officials to consider additional measures to accompany such digital occupational health initiatives. Since privacy laws prevent the PA to establish a mandated use of physiolytics for most areas of work [13, 14], a relevant approach is to draw on positive reinforcements to recognize and reward this effort. For this, *gamification* and *nudging* approaches might be employed. Gamification is often defined as the use of game design elements in non-game contexts [57]. It aims to transform eventual obstacles into engaging, positively reinforcing and perhaps even fun experiences that encourage IS users to activate the desired behavior for the benefit of their health and wellness. Nudging or choice architecture refers to strategic modifications in the environment that are anticipated to alter the individual behavior and attitudes in a predictable way, without forbidding any options or significantly changing their economic incentives [58-61]. All stakeholders and components of an environment are taken into account to gently influence an action. It stands in opposition to strategies that are only structured around human rationality [62]. This notably refers to how choices are presented, so that individuals' cognitive biases (i.e., people's subjective reality) lead them to act in the best-defined interest for themselves and/or the organization [58, 61, 63].

6 CONTRIBUTION AND LIMITATIONS

We decided to propose this work because (a) there is still little perspective on the practical use of such systems in PA, and because (b) the COVID-19 pandemic might primarily impact decisions to participate (or not) in such initiatives. With our research, we are situated a step further (when people have accepted to engage with health surveillance technologies) and offer a view on practical elements related to the use of these systems. For this reason, this work might be seen as a set of pragmatic prescriptions that guide the implementation of new forms of work surveillance and occupational health monitoring. It may therefore help public managers, that envision integrating this technology for sanitary purposes, to draft occupational health programs. It is an essential first step, that sets the stage for further design iterations.

In terms of limitations, this study, as every empirical research, is rooted in a context and holds a part of particularism [64]. Design challenges are thus linked to the characteristics of the devices, the

specific timeframe when we conducted the tests, as well as the general context under which the tests were made. During the pandemic the utility perceptions and concerns about health surveillance are constantly changing. Hence, we believe that this might also have impacted our observations.

7 CONCLUSION

In sum, the introduction of health surveillance technologies, such as physiolytics, faces various challenges, especially ethical issues (e.g., employees being suspicious and concerned about getting monitored during work), or long-term engagement (e.g., maintaining a continued use of selected devices). This also adds up to the relative resistance to technological innovation that is possible to encounter in the public sector [23, 24]. Through our study, we aimed to provide Swiss public managers with a more concrete perspective on the use of physiolytics in the workplace. We believe that it is necessary to gain an applied knowledge on organizational challenges that such technology carries, and consequently adapt managerial processes to ensure the viability of these devices. This goes by accompanying digital health programs with a catalogue of additional measures (e.g., regular feedback, gamification, or nudging) to maintain the engagement of public agents and truly benefit from such innovative initiative.

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Digital transformation in local government organisations: empirical evidence from blockchain initiatives

Stanislav Mahula
PhD student, KU Leuven
stanislav.mahula@kuleuven.be

Mikael Lindquist
Doctoral student, University of Gothenburg
mikael.lindquist@ait.gu.se

Livia Norström
Postdoctoral researcher, University of Gothenburg
livia.norstrom@ait.gu.se

Juho Lindman
Senior lecturer, University of Gothenburg
juho.lindman@ait.gu.se

ABSTRACT

Local government organisations are the first contact between the citizen and state authorities. However, the rapid technological development in the private sector raises questions on how public actors can keep up. Seeking improvement, local governments undergo the process of digital transformation (DT). This encompasses a variety of processes and initiatives, including experimenting with new technological solutions. We focus here on experiments on one of these emerging technologies: blockchain. We report the results of a multi-case study investigating the DT processes that experiment with blockchain technology in three municipalities in Western Europe. We present our theoretical perspective (institutional logics and digital transformation), describe our qualitative comparative case methodology that relies on key-respondent interviews, and discuss our distilled categorisation of three activities (including excerpts from data).

CCS CONCEPTS

• **Social and professional topics**; • **Computing / technology policy**; • **Government technology policy**;

KEYWORDS

blockchain, local government, digital transformation, institutional logics

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1 INTRODUCTION

The private sector's technological advancements have increased citizens' expectations of the public sector to be innovative, deliver more relevant, efficient, fast, and transparent public services [25], and improve their relationship with the citizens [35]. The global phenomenon of digital transformation (DT) has introduced new roles and processes within the government and brought previously unknown opportunities and challenges. We understand DT as a fundamental change process, enabled by the innovative use of digital technologies accompanied by the strategic leverage of key resources and capabilities, aiming to radically improve an entity and redefine its value proposition for its stakeholders [15]. However, these impacts have been heterogeneous, as various levels of administration have diverse needs and face diverging pitfalls when innovating. At the local level, the decentralisation has brought the authorities more freedom but also more responsibilities, calling for novel approaches. Local governments, often viewed as the most-trusted governmental bodies [44], are particularly challenged to cultivate a culture of innovation and allocate enough time and resources to develop priority innovations [26].

Such change in the institutional logic involves consequent changes in a variety of processes and roles within the organisations, which, in light on the variety of available technologies and adoption strategies, have to be looked at carefully. For example, in the constellation of available potential tools, often advertised as silver-bullet solutions, municipal leaders must resolve trade-offs between: (i) making informed decisions on implementing modern technologies to avoid overspending and unmet expectation (ii), moving beyond theoretical debate and gaining empirical evidence on where specific technologies bring the best value. Public sector organisations need to make the right decisions in their DT efforts and hence use public recourses in a reflected and well-motivated way that aligns with pursuing public value(s): boosting government efficiency, citizen services and boosting democracy and participation while staying inclusive and transparent.

Blockchain (BCT) is one example of a group of emerging technologies that can be implemented in numerous ways as a part of DT. It can be defined as a "distributed ledger technology in the form of a distributed transactional database, secured by cryptography, and governed by a consensus mechanism"[4]. BCT minimises the power of a single party and instead represents a peer-to-peer network of decentralised actors deciding on its state and maintaining copies of all network transactions. Although it originated in the financial domain, BCT has become a general-purpose technology with several possible benefits to be of interest to the public sector [36]. In a broad sense, there are three generic ways to use BCT for

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public service: notarise transactions, automatically execute transactions and verify identity [35]. Correspondingly, these ways echo the government's three main functions: managing governmental registries, social transfers and benefits, and verified information [35]. Earlier research suggests positive outcomes of using BCT through increasing process efficiency, transparency, and flexibility, reducing bureaucracy and expenses, breaking siloes between agencies, improving autonomous organisation, and eliminating corruption [30, 32, 35, 38]

Blockchain is, however, not yet a fully mature technology, causing uncertainty and scepticism around its usage. Most BCT pilots are in the announcement stage, which is partially explained by the lack of management of governments' capacity to convert pilots into more mature projects [22]. Although some governments have put BCT initiatives on hold, several running solutions can be found, mainly driven by the central governments [6, 18, 20]. On the other side, the literature suggests possible BCT applications at the local level: more reliable assets registration, transaction tracking, data accessibility improvement, and facilitating decentralised decision-making processes [3, 8]. However, not much research is focused on the precious insights from actual BCT usage [35]. Understanding the local government's experiences with this technology, the limitations and the most salient application areas will become driving forces for BCT implementation globally and realise the whole spectrum of its benefits [28]. Investigating these activities is important to understand more generally how emerging - and not yet fully mature - technologies are diffused in organisations and what activities are involved when these technologies become institutionalised.

This study aims to explain and conceptualise the variety of local governments' approaches for (i) bringing novel technologies such as blockchain technology into the organisation, (ii) conceptualising and (iii) experimenting with this technology. We do so by collecting empirical data for several local government initiatives in Western European municipalities. We, therefore, strive to answer the following research questions:

RQ1: What activities do local public managers engage in when piloting blockchain technology?

RQ2: How do institutional logics and digital transformation explain these activities?

In other words, this paper describes and explains the DT process that local public governments undergo while conceptualising and experimenting in practice with blockchain. We propose that this process consists of several activities, characterised as driving, impeding and shaping the digital transformation.

We proceed to analyse these activities as practices enacted concerning interplaying and contradicting institutional logics already existing in the organisation to increase the understanding of the variety of reasoning that local governments have for blockchain technology. Our results are interesting theoretically and to practitioners struggling to implement blockchain and other similar technologies in public sector settings.

2 INSTITUTIONAL LOGICS AND PUBLIC VALUES

The public sector's core mission is to serve the citizens and provide quality services. It can also be seen as a set of various institutions which contribute to efficient public policy implementation and, as a result, to economic growth [44]. The term "*institution*" refers to both informal institutions (conventions) or behaviour patterns that are essential to a community (e.g., family) and formal institutions formed by entities (e.g., government). The latter correspond to formal norms that determine social, economic, and political activity, such as property rights, the rule of law, and good governance [44]. One can think of institutionalisation as the process of embedding a concept (for example, a social role, specific value, or way of conduct) inside an organisation, a social system, or society.

The institutions are associated with a social goal, transcending individuals and intentions by mediating the laws that govern behaviours, also referred to as institutional logic [34]. Its idea is concerned with how larger belief systems affect actors' cognition and conduct, implying pluralism in institutional logics, i.e., several institutional logics are available and often in conflict [14]. Institutional logics can be defined as organising principles that (i) regulate the choice of technologies, (ii) define the actors authorised to make claims, (iii) shape and restrain the actors' behavioural possibilities, and (iv) identify criteria for effectiveness and efficiency, as cited in [17, 21].

Institutional change is frequently described as shifting from one dominating logic to another [14]. Presently, the public sector is transitioning beyond the traditional public administration and new public management paradigm, which aim at efficiency and effectiveness. This new and still emerging approach focuses on recent technologies and stimulating the expansion of internal knowledge resources with externals (e.g., business or academia) as well as knowledge from the "crowd" [20]. Governance is mentioned as the key institutionalisation challenge in this approach. One can understand governance as structures, policies, actors, and institutions by which entities are managed through decisions and authority is exercised. Furthermore, while the "old" governance model implies a top-down approach to social and economic activities, a new and emerging governance model puts interaction (e.g., with citizens and industry) at the centre of all activities [19].Government management and control systems should be employed not only for efficiency and effectiveness in using public money and authority but also for legitimisation in terms of satisfying societal benefit, accounting for public value [22].

The public sector should prioritise pursuing public values and having the government as the guarantor for these values [7].There is a difference between "*public value*" and "*public values*". The former is an added value an organisation contributes to society by acting as its agent [13]. For example, "*public value*" can refer to the government's ability to increase its efficiency, citizen services, inclusion, better democracy, transparency, and participation [40]. On the other hand, Bozeman, as cited in [27], sees "*public values*" as social standards, principles, and ideals to be pursued and upheld by government agents and organisations; they are oriented toward the broader society and the promotion and sustenance of its collective norms and beliefs. For instance, public values include responsiveness, inclusivity, impartiality, accountability, respecting human rights, and collaboration, and they may impact the implementation of technology [40]. The governmental organisations necessitate the use of means (such as internal competition, contracting out, and performance monitoring), and they adopt values such as customer

orientation output orientation, found in citizen-centric organisations [17]. A shift is needed to view citizens as an active part and not just as clients, making it easier to achieve long term goals and improvements in public value creation [25].

3 DIGITAL TRANSFORMATION

Digital transformation has become an integral part of the organisational change debate. Even though change is continuously ongoing in organisations, the high interest in understanding and enacting DT relates explicitly to the recurring argument for its relevance in terms of scale, scope, and speed [42].

There are internal and external factors that influence an organisation's DT process [16]. The internal factors include organisational legacy, organisational cultures (innovation culture, willingness to take a risk), organisational strategy, managerial characteristics, and the awareness and attitudes among top management about DT. External influences include emerging technologies and their properties, environmental factors such as country and industry characteristics, and consumer characteristics [16]. In the governmental organisations' context, one must consider the pressure from the environment (citizens, businesses, politics) and technological change, mainly resulting in digitised services and processes.

In DT, it is essential to understand the connections between the usage of digital technology and the changes that occur with various organisational aspects [15]. Some properties of digital technologies are especially important for understanding DT. The open architecture of digital technologies enables new forms of collaboration and interactions in ecosystems yet calls for continuous adaptation [16, 42]. The consequence for organisations adapting to DT is a move toward more flexible organisational structures that allows for continuous change and unpredictability, particularly because technologies and competencies are often outsourced to external actors [16, 42]. Hence, the DT operations, services, and products need to be incrementally adjusted in response to external demands [25].

A range of factors can create inertia, e.g., existing relationships, already highly optimised production processes and resources that cannot easily be reconfigured [16]. One way to achieve cross-functional collaboration is through units with some independence from the rest of the organisation [42]. However, there is a traditional separation of IT and business that may have strong roots in the company's values, which may hinder DT [42]. Furthermore, employee resistance can be a barrier if the rate of recent technology introduction is high, and there is a lack of visibility on the potential benefits of the novel solutions. Moreover, the people in organisations will also need to assume roles outside of their traditional functions [42]. These new roles will require different skills and competence in governing the change [2, 37].

DT still undergoes conceptualisation [23] since there is a lack of coherence as to exactly what DT is [16] and what are its implications at multiple levels of analysis [42].

Lack of understanding of DT through oversimplifying the important and difficult changes associated with DT that ignores the public sector's complex institutional environment will understate the obstacles faced throughout the governmental transformation [15]. Hence, the effectiveness of digital transformation would depend on how confronting institutional logics becomes imbricated, which could be transformative or could embed the existing logic in a new and more complex form [17].

4 BLOCKCHAIN TECHNOLOGY IN THE PUBLIC SECTOR

Some of the properties of blockchain include it being (i) decentralised, (ii) transparent, (iii) immutable, (iv) secure, (v) (pseudo)-anonymous, (vi) time-stamped and (vii) robust [9, 32, 46]. These properties are not necessarily afforded, however, just by choosing blockchain as a platform for a planned application. The specific fulfilment of these affordances and overall performance properties, depending on the specific technical details and capabilities of the blockchain configuration chosen during the design phase [31, 32].

The government could utilise BCT to reduce cost and bureaucracy, increase efficiency for authenticating many types of persistent documents [9], avoidance of fraud, reduce corruption, increase trust, auditability, resilience, better data quality, security, increased transparency, accountability [28, 29], data accessibility [8]. Furthermore, BCT could enhance identification and data integrity procedures, enable more reliable asset registration, strengthen transaction monitoring [3], and promote decentralised decision-making processes, making it an appealing instrument for democracy [48].

BCT could arguably become the fundamental backbone technology to orchestrate a new, peer-to-peer fashion for public administrations [24, 39, 47] or even shift power from economic and political institutions towards the ecosystem [10, 31, 35], and thus, creating a token or blockchain economy [5, 33]. It is, however, early to discuss such an alternative economy [35].

Moreover, there are also areas where blockchain is not the best solution since it is not a one-size-fits-all tool [9]. In other words, a traditional database solution could be used in many situations instead of BCT. Therefore, researchers call on public managers to be aware of the current trends in blockchain implementation to understand the main domain of application better and intervene with appropriate policy at various levels of administration to steer and guide the deployment of the blockchain [22]. Moreover, policymakers should also ensure that public values and societal needs are fulfilled and considered when developing and maintaining BCT architectures and applications [29]. Various choices and trade-offs of blockchain in the public sector are also affected by contextual factors, which means that each choice concerning blockchain governance must be made in accordance with policy objectives, public values, institutional structure, and social expectations [36].

5 METHODOLOGY

The case of the study is located at a local government level. The reform of public administration considers the organisational structure of local governments, whilst the political dimension takes into account the locally appointed executives, meaning that more power and resources are being allocated to lower levels of administration [11]. As studies assert, citizens tend to trust local governments even more than central governments [44]. The services provided by local municipalities vary per country and even per municipality. Commonly local government organisations can be responsible for

Table 1: Municipalities analysed in the study

Municipality	Country	Population	Number of interviews
Municipality A	Netherlands	200,000-250,000	9 (incl. one group interview)
Municipality B	Belgium	250,00+	4
Municipality C	Belgium	50,000-100,000	3

(i) primary and secondary education, (ii) culture, (iii) healthcare, (iv) welfare, (v) public utilities, (vi) sport and leisure or other things.

Local and regional institutions promote development and growth by creating suitable conditions for investment, economic interaction, and trade [44]. It can be argued that it also enhances democracy since the decision-making happens closer to citizens. When local governments and central governments regard themselves as partners in development rather than enemies, decentralised governance is more likely to last and contribute to peace and prosperity [41].

Our research questions are explorative because the phenomenon of interest in our study can still be considered under-explored. Furthermore, a case study approach allows us to investigate a contemporary phenomenon within a real-world context when there is less theoretical ground and when separating the case and case context is difficult [45]. We thus opt for a qualitative research approach with an interpretative stance [43]. Finally, in terms of research design, we follow a multiple case protocol aiming for robustness [12, 45].

This study investigates how local governments approach BCT in their digital transformation. For this reason, we have chosen three empirical case organisations. All three are Western European municipalities that are participants of an innovation academic-industry network related to a collaboration project financed by the EU. This project explores, enables, and delivers blockchain-enabled services for (local) governments. A commonality between these municipalities is that they all share an interest in the phenomena of transforming with BCT. The overview of the case of public sector actors is presented in Table 1

These three case organisations had, in total, nine blockchain initiatives in previous years. These pilots are described below in more detail.

As a data collection method, we have used key respondent interviews. Respondents were chosen from our case organisations. Our respondents were selected by snowballing among the project partners for professionals that had earlier expertise in blockchain implementations. Thus, all our respondents shared first-hand experience of public organisation blockchain initiatives. These experts are listed in Table 3 below.

The Corpus of data consists of semi-structured interviews. Tape-recording was the default option for the interviews, but one email interview was added to the data. Secondary material was used to support understanding the case context. Finally, all interviews were transcribed for analysis. The research team performed the analysis.

In this study, we used an abductive analytical approach as an approach to analyses to iterate between empirical data and theory [1]. This means that data was collected with open-ended interviews, and findings are inductively derived. The theory was used as an influence in a deductive manner.

In practice, we conducted our analyses in three iterations. The research design was revised for each iteration to align even better with the research question. In the first iteration, we reviewed relevant theories of DT guided by our initial research interest in understanding blockchain public sector implementations. Specific research questions were reformulated several times even though the overall aim of the study stayed the same. We identified relevant activities informed by the literature from our empirical material. This first iteration included going back between literature and empirical material to produce a structure to understand the characteristics of this process. In the second iteration, based on our analyses in the first iteration, we came up with three characteristics of digital innovation activities. These three are: driving, impeding, and shaping. In the third iteration of our analyses, we go back to the empirical material to find examples of transcripts of these three characteristics. The findings from this part are listed in Chapter 6. Throughout the abductive process of our research, an analytical lens emerged that we used to frame our findings. It reflects aspects of the digital transformation activities that are salient in our data, and it has elements from the digital transformation literature. We focused on the part of this process, the activities that involve blockchain piloting and how these can be characterised.

6 RESULTS

This section outlines and explains the digital transformation process that local governments go through while experimenting with blockchain. This process involves main activities that can be characterised as Driving, Impeding and Shaping digital transformation. Within each main activity, we identify different sub-activities (see Table 4). Main activities with their respective sub-categories are described in detail in what follows. Even though we divide these activities into three, we are not claiming that they would need to be always mutually exclusive.

6.1 Driving

DT activities have a path dependency, prior events and conditions that occurred and led to the formation of the activity. We label these as characteristics *driving* the digital **transformation**. Our data give a detailed account of these DT-triggering activities, the role of specific individuals and stakeholders, and the motivators for conducting these activities.

6.1.1 Experimenting with novel technology. Trying out novel technology in practice is perceived as an essential activity to be able to adapt to future changes and be proactive in modern service delivery: "We're a government organisation which usually doesn't lead innovation, [however] we still do think, if you try more different things and are more innovative, then it's also easier to adapt and

Table 2: Blockchain project descriptions

BCT pilot	Description	Public sector role	Municipality	Interviewees involved
#1	This case involves a voucher system for socially disadvantaged groups with limited incomes to participate in cultural, sporting, and social activities. The municipality's social administration has offered the service for many years, but the procedure was previously manual and paper-based, requiring much administrative effort. Furthermore, the system lacked a control capability to prevent spending vouchers twice. As a result, the municipality decided to place the transaction vouchers (QR codes) on a private blockchain to avoid double-spending.	Maintaining the infrastructure and providing the vouchers	A	4
#2	This is a system for distributing coupons that can be used to purchase products or activities for children from low-income families. The original procedure entails a substantial amount of manual administrative work. The main purpose of implementing blockchain technology is to program value transactions under specific conditions. Smart contracts on the blockchain can automatically condition transactions, resulting in improved transparency. A secondary focus is on decentralising the organisation in terms of distributed decision-making to bring decisions closer to citizens.	Maintaining the infrastructure and providing coupons	A	3
#3	Pilot to test blockchain technology to do more efficient elections. The system counted votes during a proper national referendum as a parallel procedure, i.e., voters were asked to also vote on an iPad for a second time. The system was set up on about five Ethereum nodes.	Providing election system and organising election practicalities	A	1
#4	This was a conceptual idea that a blockchain could be used for sharing parking permits. The system would increase flexibility in parking rights, as citizens can trade rights amongst each other. Blockchain could then play a role here by its decentralised nature, where there need not be a central intermediary, i.e., the municipality.	Providing parking permits and the marketplace	A	1
#5	In this project, residents of a newly built residential area participate in an online and offline circular economy. The BCT's role in the system is to reward inhabitants for their circular behaviours and facilitate transactions. Actors in the system can issue challenges for residents (e.g., minimise water use) that they can complete and get a reward for. Smart contracts are utilised to complete the deals. The incentives are in the form of tokens (digital vouchers) that may be redeemed for items, services, or group prizes (e.g., a barbecue).	Issuing rewards and designing the smart contracts	B	3
#6	This case is about the city's IT organisation's procurement system, which stores information on public procurement with external actors on a blockchain. The blockchain is being utilised to verify that all bids in the procurement are accurate and time-stamped. The purpose of placing the data on the blockchain was to reduce mistrust among the contending parties.	Designing and maintaining a procurement system for public procurement	B	3
#7	This initiative involves the health and well-being of municipality employees. It is a way to improve the physical and mental well-being of the employees by offering various activities for free. In addition to sports events, different types of courses are also provided. A fitness tracker device is used that is connected to a decentralised blockchain system. With a decentralised system, the data will not be controlled by a company or the employer, and the employee can decide whom to share the data with.	Offered to municipality employees	C	3
#8	In order to attract student workers to employers in industrial zones, a carpool app is built on blockchain. The aim is to ensure that every ride is transparent and that no data is tampered with. This is a contrast to, for example, Uber. Blockchain is used to provide transparency, history transactions, and a tamperproof system.	Provision of carpooling system	C	3
#9	This is a blockchain-based system for gift vouchers to replace an old paper version. The system creates more flexibility and less administrative burden, given that there are many stakeholders involved. For example, the retailers will get their money by scanning a QR code instead of heavy paperwork. The reason for using blockchain is to see if it can make the transactions of value more efficient, as the technology can address the double-spending problem.	Designing and maintaining the system and issuance of vouchers	C	3

Table 3: Summary of interviews and respondents

Respondent #	Role	Municipality	Length of interview	Pilot
R1,R2,R3, R6,R8,R9	Various (group interview)	A	161 min	#1, #2, #3, #4
R1	Project manager	A	41 min	#1
R2	Digital democracy/ethics data manager	A	41 min (same as above)	#1
R3	Strategic information manager	A	58 min	#1
R4	Project manager	A	60 min	#1
R5	Head of innovation & manager	A	57 min	#2
R6	Alderman of innovation	A	54 min	#2
R7	Product owner and developer	A	63 min	#2
R8	Project manager	A	43 min	#3
R9	Team leader	A	23 min	#4
R10	Head of innovation funding	B	56 min	#5 & #6
R11	Secretary, general	B	(email interview)	#5 & #6
R12	Business and enterprise architect	B	68 min	#5
R13	Enterprise architect	B	95 min	#6
R14	Solution Coordinator	C	48 min	#7 & #8 & #9
R15	Implementation	C	35 min	#7 & #8 & #9
R16	Vision and Strategy	C	47 min	#7 & #8 & #9
			Total: 15h 9min	

Table 4: Summary of empirical findings

Characteristics of digital transformation activities		
Driving	Impeding	Shaping
Experimenting with novel technology	Technology limitation	Organisational learning
Addressing business and societal needs	Human resources	Legal aspects
Improving service processes	External attention and the hype	Supporting and collaborating with industry
Creating publicity	Regulations	Changing the role of public organisations

change to the current new environments, to new ideas, instead of just being reactionary." (R8)

Technology should not be experimented with just because of novelty; its choice needs to be motivated by a clear business idea: "*We have the policy that people and processes come first, and technology comes second, so I really had to question the technology and see if we could do it with easier technology because this radical technology costs a lot of money because it's experimental, [. . .]is it worth it?*" (R5)

On the other hand, experimenting also involves testing technologies without a specific business idea: "*We wanted to test new technology, and the manager wanted*" (R3).

6.1.2 Addressing business and societal needs. It is important to use technology to improve services, not only digitise them: *"If you have a challenge as a local authority, you don't say anymore: Well, we have now this procedure, and we will digitise this procedure. No, you have to think digital and say: We have this service or delivery. Is there a technology or an IT possibility to make it easier for us and for you?"* (R16).

Solving business and societal problems are discussed as a crucial driving activity prior to initiating the pilots: *"It was crucial for them [the project leaders of the pilots] to have pilots that we can go along with and can proceed, and that we do not have some legal burdens and that it will be societal added value, and that we have a link with the sustainable goals of United Nations."* (R14)

6.1.3 Improving service delivery. Related to solving business and societal needs is improving service delivery processes. Blockchain is thought of as a technology that could make services more flexible and scalable and thereby beneficial to more people while still protecting the privacy of users: *"The paper voucher with 50€ they had to spend it all at once because [. . .] you couldn't get money back. [. . .] It was not flexible or scalable. And also, if you go to a shop and are poor and you come in with vouchers, it's really shameful, people hesitate to do that, so, it wasn't successful. That was our use case that we wanted to change."* (R5)

Blockchain can also help to decrease the administrative burden of services, making internal processes more efficient and freeing the personnel from back-office tasks. This results in more resources for providing face-to-face service to citizens: *"There was a lot of work, and blockchain would solve some pieces in the process and work. When people had to do something on a computer, now blockchain could do that. [...] We automated those processes with blockchain. [...] The shop owner [for example] got the money automatically when the code [on the voucher] was scanned."* (R3)

"We want to invest in personnel in the front office and keep the back office as small as possible. Not only to save money, but if [...] we could put the people that are now at the back office and put them in the streets, it's much more interesting for our clients, [...] try to be as much in the streets, where we can make a difference and not in offices." (R10)

6.1.4 Creating publicity. Experimenting with novel technologies such as blockchain in the local government creates publicity, media and research presence, showing it at the forefront of innovations, despite the majority thinking otherwise: *"Doing [pilot 3] in a government organisation such as ours really was a head-turner. We suddenly had a lot of opponents who thought it was a bad idea. And there were also a lot of people who were very interested, especially from other municipalities and cities what we were doing [. . .] because we were using blockchain in a very political environment. [. . .] We had a lot of exposure on the Blockchain pilot of counting votes."* (R8)

6.2 Impeding

As we found evidence of impeding factors and other forms of challenges in conducting digital transformation activities in the studied organisations, this is highlighted as a group of factors in our model.

6.2.1 Technology limitations. The expectations did not scale up from the theoretical promises; it was expected that *"blockchain was more reliable, that you can't alter the data, [...] it would be faster, handling the transaction. But that wasn't the case in the end. That's why we don't use blockchain anymore." (R3)*

The technological limitations of blockchain, such as its immutability, have also been discussed: *"And as a municipality, [. . .] you want to have the possibility to revoke or undo the transaction on your data. And with Blockchain, that is not possible." (R8)*

6.2.2 Human resources. Projects are often initiated and driven by one person, which makes the piloting vulnerable: "*It was our former CEO who went to the politicians and convinced them about this technology [. . .] It was not that big budgets, so they [politicians] said "Go on". And for the rest, they were not so interested in it actually.*" (R10). Furthermore, the absence of such a person among leadership was named as another impeding factor for not using BCT: *"because we're missing somebody in the higher management who wants to do that."* (R3)

6.2.3 External attention and the hype. Publicity is also perceived as extra scrutiny, disturbing the work, and that should be avoided: *"And he [a colleague] said no, I don't want any publicity, because we work in really small steps, and I don't want the media to look at this and starts to interrupt us."* (R5)

The media tries to polarise the discussion about blockchain and how difficult it is to work with a technology that is hyped and look at BCT objectively: *"In the beginning [the journalists] were super enthusiastic [...] And then after a while I met a journalist, and he was supercritical. And I said: [...] we are not logging any transactions anymore, but there is a bigger story, it's the whole process, it's the position of the government. It's about shifting power, decentralisation, new financial system, and that's interesting. But he couldn't see that because he was already obsessed with this idea of writing this article, which would portray this technology as something negative, because he knew that because of the hype that this was the thing to write [to get] most views."* (R7)

6.2.4 Regulations. Some pilots were politically loaded and sensitive to experiment with, such as pilot 3, which developed a new way of voting in national elections. The pilot team was therefore only allowed to pilot it in a parallel voting system: *"We basically let people vote twice. So, we made the parallel efforts so as not to interfere regular voting process"* (R8)

6.3 Shaping, organisational context

The characteristics of DT activities are highly contextual. With shaping factors, we refer to high-level factors that frame the DT process. All these factors work as contextual conditions and characterise the digital transformation activities.

6.3.1 Organisational learning. The managers are unsure of the outcome and benefits of blockchain piloting, which impacts possible investments: *"We don't have enough people who can assess [blockchain] very well"* (R10)

There is a need in the organisation to learn how blockchain's functionality and potential, which requires more effort: *"We are on a level [where] we understand that there is a lot going on in the field, but we need the grabbing of how can it help us solve problems and is it the most effective technique to use.[. . .] We haven't had the discussion in a group [. . .] about this question."* (R1)

6.3.2 Legal aspects. Next to the technical limitations, legal implications of using blockchain were discussed, including the right to be forgotten: *"In personal details, when it's put in a blockchain, you can take it out, in a good blockchain, so if you have municipal services and the citizens say: "We want you to remove the data", it's really hard to comply with because it's in the blockchain and it's there forever, at least that is my understanding."* (R8, workshop)

"Yes, like sometimes we are obliged by law to actually keep stuff in our archives, and maybe we are also legally obliged to destroy those archives after fifteen years, for example." (R2, workshop)

6.3.3 Supporting and collaborating with industry. Collaboration with city stakeholders and especially start-ups are mentioned as necessary when recruiting experts for the blockchain pilots: *"We wanted to help this company, for [start-ups] was important to get the experience. [. . .] For our city, it's good to show that we support this kind of developments; we could show our helpfulness with this."* (R4)

"There is this philosophy to buy from start-ups, so we need to find start-ups. [However], we can't really say: only start-ups can apply. It's a public tender under European legislation." (R10)

6.3.4 Changing the role of public organisations. As part of the organisations automating and delegating decisions to external parties, the role of the changed role of public sector organisation is discussed: *"The main part of using blockchain is that you can eliminate a third person. So, it's also for the city. So, if you use blockchain, flows are going more easily, you have less administrative burden. Everything goes automatically."* (R14)

Smart contracts are especially discussed to automate and distribute processes, hence decentralising decision-making: *"The possibility is that you can programme all these processes [create smart*

*contracts for processes such as, e.g., validation] and take out the human factor, and make the process more efficient. And you do this by not monopolising [. . .] but sharing these roles" (*R5). The argument is further illustrated that other parties, such as welfare organisations, can validate transactions. It was highlighted that giving away some control as a municipality implies decentralising: "Y*ou are decentralising budgets, and that's the concept. blockchain is a decentralised technology, and if you can do this, blockchain comes to effect. "(*R5)

Another way to describe what smart contracts can do is that it transfers value under pre-set conditions. Considering municipal use of public money (e.g., building and maintaining houses, public spaces, bridges, roads, and providing social welfare systems), for the welfare, the government transfers value under pre-set conditions, i.e., executing a smart contract. *"We use these funds to buy services or distribute the funds amongst people.*" (R5)

Co-governance of services was noted as another issue: "*The idea behind [the pilot 5] was to have like a system that could be rolled out on a broader level [...], that everybody could fund challenges and those challenges would be defined with smart contracts. [. . .] The idea was to have like a crowdfunded platform.*" (R12)

7 DISCUSSION

The previous section reported the results from the empirical part of this paper. In the following paragraphs, we elaborate on answering our research questions. Our contributions can be structurally divided into theoretical and practical ones. On the one hand, we systematise and explain local governments' experiences to introducing, conceptualising and experimenting with BCT as a part of its DT, using the theories from sections 2-4. We also derive practical conclusions for consultation on possible future BCT use-cases.

By seeking the answer to our first question, we have acknowledged that DT is a continuous process [16, 42]. We chose to distil the DT process into a set of *digital transformation activities* characterised as either *driving*, *impeding*, or *shaping the* digital transformation. The "driving" and "impeding" activities are reflected in the first theme, which illustrates how experimenting with blockchain is motivated and the obstacles and concerns of this process.

Drivers can be perceived as pressures [25] or as a confluence of technological, organisational, and environmental forces [16]. The dynamics of public sector institutions show the trends of striving to a better user focus and involvement, and also outsourcing the knowledge and resources from outside. On the contrary, a more conservative institutional logics predicts a threat for government's role as a service provider and public values guarantor could be questioned due to the decentralised nature of blockchain. However, such drastic change was not a necessary nor feasible part of digital transformation.

Instead, the governments' innovation ambitions were driven by addressing specific business and societal needs and public value creation, publicity, or general curiosity to test available tools. Among those needs, one can indicate protecting users' privacy, providing better services, automating bureaucracy. The change can be driven by the ambition to stay adaptive and proactive in public service delivery, while it can also be argued that there must be specific business needs to motivate experimenting with new technologies beyond mere digitisation.

These impeding factors, closely related to the blockchain piloting activities, can be of a social/organisational nature, such as inertia and resistance [42]. However, data shows that a common source is technical limitations, which surfaced when the blockchain technology was instantiated and tested in a piloting environment. The results proved that a motivated and aware leadership is needed for such changes to be sustainable, as pilots can be abandoned due to a lack of thereof.

Therefore, some crucial conditions need to be met to achieve sustainable long-term change. First, in terms of institutional logics transition: changes in bureaucratic culture and external relationships are needed to adapt to new demands and technologies and not be held back by conservative and cautionary approaches. Second, a change in the individual mindset and competencies of the public servants is needed. Third, citizens were mentioned as both supporting and opposing local governments' innovative approaches, so it is essential to ensure that they understand what using blockchain means, especially in a political environment.

The second theme illustrates the "shaping" activities, explaining how digital transformation is affected by internal and external factors. Such factors include internal factors such as organisational strategy and legacy [16], structure, culture, leadership, and employee skills [42], as well as environmental factors, such as legal and infrastructural conditions and material factors, such as digital properties and data availability [16].

For blockchain pilots, we revealed that given its novelty, building organisational capacity and informed leadership is essential for projects to be sustainable. Additionally, the DT literature argues that organisations must be flexible and adaptive to recent technologies due to their unstable nature [16, 42]. Moreover, any decision about blockchain must be taken considering policy goals, public values, institutional structure, and social expectations [36].

The know-how about the technology's opportunities is also essential to make an informed decision when it is a good fit and when an alternative solution can be used instead, hence avoiding unmet expectations and fitting the existing legislation.

The results indicate that blockchain sometimes was used because it was available due to a missing intellectual and staff capacity to conduct an ex-ante evaluation. However, DT success also partially depends on organisation collaboration capacity, and the experts agree on that. Therefore, citizens and other stakeholders (such as start-ups) could be considered not only consumers of services but also co-producers, resulting in better knowledge capacity and improved cross-industry and citizen relationships.

In the third theme, we discuss the change process in local governments from institutional logic and digital transformation perspectives. The former implies introducing more user-centricity and sourcing the "*knowledge from the crowd*", and the latter also advocates for an increased relationship in the local governments' ecosystem.

While pursuing public values remains the main goal for local government organisations, they might adopt novel methods, including experimenting with new technologies. Remarkably, this concerns making public services more flexible and scalable, and the technology has such an offer. Furthermore, blockchain promise to decrease administrative burden is beneficial both for citizens and public service, creating more public value. Moreover, BCT can

facilitate direct interactions between institutions, people, and economic agents, enhancing inclusivity and democracy. It is, however, essential to ensure that BCT-based projects do not come with unnecessary complexity.

In general, the technology may be viewed as a direct attempt to fight the dominant institutional logic and turn it into a citizen-centric logic because it allows for the imbrication of a citizen-centric institutional logic within public sector organisations. In turn, this calls more attention to ensuring that the public servants possess sufficient skills and knowledge when engaging with new technologies. Furthermore, additional adaptivity and flexibility will be needed with blockchain, given its ongoing development as a technology. When decentralising public administration and automating public services, it is vital that these services are thoroughly developed so that there is no monopolisation because even decentralised decision-making must be programmed by some party.

8 CONCLUSION

During the BTC's 14-year life span, it has been altered and used in many applications and sectors with varying success while receiving noticeable support on the political agenda by being included in large-scale initiatives on the international level. However, it is yet neither a "*one-fits-all*" nor a mature technology, as there are still many uncertainties associated with it. In this article, we aimed to address the knowledge gap on how blockchain technology is perceived and used by local governments in light of the ongoing digital transformation.

This study focuses on public sector actors, though private organisations have a role to play in these initiatives. Change in private and public sectors is partly based on different aspects. On the one hand, while the private sector is primarily driven by economic advantages and competition, which may restrict sharing of good ideas with partners, the public sector is motivated by the diffusion of improvements (e.g., the efficiency of public service), to increase the public value. As such, the public sector may have fruitful premises for its institutional change to become more open to collaborations and innovation. On the other hand, the public sector is more sensitive to political influence; it is less autonomous and subsequently less flexible than private sector institutions. Despite all the surrounding promises, pre-mature technologies like blockchain need to go a long way and demonstrate sufficient success before becoming mainstream tools for local governments to innovate.

It would be valuable to also focus research efforts on private organisations' role in these initiatives and, in that way, understand the unique characteristics of both private and public organisations, digital transformation and changing dominant institutional logics. The limitation of the study is that we report early findings from limited blockchain pilots, and the only limit is to Benelux countries. Future research is needed to investigate these findings in other contexts (countries, regions, local governments) and other technologies. Our case methodology poses some limitations to the findings and could be complemented with other research methodologies. More research is also needed for the designs of different potential blockchain solutions and usage of these systems, and organisational change brought forward when these systems are taken into use. More research would also be needed from the citizen's perspective.

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A Study on Privacy Protection of Mobile Evidence in Relation to Criminal Investigative Procedures

Ok Heo
Graduate School of Information Security, Korea University, South Korea
starlitok@hotmail.com

Hee-Jin Koo
SAMIL PwC, South Korea
kheejin9@gmail.com

Hun-Yeong Kwon
Graduate School of Information Security, Korea University, South Korea
khy0@korea.ac.kr

ABSTRACT

The growth of mobile devices used in our daily lives can mean more than one type of digital forensic targets may exist. Unlike desktop computers and file servers, mobile devices are more often used in daily life and contain precise and detailed personal information. Accordingly, if a mobile device is confiscated and digital forensic procedures are conducted, various private information may be disclosed during the investigation process. Moreover, privacy exposure from the investigative agency is not the entire risk. For example, privacy exposure may occur when evidence is released outside the investigation agency or possibly when other case managers arbitrarily read the evidence. Additional risks may arise during storage process as well. Privacy is a fundamental right of the people protected by the Constitution. Thus, if under the confines of the law, infringement or privacy limitations are necessary then it should be done to the minimum extent possible. In this paper, we will study 1) the laws relating to digital forensic procedures in Korea, the United States, the E.U., 2) examine the types of private information that can be exposed through mobile devices, and 3) suggest passcode (which is a first-generation cryptography, based on authentication) and other encryption methods, more specifically public-key and isomorphic encryption to protect the privacy of mobile evidence.

CCS CONCEPTS

• **Security and privacy** → Human and societal aspects of security and privacy; Privacy protections.

KEYWORDS

selective seizure, homomorphic cipher, privacy, mobile forensics

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1 INTRODUCTION

Following rapid advancements in IT, the time spent using electronic devices everyday increased and naturally more data and private information are being stored in electronic storage medias. These storage medias may hold private information that can tell a lot about a specific individual. For example, search keywords that are a fundamental necessity while surfing the net provide information that allow a look into the person's thoughts or lifestyle. Also, by looking at image files such as pictures saved to the smartphone gallery, an educated guess can be made of an individual's relationship status, and more. In other words, nowadays electronic devices can store very private information. However, these private devices are vulnerable and can become the target of a seizure order or an investigation and be subject to digital forensics.

In most countries, including the Republic of Korea, U.S, and France, privacy is protected by the Constitution. However, these rights may be protected but can also be limited by the law. A common example is the seizing and search procedure rights provided by warrants. In Korea, Article 17 of the Constitution stipulates freedom of privacy, and Article 12 stipulates the principle of due process. In the U.S., the Fourth Amendment to the Constitution specifies privacy and due process. Likewise, efforts to protect privacy are needed when seizing information storage medias in criminal cases. Currently, several papers try to solve the privacy problem by limiting the scope of information collected and seized by prosecutors and investigators. Josh Goldfoot, in his paper illustrates the "subcontainer perspective" how it handles issues that arise between computer forensics and rights provided by the fourth amendment to the U.S Constitution [1]. Lee's article illustrates the method the possessor should take in the seizing process and in to not take material irrelevant to the crime. [2] But, confiscating only relevant information may not be enough to protect privacy during investigative procedures. It may also not be sufficient to protect various privacy risks that may occur during storage inside law enforcement agencies.

According to the Internet Crime Report 2020 from the FBI Internet Crime Complaint Center, personal data breaches and identity theft are ranked in the Top 5 crimes in the last five years. Also, the FBI defines a personal data breach as "a leak or spill of personal data which is released from a secure location to an untrusted environment. . . a security incident in which an individual's sensitive, protected, or confidential data is copied, transmitted, viewed, stolen or used by an unauthorized individual." Identify theft is defined as "someone stealing and using personal identifying information, like a name or Social Security number, without permission

to commit fraud or other crimes and/or (Account Takeover) a fraudster obtains account information to perpetrate the fraud on existing accounts" [3]. Government agencies are always attractive targets for cyberattacks. Therefore, the risk of law enforcement being attacked should not be overlooked. Even if it is enforced by law, if the information was obtained from an individual, enforcement is obligated to protect that information. Also, hacking attacks may be a risk along with arbitrary access of digital evidence by an investigator who is not involved in the case and access of digital evidence by an investigator after the case is over.

Encryption is the most effective method to reduce exposure to invasion of privacy data breach or unauthorized data access. Recital 75 of EU GDPR lists the risk to the rights and freedoms of natural persons, of varying likelihood and severity, that may result from personal data processing including cases where the data subjects are deprived of their rights and freedoms or unable to exercise control over their personal data. Compulsory enforcement is one situation where the control of privacy in digital evidence has been taken away from the individual person. Article 32 of EU GDPR regulates the 'Security of processing' and Article 32(1) regulates the taking into account the risk of varying likelihood and severity for the rights and freedoms of natural persons, the controller, and the processor shall the pseudonymization and encryption of personal data. An investigator's improper approach may encroach the defensive rights of the suspect such as, unilateral physical computer seizure, access by other case officers and future access to past cases, etc. When the computer is physically confiscated, the accused has no idea exactly what kind of information had been transferred to enforcement. There is the risk that other case officers can be granted access to digital evidence or arbitrary access to physical forensics image is possible for past cases. In this paper, we are going to study the privacy protection laws and search and seizure procedures of Korea, the United States, and Europe and then explain the characteristics of digital evidence containing personal information and the different methods of seizing evidence. Then we will emphasize the necessity of encrypting digital evidence while it is being stored in enforcement agencies.

2 DIGITAL EVIDENCE SEIZURE PROCEDURE AND CASE RELEVANCY

2.1 Regulations related to search and seizure in the Republic of Korea

In Korea, search and seizure procedures in criminal cases are under the Constitution and Criminal Procedure Act. Article 12 of the Constitution stipulates due process, and Article 10 stipulates the right to pursue happiness. Also, Article 17 of the Constitution stipulates the right of privacy that "The privacy of no citizen shall be infringed." Based on these constitutional provisions, the provisions of the Criminal Procedure Act that we will pay close attention to are Articles 106 (1); 106 (3) , and 122 , and Article 313 (2). First, Article 106 (3) of the Criminal Procedure Act stipulates the principle of selective seizure. The revision of the Criminal Procedure Act in 2011 is a very significant change in the investigation of digital evidence in Korea. The amendment in 2011 has added a case relevancy regulation to Article 106 (1) and added to Article 106 (3) that the scope and method were specified when seizing information storage media, etc. also, seizure needs to be selectively carried out. In addition, in Article 106 (4), a provision was newly added to notify the subject of personal information if personal information was provided during the investigation process. All these regulations are intended to protect the rights of the defendant or suspect.

However, there is no regulation considering the characteristics of digital evidence or electronically stored information and just depends on the Supreme Court precedent. [4] Recently the most memorable case is the Supreme Court en banc Order 2011Mo1839 in the digital forensic area. The Supreme Court held that there was no admissibility of evidence in the case, and the background as follows : "Where the Prosecutor of this case obtained a warrant (Warrant 1) to search and seize Party B's office located in Company A's building; took the storage containing information both relevant and irrelevant to the criminal offense to one's office with Company A's consent; copied the entire digital information file stored in the storage device in this case via imaging onto another storage device in the presence of Party B; re-copied the above duplicate onto an external hard drive and printed out information relevant to the offense as well as information irrelevant (pertaining to a separate offense involving Company A) from the hard drive without Party B's presence; obtained a search and seizure warrant (Warrant 2) following the submission of information pertaining to a separate offense as evidence by another prosecutor; and searched/printed out such irrelevant information from the hard drive without Party B's presence, the case holding that the search and seizure based on Warrant 2 is deemed unlawful in its entirety on grounds that: (i) digital information subject to seizure at the time of requesting Warrant 2 was information stored in an external hard drive that was arbitrarily duplicated without guaranteeing the relevant party's presence during the search and seizure based on Warrant 1, and thus, it is deemed an unlawfully seized article and does not meet the requirements to request a warrant for the Separate Information; and (ii) Party B was not guaranteed the right to be present during the search and seizure based on Warrant 2." [5] This case shows the stance of the Korean courts in dealing with evidence unrelated to the case and the defendant's defensive right. The Supreme Court held that the search and seizure of electronic information should not be carried out comprehensively, as there is a high risk of infringing on the privacy and freedom of information, the right to personal data self-determination, and information property rights. So, according to the Supreme Court, the search and seizure of digital evidence should be done within the minimum necessary range. That is the Korea Supreme Court has a very straightforward position to treat the scope of digital evidence. the court does not allow the seizure that exceeds a scope which is specified in the warrant.

In addition, Korean precedents do not judge that the searching and seizing are completed until the relevant files are selected. When investigators take media or fully duplicated physical images to the investigation agency office, then courts in Korea judge they are still being searched and seized. And in this case, it is judged that the investigator should give an opportunity to be present for the defendant/suspense in the file selection process. Compared to the general view that a search and seizure is completed and done on the crime scene spot, this investigation procedure in Korea is unique.

2.2 Regulations related to search and seizure in the Republic of the U.S.

Rule 41 of Federal Rules of Criminal Procedure in the United State regulates the search and seizure procedure. Especially Rule 41(a)(2)(A) lists up the target of search and seizure. Also, Rule 41(a)(2)(A) includes the 'information' as the object of search and seizure. Thus, according to Rule 41(a)(2)(A), electronically stored information which means digital evidence can be the object of search and seizure. And Rule 41(f)(1)(B) contains the following: "In a case involving the seizure of electronic storage media or the seizure or copying of electronically stored information, the inventory may be limited to describing the physical storage media that were seized or copied. The officer may retain a copy of the electronically stored information that was seized or copied." Thus, officers can seize as storage media it is which is not limited to case-relevant files. And even if officers executed the seizure as case-relevant files, they don't need to describe a detailed list. they just have to describe a storage media comprehensively under the law in inventory. Also, the officer can retain the digital evidence as media it is or copied files as evidence files. Then, there remains the question about case relevance. However, the rule 41(e)(2)(B) of Federal Rules of Criminal Procedure stipulates as follows: "A warrant under Rule 41(e)(2)(A) may authorize the seizure of electronic storage media or the seizure or copying of electronically stored information. Unless otherwise specified, the warrant authorizes a later review of the media or information consistent with the warrant." That is, officers can retain digital media. And also, they are allowed later review, not on sites.

However, the court realized that there are significant dangers inherent in executing a search and seizure of a person's information. that there is the risk of examining 'innocuous documents. Then the court said, "must take care to assure that they are conducted in a manner that minimizes unwarranted intrusions upon privacy." in Scott v. United States, 425 U.S. 917 (1976). [6] Some federal magistrates rejected law enforcement's warrant requests for digital evidence because of the suspects' privacy rights. They request when enforcement would search, such as limiting how long the enforcement could keep the hardware it seized, specifying how the enforcement would conduct the search, or explaining what the investigator would do with the information. That is, they request the exact scope of the warrant which law enforcement will carry out the search and seizure. [7] Some magistrate judges have considered limiting the scope of items narrowly to be seized or to ensure due process. and they considered some ways to do so. The ways are as follows: (1) requiring an independent review team, (2) utilizing targeted search terms, and (3) requesting an initial keyword screening by service providers.[8] This can be interpreted as the need for the selective seizure to protect privacy is gradually emerging in the US criminal procedure system.

2.3 Regulations related to search and seizure in the Republic of EU

Germany is one of the countries in the EU that places great importance on the protection of the right of defense and privacy of the accused in the search and seizure procedure. The German Criminal Procedure Code and the Constitution guarantee the right of the accused to participate and privacy in the search and seizure process. First, the German Code of Criminal Procedure Section 94(1) stipulates as followed: "Objects that may be of importance as evidence for the investigation are to be kept in safe custody or otherwise ensured." That is, Section 94(1) stipulates that evidence must be kept safely. And section 106(1) regulates that a person who is subject to search and seizure can present at the procedure. And the memorable part of the German Code is part 4. Part 4 stipulates the protection of personal data in electronic files; the use of personal data extracted from electronic files. And section 496(2) under part 4 stipulates that: when processing or use of personal data in electronic evidence then, organizational, and technical measures are to be taken which are necessary to meet the specific requirements of data protection and data security. and data must be constantly available, and precautions must be taken to prevent data loss. It is unique in that it explicitly stipulates the duty to protect personal information even in criminal proceedings. The German Federal Constitutional Court, in a 2005 decision contesting the validity of a search and seizure order for data storage media, said that the right to self-determination of electronic information could not be sufficiently guaranteed by the principle of proportionality alone, and as a procedural limitation; prior notice; guarantee of participation; notification of information collection; return/deletion of unrelated information; prohibition of the use of evidence. [9]

The German Federal Constitutional Court holds that the comprehensive seizure of electronic information is an illegal execution that goes beyond the existing procedural safeguards. [10] In this case, the German Constitutional Court interprets the privacy and personal information protection of information storage media as fundamental rights of the people, so excessive seizure of information constitutes a violation of fundamental rights.

3 CONFISCATED DIGITAL EVIDENCE AND PRIVACY

3.1 Privacy that may be exposed in digital evidence from mobile devices

Nowadays, It is not an exaggeration to say that almost all activities in people's daily life are using digital media. And the individual's daily life can be classified as a private area. Some people may think that files created for personal purposes and photos taken privately are entire categories that can be extracted from digital media. However, such that assumption is a common mistake made because they do not know how many forensic artifacts can remain in digital media. According to Edmond Locard who is a forensics expert from France, When two objects touch, they exchange vestiges. And that theory is called Locard's exchange principle. The Locard's exchange principle can apply in the digital forensics area, and the forensic artifacts are the results of the Locard's exchange. The typical examples of forensics artifacts in mobile devices are below:

As you can see in 'Table 1', forensics investigators can get information about private activities or personal thoughts and individual intentions from forensic artifacts in mobile devices. In the Android system, full disk encryption was introduced from Android 4.4 to protect privacy and user data.[12] And in Android 5.0 they added a new function to more sophisticated encryption. According to [12], since Android 4.0 all user-created data is automatically encrypted and since Android 5.0, added hardware-backed storage

Table 1: The forensic artifacts that can reveal privacy in Mobile Device [11]

Type	OS	Artifacts Name	Description
Password/Account	Android	com.android.providers.setting	Username and password
Communication	Android	mmssms.db	SMS and part
Browser Usage	Android	browser2.db	Internet History
Synking	Android	com.google.android.apps.docs.editors.doc	Google Docs
Location	Android	da_destination_history	The destination history
Password/Account	IOS	healthdb.sqlite	Health data, personal data, iOS version info, etc.
Communication	IOS	- sms.db - sms-temp.db	- SMS/MMS messages - SMS Temporary storage (Before First Unlock)
Browser Usage	IOS	History.db	Safari browser history
Synking	IOS	/.OfflineCache	iClould offline cache
Location	IOS	GeoHistory.mapsdata	Apple Maps history

Table 2: Mobile device acquisition tools/Method [14]

Type	OS	Tools/Method
Open Source	Android	viaLogical
Open Source	Android	ADB Backup
Open Source	Android	OSAF Toolkit
Open Source	Android	Santoku
Open Source	Android	DD (Not for all)
Open Source	Android	JTAG/Chip-off
Open Source	IOS	Zdziarski Methods
Open Source	IOS	Boot Rom Vulnerability Exploits
Open Source	IOS	iTunes
Commercial	various OS	Cellebrite Collection Series (Cellebrite UFED, Cellebrite 4PC etc.)
Commercial	various OS	HANCOM WITH MD-NEXT
Commercial	various OS	GRAYSHIFT GrayKey

of the encryption key. And according to [13], Apple devices are encrypted by default for all devices running the new iOS 8 software. It can be understood that the introduction of such encryption technology reflects users' expectations for privacy. Various tools that support mobile forensics, but it may or may not succeed in collecting evidence depending on the operating system version because of encryption functions for privacy. For example, most of the tools listed in 'Table 2' that are open source have not been updated since around 2015. And that time is similar to when Android 5.0 and IOS 8 were introduced. However commercial tools try to catch up with the continuously updated encryption technique and bypass the encrypt module etc. they can successfully do mobile device acquisition.

An individual's private thoughts and intentions are confidential areas protected by the Constitution, and care must be taken when handling such information. As we saw in Part 2, the laws of many countries around the world stipulate that only relevant information should be seized during the investigation procedure. However, since the execution of seizure occurs at the beginning of the investigation, it is impossible for investigators to completely select only relevant information no matter how hard they try. It is because the investigation may need to be progressed to determine whether there is a relevant or not. As a result, digital evidence may contain information irrelevant to the case, regardless of whether or not it has been selected. Even though Investigator who collected the evidence thought it was information related to a crime, then he may realize it was irrelevant at a later time. Moreover, mobile devices use a different type of file management system than PCs. This difference is very critical to file selection in criminal seizures. It can be understood that a typical computer manages data in units of files. Therefore, data can be selected by extracting only the specific files to execute seizures in criminal cases. However, unlike the typical computer, mobile devices manage data in units of databases. Therefore, in general, it is usually impossible to completely select data in units except for photos and attached files on mobile devices.

In addition, digital evidence collection can be carried out in various cases. In the case of cybercrime investigations, the entire media is collected without selection because the digital media itself is a crime scene. In this case, even personal information unrelated to the crime is transferred to the prosecutor's office without filtering. If the seizure is executed to collect evidence from the victim's devices not the attacker's devices (e.g. confiscation through voluntary

submission), privacy protection will be more essential. Also, there is the case that involves confiscating employees' devices to investigate corporate crimes. Company work and employees' private lives should be clearly separated, but in the confiscated digital media, company business files and employees' personal files exist with each other.

Various papers research privacy conflicts related to digital forensics in procedural supplementation methods.[15] However, this procedural supplementation has a limitation in that it will ultimately depend on the ethics of the investigator unless it is accompanied by a technical method.

3.2 The Possibility Of Mobile Evidence Leakage And The Need For Mobile Forensics Data Encryption

In 2016, Occurred mobile forensics data leakage from police in the United States. The US Police is provided mobile forensics services from Cellebrite, an Israeli mobile forensics company. The Cellebrite either sells mobile forensics tools it is or provides forensic reports which have been exported as a result of tools. According to [16] the leaked data is as follows: The calendar, call logs, chats, contacts, internet usage cookies, installed application, locations, MMS/SMS messages, notes, timelines, user account information, voice mail, networks usage information, data files, activity analysis, etc. even in device information on the forensically exported report, contains apple ID, device name, ICCID, IMEI, last activation time, phone number, serial number, etc. According to the GDPR, IMEI, phone numbers, cookies, network IPs, etc. are explicitly personal data. The problem is not that this information was collected by an investigative agency it is. but that information was leaked to the private sector. This report itself can be considered as forensic evidence because it is just a human-readable form of the contents collected by mobile forensic tools. Investigators analyze this report and use it for investigation. Mobile forensics tools bypass or break all encryption barriers created by mobile device/mobile OS manufacturers, allowing the data inside to be read. Therefore, the data on which the mobile forensics has been completed can be viewed in a state in which the internal data is exposed as it is, including privacy.

In the disk forensics area, digital forensic experts use some kind of special file format to handle digital files which are easy to pollute as evidence. First, the format typically used when collecting evidence on the PCs is as follows. The file formats are called 'Expert Witness Compression Format'. To ensure the integrity of digital evidence for admissibility digital forensics experts and investigators are using this format to handle digital evidence. Generally, these file formats are focused on duplicates like the original without any difference. Typically, in the digital forensics area, they use E01, Ex01, L01, Lx01, DD file format to make digital evidence from original media. And the media mean personal computer, mobile device, file server, etc. In this kind of expert witness file format, we can classify two types based on software version. Thus, the E01, Ex01, L01, Lx01 file format is a very popular and typical evidence file format, however just one of the file formats for specific applications initially. The E01 started with a file format called S01 and the S01 format is a format of SMART application of ASR Data which is a forensic vendor. [17] And, the OpenText which is another forensic vendr developed the S01 file format to the E01 file format for a program called EnCase. The EnCase program is one of the typical digital forensics tools accepted by the court and digital forensics experts in many countries around the world. Therefore, we can understand the E01 file format developed for the EnCase program came to be used as an industry standard. L01, Ex01, Lx01 format is also developed for EnCase. Even PC disks can expose a lot of private information, though not as much as on mobile devices. So, some forensics tools provide image encryption functions/password functions to protect data security.

According to Access Data, which provides FTK and FTK imager which is one of the popular forensics acquisition tools, FTK Imager 3.0 and later has the ability to encrypt data during export to an image so-called 'AD Encryption' function.[18] And also according to [18], the AD encryption function can be used for (AD Custom Content Logical Image), E01 (EnCase Compatible), S01 (Smart), AFF (Advanced Forensic Format), and 001 (RAW/DD) extensions. And these are encrypted using AES crypto algorithms. However, as described above, since these formats are the technology developed for a specific application, this example cannot be directly applied to mobile forensics. However, mobile devices contain more private information than any other device, so encryption methods must be discussed.

4 THE PRIVACY PROTECTION METHOD ON MOBILE FORENSICS USING ENCRYPTION METHODS

In mobile devices, they do not manage data in file units like PCs. but store and manage data in database format. Therefore, it is difficult to select only crime-related files on a mobile device. Also, it is difficult to select only evidence related to criminal activity at a crime scene within a limited time. The warrants have time limits, and the search and seizure must be completed within the effective time. But investigators are often accompanied by technical difficulties. Mobile devices can be synchronized at any time through the network, which may result in data changes by criminals, etc. This means that the status is not static, and there is a risk that the evidence will not be collected anymore if it is not collected at this point. Therefore, it is necessary to collect a forensic method known as imaging the entire mobile device at the time of initial seizure in order to understand the facts related to the crime. That is, it is necessary to preserve the entire mobile devices system. However, mobile devices contain communication records(call logs, chat logs, voice mail, etc), location information, payment information, various personal account credentials, and information linked to the account. Therefore, it contains more types of privacy information than PCs.

4.1 Prevent Access By Unauthorized Persons Using Passcode/Crypto Functions On Forensics Tools

The applications that typically create and write files provide the ability to restrict access through passwords. This is not different for digital forensic applications. Therefore, when creating forensics image files, it is possible to protect the privacy of the confiscated

Table 3: Detail of Header Section

Field Name	Description
C	Case number
N	Evidence number
A	Unique Description
E	Examiner name
T	Note
Av	Application version
Ov	OS version
M	Acquired date
U	System date
P	Password
R	B: best, F: fast, N : no compression

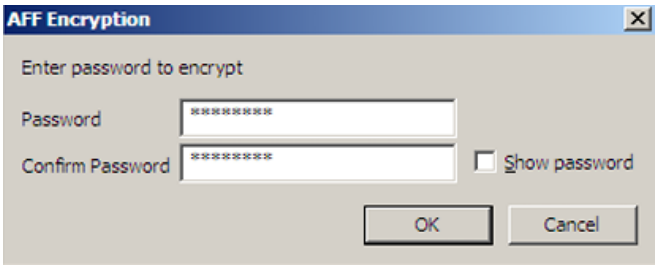


Figure 1: The example of evidence setting in forensics tool (FTK)

by using the passcode/crypto technology supported by the forensic imaging tools.

4.1.1 The Passcode/Crypto Function On Forensics Tools. Typically, the forensics image file format is divided into EWF(Expert Witness Compression Format) and AFF(Advanced Forensic Format). The Expert witness format is divided into the fixed size of the section and based on media volume the number of result files is increased like E01, E02, E03, E04, etc. And according to reference [19], the EWF contains the header section which contains information about cases such as tool information, physical media types, etc. And the last section has a unique digest section for checking the entire section's integrity. Also, according to reference [19], the header section contains specific case information as 'Table 3'. That is, It is possible to know the background of how the evidence file was created through the header information.

As can be understood from the foregoing, the expert witness file format contains case information and is that format focused on keeping data intact. 'Table 3' is the details of the header section in EWF. As you can see, EWF can be set protected using passwords. Generally, the forensics image file formats include EWF and AFF and can be protected using the password.[20] These forensics image file formats are the file format that is the result of duplicating bitstreams. So, when collecting mobile devices, they can also be preserved and collected using EWF/AFF. Therefore, when investigators create forensics images from mobile devices, they can keep confidentiality using passwords.

4.1.2 The suggestion procedure using the passcode/crypto function in the tools. Various digital evidence collection tools provide password application or encryption functions. Therefore, realistically, we propose a method to set a passcode or encryption using the function of the imaging tool at the time the investigator collects evidence. And then, the investigator must seal the media (CD, USB Drive, Hard Disk, etc.) containing the collected mobile evidence file and obtain a signature from the participants in the searching and seizing procedure. If digital evidence is encrypted before sealing, it can be protected even if lost or stolen.

4.1.3 Cons With Tool-Dependent Encryption. Setting a passcode using the forensic imaging tool at the time of collection, they can safely protect the privacy from theft by third party or loss of the evidence file. However, this method has its drawbacks. Since the person in charge of collecting evidence sets the password, various risks may occur if the investigator remembers the password and abuses it or shares the password with an unrelated person. Also, if the password is lost, it may damage the analysis phase of evidence. In addition, if the investigator who set the password uses an uncomplicated but simple password, entropy may be significantly lowered, and files may not be protected from various risks. In addition, simply setting the passcode to lock the evidence cannot solve the fundamental privacy problem because it can be viewed by investigators at any time even after the case is closed.

4.2 The Improved Encryption Application Method

The modern encryption method can be divided by generation, the first generation can be divided into a simple password method (based on authentication), the second generation is a symmetric key encryption method, the third generation is a public-key encryption method, and the fourth generation is a homomorphic encryption method. Applying a password to a mobile forensics evidence file or applying symmetric key encryption has the same problem as in part 4.2.3, so it can be overcome by applying more advanced encryption methods. It is possible to consider the application of asymmetric cryptography to prevent arbitrary access to evidence that is not related to the crime.

Table 4: Encryption functions in forensics imaging tools [21]

Tool	Encryption	Output Formats			
		Raw	E01	Ex01	Split
FTK Imager 3.2	√	√	√		√
FTK Imager CLI 3.1.1	√	√	√		√
EnCase Forensic Imager 7.0	√	√	√	√	√
dd		√			
dcfldd		√			√
dd_rescue		√			
dd.exe	√	√			
dc3dd		√			√
ewfacquire		√	√	√	√

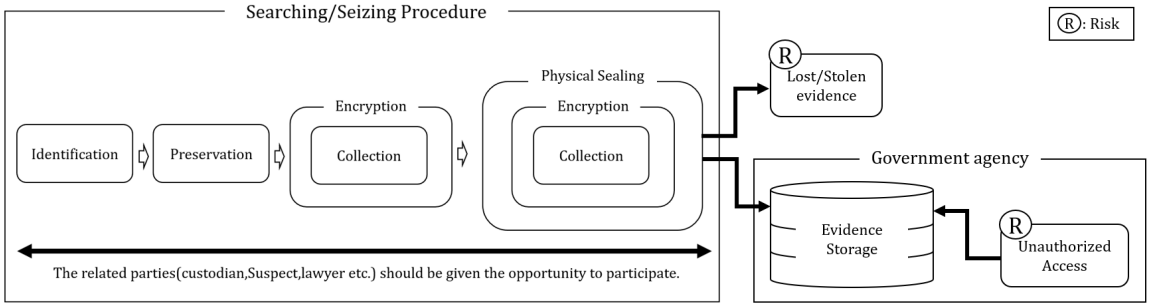


Figure 2: The searching and seizing procedure using passcode/crypto function in the tools



Figure 3: The asymmetric key encryption method [22]

4.2.1 Asymmetric Key Encryption. The method of encrypting information can be divided into "asymmetric key method in which the key used for encryption and decryption is the same" and "asymmetric key method in which the encryption key and the decryption key are different". It is not an appropriate measure to protect the privacy of the defendants/suspects from the various risks discussed prior chapters that the investigator can decrypt using the same key as the key used at the time of the seizure of the digital evidence. Therefore, an asymmetric key encryption method must be used. The asymmetric key encryption method is a method in which a public-key and a private key are generated by a trusted center as shown in 'figure 3' below, and the public-key is used for encryption and the private key is used for decryption. Investigators use the court's public-key to encrypt the evidence at the time of seizure, and if decryption is necessary, they request and receive a private key from the court to decrypt. These steps can prevent exposure of privacy in evidence from loss, theft, and unauthorized access by other case officers.

The thing to be aware of in this process may forgery, such as external hacking, in the process of delivering the public-key. Among

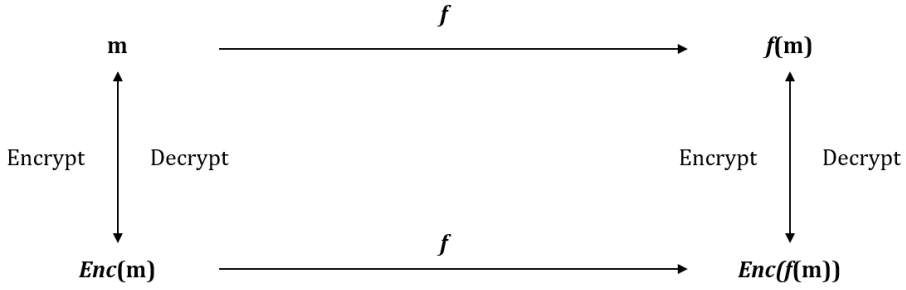


Figure 4: Fully Homomorphic Encryption

the key distribution methods that prevent such a risk of forgery, there is a PKI(Public-key Infrastructure) which securely distributes the public-key. PKI is a model for creating, distributing, and revoking certificates based on X.509(Public-Key Infrastructure X.509, called "PKIX"). The PKIX is established by the Internet Engineering Task Force (IETF). According to [22], PKI's duties are as follows: 1) issue certificates, 2) renewal certificates; 3) revocation certificates; 4) storing keys; 5) update keys; 6) providing services to other protocols; 7) providing access control.

4.2.2 Homomorphic encryption. Homomorphic encryption is the fourth generation of encryption technology following passwords, symmetric key encryption, and asymmetric key encryption. Homomorphic encryption is unlike existing encryption methods, it is a next-generation mathematical technique that combines data in an encrypted state, and enables calculation and analysis [23].

$$E(m1 + m2) = E(m1) + E(m2) = c1 + c2 \quad (1)$$

$$E(m1 * m2) = E(m1) * E(m2) = c1 * c2 \quad (2)$$

According to [23], when plaintexts m1 and m2 are encrypted (E) and c1=E(m1), c2=E(m2) respectively, no information could be known if not decrypted using the existing encryption method. However, when the data is encrypted by homomorphic encryption can be calculated using the property that the value calculated on the ciphertext as in (1) and (2) and the operation performed with each ciphertext is the same even if the data analyst does not know the plaintext. Homomorphic encryption can perform repetitive operations, but 'PHE (Partial Homomorphic Encryption) method that allows only one operation of addition or multiplication', 'SHE (Somewhat Homomorphic Encryption) method that allows two operations but increases noise when repeated', 'leveled fully homomorphic encryption (LFHE) technique that can be evaluated only for circuit (bounded circuit) operations of a limited size (limited levels of circuit, subset of SHE)', fully homomorphic encryption (FHE) technique that is a technique (SHE + Bootstrapping) which addition and multiplication can be applied infinitely.

The FHE was introduced in [24]. FHE (fully homomorphic encryption) is said to be Turing Complete, which means that even if certain computer operations are executed in the encrypted state with conditions set and repeatedly executed, the same result as the operation on the original plaintext can be obtained. With FHE, all computations that can be performed by a computer can be performed as desired, so it can be applied not only to searches and statistical analysis but also to very complex computations such as machine learning and image processing. Therefore, when homomorphic encryption is used for forensics evidence files, only crime-related facts can be searched without revealing all information.

4.2.3 Encryption application to the investigation procedure. The encryption method we propose is as follows. When the court issues a search and seizure warrant for mobile devices, they also create a public-key and a private key. And then, the public-key is issued along with the warrant to the investigator/prosecutor by courts. When the investigator/prosecutor creates a forensic image from the mobile devices, they must encrypt the image files using the court's public-key. And before the stage of analyzing the evidence, the investigative officers must again request a private key to court to decrypt the forensics image file.

However, once decrypting the evidence files there are additional problems that may occur. Specifically, such a problem arises when 'decrypting whole image files'. After the whole evidence file is fully decrypted, the privacy issue may arise, and even more, the investigators who are unrelated to the case may read the evidence.

These issues can be seen as a failure of the internal control of the investigation agency. So, in this case, security measures can be established by establishing the internal procedures of the investigation agency. The case-unrelated data can be protected, for example, by creating internal controls that 1) prohibit copying if the evidence is fully decrypted, 2) Re-encryption if the evidence is kept by investigators/prosecutors, not courts, 3) prohibit storing decrypted forensics image files without permission at the places other than the court. As another method, there is a method in which a court or an observer participates in the searching and seizing, selects only files related to the crime, using keywords, file creation time, last access time, modification time, deletion time, and file extensions, and decrypts only those files. In this case, only the files related to the crime are decrypted, and the court must retrieve the decryption key.

When the prosecutor requests the warrants, specify the information necessary for file selection, such as case-related keywords. And using the file selection criteria set out in such a warrant, only files that meet the criteria are selected(Hereinafter, called "evidence A"). After that, only the case-relevant files are made into the logical forensics images, and then encrypt the forensics evidence using the court's public-key. And files that don't meet the criteria, perform

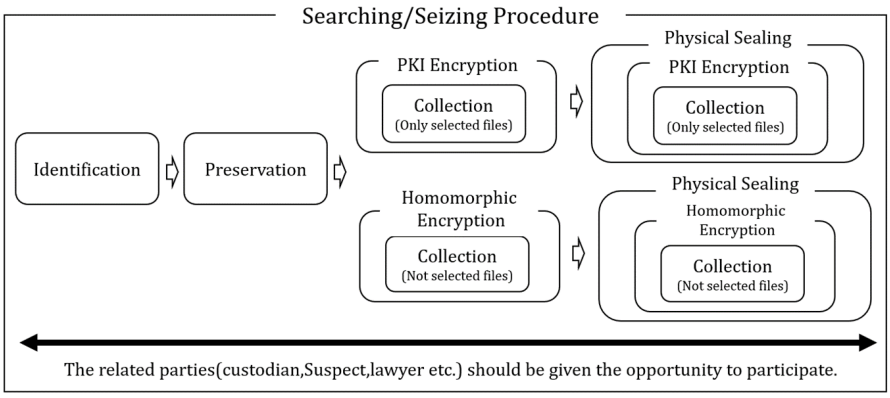


Figure 5: The searching and seizing procedure using PKI and homomorphic crypto

full forensically imaging and are encrypted using homomorphic encryption(Hereinafter, called "evidence B"). Evidence A is decrypted by requesting a private key from the court before analysis. and if additional evidence is needed (for example, case-related keywords are additionally identified) An additional search is performed to select from evidence B, and only the corresponding part is decrypted.

4.2.4 Pros and Cons. When a password is applied to the evidence file of a mobile device, it is relatively easy to protect the privacy of the seized person. However, the only protection from simple risk and may simply be bypassed. In the method of locking the entire evidence using a passcode, if the passcode is released, the entire evidence can be viewed, so the investigator can see information irrelevant to the case. In addition, if the password is leaked or shared with an unrelated investigator, various unrelated people can view the sensitive information, and if the investigator's computer is hacked, the risk is increased.

Moreover, if the password is lost, there is a fatal disadvantage that evidence cannot be used. On the other hand, If the KPI is used for encrypting evidence, the privacy of the defendants/suspects can be protected from the loss of the seized evidence, unauthorized person's access to the evidence, and arbitrary access to the evidence. However, since encryption and decryption are required in the process of obtaining and analyzing evidence, additional time is required.

5 CONCLUSION

Compared to other information storage media, mobile devices are closely related to privacy. Therefore, it is true that a lot of information related to personal life remains. The common categories of privacy exposure on a laptop or desktop computer are chat content, user-generated files, and search queries/terms. However, on mobile devices, there can be serious privacy exposures such as biometrics information, bank certificates, photos, etc. Therefore, privacy issues in the realm of mobile forensics are even more critical. As discussed in Chapter 2, Korea, the United States, and Germany, regulate the due process in criminal investigation procedures and stipulate minimizing the infringement of fundamental rights in the investigation procedure. Therefore, based on these laws and regulations, the exposure of private life unrelated to the case should be minimized in criminal procedures.

Accordingly, we recognized that a slightly more special processing procedure was required when dealing with mobile devices which contain condensed privacy. Therefore, there are two main methods we propose to handle mobile evidence in a special way. One is to strengthen internal control, and the other is to graft encryption techniques into internal control. Naturally, since strengthening only the internal control of the investigative agency depends on the ethics of the actors, creating only the internal control in the paper is not a best practice to protect privacy. Therefore, the method we mainly proposed is to apply the encryption of mobile evidence procedurally. These encryption methods have the advantage of being able to protect privacy even when evidence is leaked to the outside of the investigation agency. In particular, homomorphic encryption is a new generation encryption method that is able to do keyword searches even after encryption, so it is the best encryption method if computing power is supported. It is very important to extract the files related to the cases, and the use of homomorphic encryption is a way to solve both the need to extract case-related files and the prevention of privacy exposure.

We focused on the existence of privacy concerns that may arise while custody mobile evidence in the government agency. Therefore, in this paper, we tried to solve the privacy problem in the investigation procedure and evidence storage through the advanced encryption method. And the results of these discussions as in chapter 4 can be reflected in the internal regulations of the investigation agency that stipulates the investigation procedure, and technical research and support must be accompanied.

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Digital Decoupling: A Population Study of Digital Transformation Strategies in Swedish Municipalities

Kristian Norling[1]
1 Swedish Center for Digital Innovation, University of Gothenburg, Sweden

Tomas Lindroth[1]
1 Swedish Center for Digital Innovation, University of Gothenburg, Sweden

Johan Magnusson[1,2]
1 Swedish Center for Digital Innovation, University of Gothenburg, Sweden, 2 Kristiania University College, Oslo, Norway

Jacob Torell[1]
1 Swedish Center for Digital Innovation, University of Gothenburg, Sweden

ABSTRACT

Abstract. Digital transformation is advocated as a strategic imperative for public sector organizations. With the increased permeability of digital technologies in society, i.e., the digitalization of society, public sector organizations need to find novel ways of utilizing the technology to meet new and fluctuating demands from their citizens. This study approaches the issue of digital transformation strategies through a strategy-as-practice perspective. Through collecting and analyzing all available top-level annual steering documents from Sweden's 290 municipalities in 2021, we employ content analysis to identify the current direction of digital transformation activities. The study finds that the dominant direction of digital transformation in Swedish municipalities is focused on internal efficiency, with only minor impacts from contingency factors such as the political majority and financial stature. This is discussed from a perspective of democracy and equal access to digital welfare, highlighting the empirical phenomenon of digital decoupling as a potential problem within digital government warrant of additional study.

KEYWORDS

digital transformation, strategy, municipalities, public sector, digital government, digital decoupling

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1 INTRODUCTION

Digital transformation, here understood along the lines of Hanelt, Bohnsack, Marz and Antunes Marante [1] as "organizational change that is triggered and shaped by the widespread diffusion of digital technologies", is a fundamental phenomenon in private and public sectors alike [2, 3]. With the increased permeation of digital technologies in society, new patterns of use spill over to the consumption of welfare services and demands placed on public sector organizations [4]. Magnusson, Koutsikouri and Päivärinta [5] argued that public sector organizations that fail to keep abreast with the development will find themselves in a situation of decreased relevance to its stakeholders. This makes digital transformation a prerequisite for sustained relevance in the public sector.

While digital transformation has received ample scholarly attention within the private sector, there is still a dearth of empirically grounded research of digital transformation within the public sector [5]. As highlighted by Mergel, Edelmann and Haug [2], further studies are needed to fully grasp the phenomenon per se and the necessary practices for how the public sector best achieves it.

Digital transformation strategies, i.e. the strategies employed by organizations to perform the digital transformation are as noted by Chanias, Myers and Hess [6] necessarily emergent and fluid due to the disruptive nature of technology itself. This counteracts earlier conceptions of strategy as a formally decided and grounded course of action formulated and implemented without explicit feedback loops and organizational learning [7]. Instead, it pushes for a need to understand strategy along the lines of the strategy-as-practice tradition [8], where strategy is action, i.e., calling for strategizing. Traditionally, the focus of the public sector has been strategic planning [9], but this has shifted towards strategic management [10] with a greater emphasis on implementation, i.e., strategizing [11]. Kane, Palmer, Phillips, Kiron and Buckley [12] make the argument that strategy is what drives digital transformation, which further accentuates the need and importance of strategy and strategizing [13].

Digital transformation is perceived as a means rather than an end. As such, the digital transformation strategy is instrumental in achieving overarching organizational objectives. As noted by Kohli and Melville [14], digital transformation can be directed either internally (i.e., targeted direct value for internal operations and stakeholders) or externally (i.e., targeted direct value for external operations and stakeholders). At the same time, digital transformation can consist of activities related to exploiting existing opportunities (i.e., continuing doing what is already done but in a more efficient manner) or exploring new opportunities (i.e., changing the value offering of the organization). We posit that the combination of said



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two dimensions constitute the direction of the digital transformation strategy.

This study aims to contribute to research by answering calls from Chanias, Myers and Hess [6] on the emergent nature of digital transformation strategies and Mergel, Edelmann and Haug [2] on the need for additional empirical studies of digital transformation in the public sector. In addition to this, we answer the call for new approaches in studying corporate strategies as issued by Menz, Kunisch, Birkinshaw, Collis, Foss, Hoskisson and Prescott [15]. This research is guided by the following research question:

What is the direction of digital transformation strategies in municipalities?

We operationalize this question through a population study of the 290 municipalities in Sweden. Through collecting and analyzing the top steering documents, i.e. the goals and resourcing plans for 2021 of all municipalities, and then conducting a content analysis to categorize each municipality's digital transformation direction, we answer the research question and discuss implications for future research.

This paper is organized accordingly. After this brief introduction, we present previous research on digital transformation and digital transformation strategies within the public sector, along with the theoretical framing for categorizing the direction of digital transformation strategies. This is followed by the method of the study and the results, where we briefly analyze demographic contingencies and differences between the municipalities. To conclude, we discuss our findings by highlighting issues related to equal access to digital welfare and democracy. We highlight digital decoupling as a foundational issue for future studies of digital government.

2 PREVIOUS RESEARCH AND THEORETICAL FRAMING

Digital transformation has received ample scholarly attention during the past couple of years [1, 3, 16]. Albeit associated with an identified inherent low construct validity [3], most of the definitions focus on the transition from a pre-digital value creation/business model to one (to a more significant extent) utilizing digital technologies [1]. In this study, we use the definition as proposed by Hanelt, Bohnsack, Marz and Antunes Marante [1] as "organizational change that is triggered and shaped by the widespread diffusion of digital technologies", i.e. emphasizing the shift/change rather than the new state.

As noted by Mergel, Edelmann and Haug [2], there is still a dearth of research addressing the phenomenon of digital transformation within the public sector. Previous studies of eGovernment [17-20] predominantly highlight the introduction and implementation of information technology to automate previous manual routines. As proposed by Janowski [4], the shift from a focus on digitization (i.e. implementing technology in government) to one of contextualization (technologies impacting sectors and communities) should be regarded as a path of development toward digital government rather than eGovernment.

Digital transformation strategies constitute the strategies employed by organizations to enact digital transformation [6, 21]. Through seeing strategy not as a document or an instantiation and formalization of the intended course of action but rather as a set of emerging activities, there has been a shift in strategic management research toward what is commonly referred to as Strategy-as-practice [8]. As highlighted by Jarzabkowski [22] organizations engage in strategizing as a means for enacting the strategy as such. Hence, the strategy is not intent but action. It is the sum of all activities directed toward the sustainable success of the organization.

In previous research, there have been a limited amount of examples that create typologies of digital transformation strategies (see Oberländer, Röglinger and Rosemann [23]). As noted by Kohli and Melville [14], digitalization initiatives can be focused on either internal (e.g. processes) or external (e.g. products and other vehicles for consumer interaction). In conjunction with this, several researchers have identified the possibility of categorizing digital initiatives based on the outcome [24, 25]. Magnusson, Koutsikouri and Päivärinta [26] study the digital initiatives of two large agencies, categorizing not the outcomes of the initiatives (which, according to the authors, is secondary and subject to a multitude of contingencies) but the activities. Through utilizing organizational ambidexterity theory [27, 28], digital initiatives are categorized on the basis of if they involve activities that are exploitative (e.g. efficiency) or explorative (e.g. innovation) (for a more elaborate breakdown of the equation of exploitation-efficiency and exploration-innovation see Benner and Tushman [29]). By not focusing on the outcome but activities involved in the digital initiative, Magnusson, Koutsikouri and Päivärinta [26] are able to analyze resourcing, i.e. the explicit prerequisites for digital transformation.

This study utilizes the two dimensions of focus and activities to categorize individual expressions of intent related to digital transformation (i.e. direction). In terms of the first dimension, focus, this can be either directed externally or internally. In terms of the second dimension, activity, this can be either directed toward efficiency (exploitation) or innovation (exploration). Based on said two dimensions (see Figure 1), the direction of a digital transformation strategy can be interpreted through steering documents that are not explicitly framed as digital transformation strategies but rather as overarching steering documents, see Menz, Kunisch, Birkinshaw, Collis, Foss, Hoskisson and Prescott [15].

3 METHOD

The rationale for selecting municipalities was three-fold. First, with the municipalities in Sweden constituting the primary and first line of welfare services, we wanted to assure the relevance in our study through a high representativeness for the public sector. Second, with our approach informed by the strategy-as-practice movement, we wanted to have access to documents that formulated the goal setting and resource allocation of each organization. Third, with the municipalities all governed by the same set of regulations, their top steering documents follow the same basic template and allow for easy access and comparability. The rationale for choosing Sweden was one of convenience, since the authors all speak Swedish and are active in the Swedish setting.

Data, in the form of top steering documents, were collected through accessing the municipalities' websites during the spring of 2021. Out of the population of 290, eight municipalities (2.8%) were excluded on account of the municipalities not making the documents available through their web or the documents not being in a

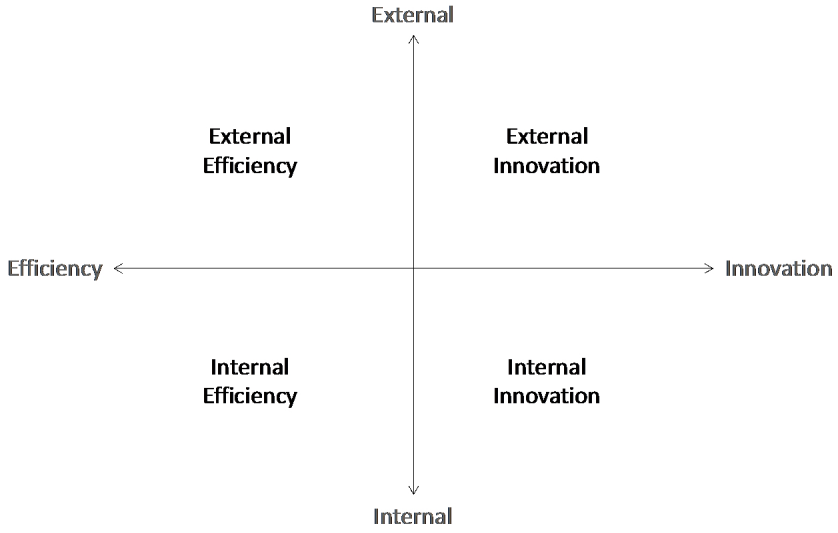


Figure 1: The direction of digital transformation strategies.

machine-readable format. We deem the loss of 2.8% as acceptable for the aspired quality of data. For each municipality we also collected discrete demographic data from 2020 (to assure accuracy and access) in the form of political majority (left, right or combined), financial stature (positive, negative results), size (small, medium, large), geographic position (rural, metropolitan-adjacent, metropolitan) and growth (positive or negative population development).

The data was analyzed from the perspective of strategy-as-practice, identifying and coding only action-oriented accounts from the steering documents. This involved differentiating between accounts of goal setting (i.e., what was to be achieved by digitalization) and resource allocation (i.e., what resources were allocated to achieving the goals of digitalization). The first selection was done based on identifying statements associated with explicit notions related to digital*. After cleaning the data from generalized, non-directive statements (e.g., "digitalization has an enormous impact on society"), the remaining accounts were categorized according to the two dimensions constituting the digital transformation strategy. The coding for the first dimension (Direct Value: Internal vs External) was done Boolean through stakeholder analysis of each account. If the direct value was directed toward an external stakeholder (i.e., citizen, firm) it was coded as External, whereas if the direct value was directed toward an internal stakeholder (i.e., co-worker, internal process) it was coded as Internal. The coding of the second dimension (Activity: Efficiency vs Innovation) was done Boolean through word-count analysis based on March [27] identifiers of exploitation vs exploration. If the activity involved exploitation activities (e.g., decreased lead-times, cost) it was coded as Efficiency, whereas if the activity involved exploration activities (e.g., goal-seeking, innovation) it was coded as Innovation. All coded accounts were then added up to a mean position in each dimension, constituting the final positioning/direction of digital transformation strategy in each municipality.

Each municipality was coded separately and checks for code-concurrency were performed with a result of >95%. The analysis was complemented with a descriptive contingency analysis looking into patterns related to demographic factors that may explain the differences in direction in digital transformation strategies. The results are presented solely through descriptive statistics on account of the deepened analysis (regression et cetera) being one of the next planned steps in the research.

4 RESULTS

The current mean digital transformation strategy in Swedish municipalities is primarily focused on internal efficiency. The mean strategy displays a balance between internal vs internal focus of 36 vs 64 % and between efficiency vs innovation activities of 78 vs 22 %. Digital transformation is in other words enacted as a means for continued operations with enhanced efficiency, where the primary objective is related to decreased cost and lead-times. As seen in Figure 2, the lion share of municipalities in Sweden are positioned within the internal efficiency element of the matrix. Only minor occurrences of municipalities within the other three elements of the matrix are observed.

In terms of how often digital* is mentioned in the steering documents, we identify a clear pattern where financial standing, size and geographic positioning and political majority all have a direct impact on the number of mentions. Figure 3-5 contains a summary of the three contingency variables and their respective mean number of mentions of digital*.

As seen in Figures 3-5, there are clear patterns emerging from the three contingency variables. In terms of financial deficit vs surplus, we see a 20% higher mentioning of digital* in municipalities that are running a surplus (Figure 3). In terms of size and geographic position as well as political majority, we see an almost 300% higher utilization in major cities (Figure 4), as well as in municipalities with right-wing majorities (Figure 5). From this perspective, the

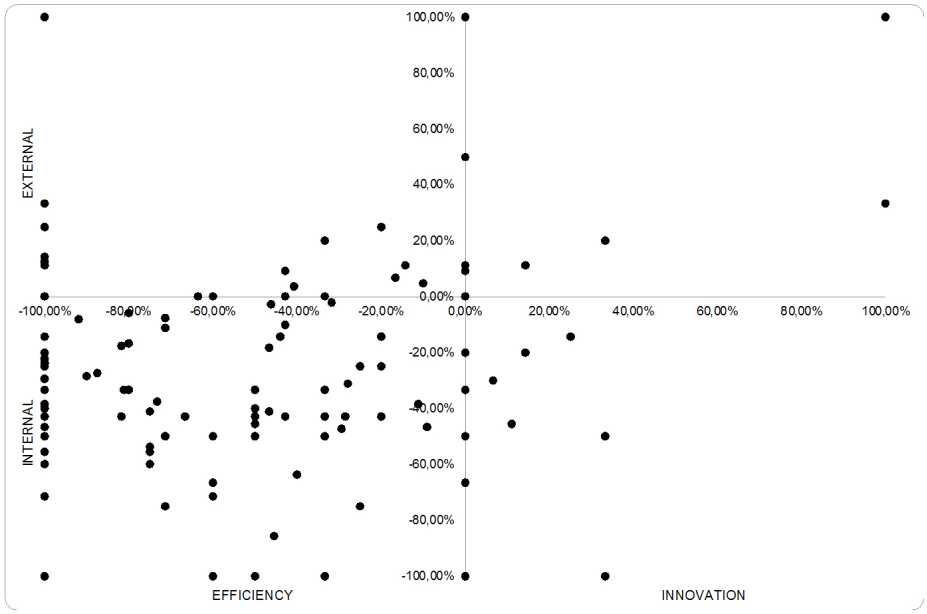


Figure 2: Overview of the direction of digital transformation strategies in Swedish municipalities (n=282).

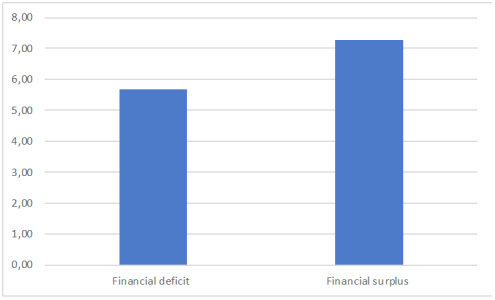


Figure 3: Financial stature overview.

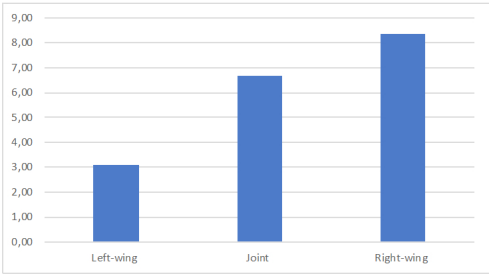


Figure 5: Political majority overview.

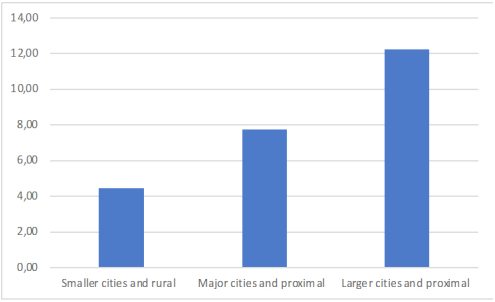


Figure 4: Size overview.

patterns identified are indications of the utilization of digital transformation not being equally distributed between different types of municipalities. With rural small municipalities with financial deficits sub-utilizing (in comparison) digital transformation, this threatens to create an A and B team regarding digital accessibility. With the rural small municipalities being under heavy duress through ever-decreasing populations (i.e., tax revenues) coupled with (in Sweden) large physical distances, digital transformation offers a solution where digital service alternatives to physical services would be even more relevant than in the metropolitan areas, see Menz, Kunisch, Birkinshaw, Collis, Foss, Hoskisson and Prescott [15]. The comparative under-utilization of digital in these municipalities is a significant cause for concern that we will return to in the Discussion.

Utilizing the same demographic variables but focusing on the direction of the digital transformation strategies, the analysis identifies only minor differences between the types of municipalities in all variables but size.

In terms of financial stature (Figure 6), we see a minor difference between municipalities running a deficit being less (4 pp) focused on external stakeholders and more focused (2 pp) on innovation than municipalities running a surplus. In other words, the impact of financial stature on the direction of digital transformation strategy is deemed as low.

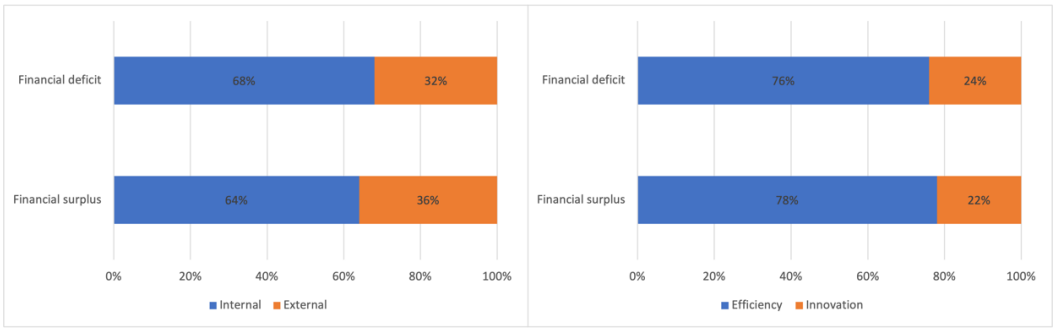


Figure 6: Direction of digital transformation strategy, Financial stature.

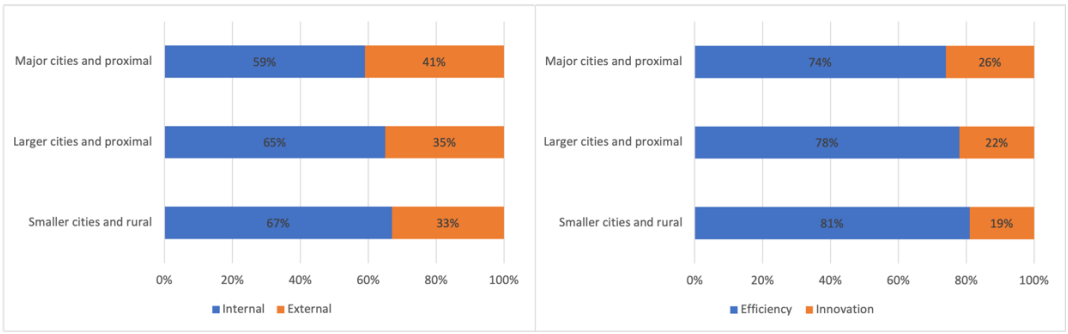


Figure 7: Direction of digital transformation strategy, Size.

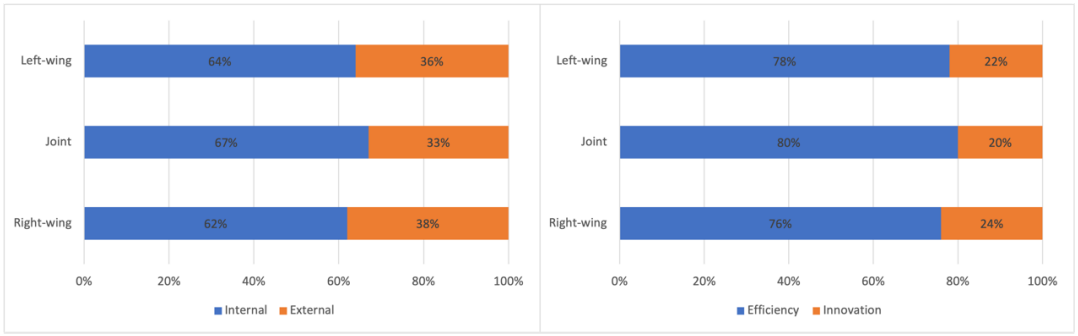


Figure 8: Direction of digital transformation strategy, Political majority.

In terms of size and geographic positioning (Figure 7), we see municipalities in the form of smaller cities and rural being less (8 pp) focused on external stakeholders and less (7 pp) focused on innovation than major cities. Given the gradual increase of an emphasis on external and innovation dependent on size, this is indicative of a relationship valid for additional studies.

In terms of political majority (Figure 8), we see left-wing majority-controlled municipalities less focused (2 pp) on external stakeholders and less focused on innovation (2 pp) than right-wing majority-controlled municipalities. At the same time, we see that municipalities with joint political control as having the least focus on external stakeholders and innovation. In other words, the political majority seems to have but minor impact on the direction of digital transformation strategies in municipalities.

5 DISCUSSION AND CONCLUSION

As found in the results, the primary digital transformation strategy of Swedish municipalities is directed toward internal efficiency. The patterns identified in terms of directions for strategies in different municipalities are all weak in descriptive power, whereby the primary interpretation is along the lines of Warner and Wäger [30], where digital transformation is not sufficiently differentiated from the implementation of information technology. As a consequence, digitalization is found to be regarded as value-neutral, i.e.

a matter of implementation or not, rather than how and what is actually implemented. In Magnusson, Elliot and Hagberg [31], this is indicative of an organization that has decoupled digital from its strategic intent. Digital is merely subjugated into a functional strategy, co-opted by the primary objectives of increased operational efficiency [15]. Digital decoupling in the case of municipalities has two consequences that we will address further below.

First, decoupling of digital transformation has consequences for the very fabric of democracy in municipalities. As local governments with local elections appoint representatives for the voters to govern operations, the democratic process is foundational for the municipality. Elected officials are tasked with making sure that the interests of their constituents are taken into account in setting the strategic intent of the municipality [17].

Through decoupling digital transformation, perceiving it as value-neutral, politicians retreat from issues related to how digital transformation should be directed in the municipality (for a tangent to this, see Nielsen and Moynihan [32]). With the ideal-societies of the parties represented in the municipality board differing (e.g. right-wing ideas of libertarianism vs left-wing ideas of a strong welfare-state), digital decoupling creates a situation where choices in direction are either not given sufficient room for discussion or simply handed over to public servants. We regard this tendency, supported by our data and analysis, as in essence constituting a threat to democracy. The present state in Sweden is one where there are no differences in directions of digital transformation between left- and right-wing majority municipalities. In other words, the ideological foundation in the representatives elected to lead does not impact how digital transformation is used to change the operations of the municipality. There is, according to our findings, no impact of political control on the direction of digital transformation strategies.

This also explains the differences between the relative lower use of digital* in the steering documents of left vs right-wing majorities. With digital transformation perceived as value-neutral and equated with decreased cost and increased internal efficiency, this is more in line with the libertarian perspective of an ideal-state. Left-wing majority governed municipalities hence have lower perceived "use" for digital transformation, since it is regarded as merely a means for decreasing cost. This can also explain the lower use in municipalities with financial deficits since the transformation per se is associated with substantial investments that may not be perceived as possible.

Second, digital decoupling of digital transformation has consequences for the equal access to digital welfare between the municipalities. As found in the results, digital is under-represented and sub-utilized in small, rural municipalities with financial deficits. The consequence of this is that we expect to see increasing differences between the citizens access to digital welfare in smaller, rural municipalities that already suffer from a depleting of access to physical welfare infrastructure. At present, 1,7 out of 10,2 Million citizens live in municipalities that either not address digitalization at all in their top steering documents (0,6 Million) or have a digital transformation strategy completely focused on internal efficiency (1,1 Million).

Through not amply utilizing the opportunities associated with digital welfare, we see increasing differences in equal access to welfare (as legally regulated in Sweden) on the horizon. Given the challenges associated with demographics (increased demand vs supply) and competence (projected increased shortages of access to personnel), this development poses an existential threat to both the smaller municipalities as well as the current idea of geographically independent equality in Sweden. This perspective to the digital divide is under-represented in literature where the main emphasis has been on the individual/group level in terms of access to infrastructure and competence [37]. As we see in our findings however, the municipal setting and strategic intent associated with digital transformation is a factor that should receive increased attention. This holds particularly true given an evolutionary perspective where the current direction of digital transformation strategies in municipalities will have long-standing impacts. Equal access to digital welfare may not so much be a question of technological access, but rather the design- and prioritization choices associated with digital initiatives within the public sector.

This study has four implications for research. First, our categorization of the direction of digital transformation strategies offer inspiration to future studies within the public sector. The conceptual model, grounded in eGovernment and Information Systems research is regarded as a contribution that we hope will be further utilized in research on digital transformation. Second, the methodology of targeting steering documents and searching for concrete goal setting and resource allocation follows the recommendations of Menz, Kunisch, Birkinshaw, Collis, Foss, Hoskisson and Prescott [15] in new approaches to studies of corporate strategies and digital transformation. Here, we see a methodological contribution that will allow for future studies of strategy-as-practice within the public sector. Third, the notion of digital decoupling, as identified in this study may inform future studies through identifying an empirical phenomenon that requires additional effort from the research community. Previous research is clear in highlighting the detrimental effects of said decoupling, yet few studies have looked at this within digital transformation per se. Forth, our findings associated with the unequal access to digital welfare may inform future studies of the digital divide. Future studies should include strategic factors of the deliverers of welfare services into account when studying the digital divide.

This study has two implications for practice. First, there is a necessity for organizations to recouple digital transformation with political rule. To achieve this, we hope that our study may inspire organizations to think about the direction of their digital transformation strategy, so as not to make the mistake of seeing it as value neutral. For the Swedish municipalities of this study, we have created a digital service where they can see their own current direction [38] and use this as a litmus test for if it is aligned with the democratically comprised governing body and acquire inspiration as to how their strategic intent should be formulated to be aligned with the desires of their constituents. Second, practitioners should be aware of the agnostic nature of the direction of digital transformation strategies. There is no inherent value of either efficiency nor innovation, and practitioners should be careful not to fall into either competency- or failure traps [39].

This study has one implication for policy. With the pattern of increasing unequal access to digital welfare as identified in this study, there is a need for counteractive policy action. We hope that our study may inspire data-driven policy development where new

policies may be designed to counteract the digital decoupling and assure equal access to digital welfare on the national level.

5.1 Conclusion

This study has set out to contribute to research through answering the research question of how digital transformation strategies are directed in municipalities. According to the findings, the dominant direction of digital transformation strategies in the population of Swedish municipalities is one focused on internal value and efficiency activities. In other words, the study finds that digital transformation strategies are directed toward improving existing internal operations rather than expanding the scope of value offering toward the citizens. This utilization of digital transformation is sub-par and constitutes a potential risk for the municipality's sustainable relevance to its citizens. Further, the study finds that goals and resource allocation associated with digitalization is predominantly expressed in major cities, in municipalities with a financial surplus and in right-wing political majority municipalities. Regarding the direction of digital transformation, we find that size and geographic position is the major factor influencing how much external innovation focus the digital transformation strategy has. This is discussed through the lens of digital decoupling, where decoupling of digital from the operations of the municipality and its political governance may result in risks for the democratic foundation of the municipalities as well as the equal access to digital welfare services nation-wide.

We identify three major limitations in our work. First, the results presented in this paper are descriptive and do not utilize statistical methods for establishing the strengths of the patterns identified. There is a plethora of additional analyses that we can continue with such as regression analysis. Second, the selection of top-level steering documents does not consider the (potential) explicit and formalized digital transformation strategies present in the municipalities. Following Chanias, Myers and Hess [6], we have worked under the assumption that strategy is best studied through activities, i.e., allocated resources rather than merely expressed intentions. The majority of explicit digital transformation strategies that we have reviewed suffer from not amply allocating resources, whereby they become meaningless as data for a study of strategy-as-practice. Third, given that the empirical selection targets solely Sweden, the study is subject to the limitations as presented by Bannister [33] in that the transferability is contingent on the institutional environment in Sweden.

We identify three direct avenues for future research stemming from our study. First, with our results being solely descriptive, additional analysis is required to ascertain the strengths of the patterns. We will continue with regression analysis, searching for combination of contingency factors that may explain what influences the direction of digital transformation strategies in municipalities. Second, we will expand the empirical focus, including central and regional government with the same method to be able to compare between sub-sectors within the public sector. Here, replication of the study in other institutional environments and countries would also be an option for empirical expansion. Third, we see the longitudinal perspective as particularly interesting from an institutional drift perspective [34]. One interpretation of the heavy tilt toward internal efficiency as identified in the results may be a consequence of mirroring of ideas associated with New Public Management [35, 36]. From this perspective, a future study could track shifts in directions in digital transformation strategies and use this as a basis for understanding institutional drift in the public sector.

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Understanding Citizen Actions in Public Encounters

Towards a Multi-Channel Process Model

Ida Lindgren
Information Systems and Digitalization, Department of Management and Engineering, Linköping University
ida.lindgren@liu.se

Christian Østergaard Madsen
Research Centre for Government IT, Computer Science Department, IT University of Copenhagen
chrm@itu.dk

ABSTRACT

This paper presents ongoing research that is part of a larger engaged research project which aims to investigate what public services are suitable for digitalization. The aim of our paper is twofold. First, we explore and describe citizens' core actions in their interaction with public organizations during application for public benefits. We develop a generic process model for how this interaction can be captured empirically. The model is based on a review of previous studies from e.g., channel choice, multi-channel management, and service management, and provides a holistic view of the core actions in public service delivery as seen from the perspective of the citizen. Second, we add a channel behavior dimension to this model to create a service blueprint template that can be used to capture and analyze citizens' multichannel behavior related to benefit application. Hereby we contribute to the digital government field with a research methodology for investigation of citizens' continuous channel behavior during public service encounters.

CCS CONCEPTS

• **Social and professional topics**; • **Professional topics**; • **Management of computing and information systems**;

KEYWORDS

Public Service, Citizen Perspective, Co-Production, Channel-Choice, Process Model

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1 INTRODUCTION

Public organizations increasingly seek to digitalize their services and past decades have given us many examples of how difficult this task is. The initial technological enthusiasm which informed early policy documents and academic studies on public digitalization has since been met with sobering empirical evidence [1, 2]. While many citizens have adopted digital channels, as part of their public encounters, they hold on to traditional channels as well, especially when problems occur and when people perceive the service in question as important [3, 4]. To improve the service provision, we must understand public service encounters from the perspective of citizens.

Within the digital government and public administration fields, several studies have contributed relevant knowledge for our understanding of the digital provision of public services. For example, [5] argue that public services are different from services offered by the private sector, and consequently requires its own form of management with a service dominant approach focused on co-production [5]. Another important contribution comes from adoption studies, which are grounded in frameworks such as TAM (the Technology Adoption Model) and DOI (Diffusion of Innovations) [6–8]. These latter studies mostly apply a quantitative approach and variance models to measure the factors which influence people's intention to use a technology. They have contributed to our knowledge of technology adoption by explaining how people's perceptions of a technology's usefulness and ease of use influence the intention to use the technology. However, as they are grounded in variance models, they focus on the single point in time where people decide to use a digital service or reject it. This is a limited part of the overall process where citizens encounter and interact with public organizations.

Previous studies on citizens' interaction with public organizations show that citizens' digital public encounters may consist of numerous steps and actions [9], and can occur across both traditional and digital communication channels [3, 10, 11]. These studies have contributed with important knowledge on selected aspects of government-to-citizen interaction and how it can be managed. However, we are unaware of any detailed frameworks that illustrate and help capture an entire application process for public benefits from the perspective of citizens.

1.1 Research purpose and questions

The aim of our paper is twofold. First, we explore and describe citizens' core activities in the interaction with public organizations during benefit application. Next, we investigate and suggest how this interaction can be captured in empirical studies. We are guided by the following research questions:

- RQ1: What are the core citizen actions in their interaction with public organizations during application for public benefits?
- RQ2: How can the interaction between citizens and government organizations be captured and analyzed, from the citizen perspective?



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This study is important in several ways. We offer a conceptual contribution to the digital government and public administrative fields by exploring and illustrating how the process of applying for public benefit can play out in its entirety from a citizen perspective. Following Blaike [12], "good description is a vital part of social research" (p. 60), and fundamental for further theoretical development and practical problem solving [12]. Further, we offer a contribution to research practice by illustrating how our proposed process model can be applied in empirical studies to capture and analyze aspects of citizen-government-interaction.

This paper is structured as follows. Section 2 presents our research approach. Section 3 presents previous research to inform and position our study and highlight the gaps we seek to address. Section 4 presents our findings and the process model, while section 5 applies and discusses the model in relation to service blueprinting and channel behavior, as well as a fictional case. Finally, section 6 presents our conclusion, limitations, and suggestions for future studies.

2 RESEARCH APPROACH

Our study is part of a larger engaged research project which aims to investigate what public services are suitable for digitalization [13]. Following Mathiassen's classification [14], we regard this study as a research methodology investigation, with an "emphasis on developing new or revised research methods" (p. 19). In a follow-up study, we aim to apply the method developed here to generate empirical knowledge on citizens' multichannel behavior for several different public benefit schemes.

As indicated in the introduction, the aim of our study is twofold. We begin by exploring and describing citizens' core activities in their interaction with public organizations during benefit application. We present a process model for these activities in Section 4. This model is based on our own extensive empirical studies of citizen-government interactions and synthesis of the digital government literature. A simpler version has been used to analyze how digitalization of public services affects citizens' experiences of administrative burdens [9]. We integrate this model with previous studies [15, 16] and expand it further. To answer our first research question, and inspired by service blueprinting, we have focused on the user perspective, i.e., the citizen actions in the process. Furthermore, based on principles of good theory [17], we have strived to make the model parsimonious, i.e., including as few assumptions, variables, and relationships as possible. Thus, we have strived to identify a set of discrete activities in the process – where each activity in the process model is unique – and outline the basic relationships between these activities. Put together, these activities create a holistic process that is generic enough to apply to most public benefit application processes. While we do not claim that our process model is unique, we have been unable to find a model that fits our research purposes in the literature.

To address the second research question, each activity in the process model is unpacked based on previous work and literature. Our analysis and discussion are guided by our previous work and a hermeneutic literature review [18] covering previous work on channel choice; multi-channel management; service management; public administration; sociotechnical systems; and digital government. As indicated in our research questions, we are interested in discovering and describing patterns of social processes. In Section 5, we proceed to present a template, inspired by service blueprinting [19, 20] that can be used to capture the user's activities and channel behavior throughout the process. In our future work, we intend to complement this analysis with empirical data of citizens' applications for public benefits from an ongoing research project [13].

We perceive the work presented here as an important step towards gaining deeper knowledge on citizens' co-production of public services in a digital era and as a way of contributing to the continuous evolution of digital government research.

3 PREVIOUS RESEARCH

In line with the public service-dominant approach [5, 21] we understand public services as complex service systems that include human, organizational, and technical elements and processes [22]. This view implies that "the production of a service is dependent upon and is a product of a complex series of, often iterative interactions, between the service user, the service organization and its managers and staff, the physical environment of the service, other organizations and staff supporting the service process, and the broader societal locus of the service" [22] (p. 406). Public services must therefore be seen from a multi-actor and multi-level perspective to understand the system architecture and the institutional arrangements that underpin citizens' service experiences [23].

3.1 Co-production of public services

At the heart of the public service-dominant approach to public services lies the understanding that the citizen, as a service user, is a shaper, co-producer, and evaluator of the service [22]. The service is co-produced [24] by supplier and citizen as their respective resources are used and combined, putting emphasis on the iterative interaction between supplier and user. To utilize the service offered, the citizen must add necessary knowledge, skills, and resources. If the citizen fails to do so, the service process is negatively affected, and less value will be created. Osborne et al. [5] stress that "coproduction becomes an inalienable component of public services delivery that places the experiences and knowledge of the service user at the heart of effective public service design and delivery" (p.146). Nevertheless, the service supplier and its professionals maintain control of such co-production by structuring the opportunities and mechanisms through which it takes place [25].

Because of the above, designing public services becomes a question of facilitating the citizens' actions throughout the service process. The service supplier must provide opportunities for citizens to successfully co-produce public service. The need for the service supplier to be engaged in the citizens' practices inevitably vary across different public services; hence, co-production is seen as a continuum, rather than a steady state. In 2013, Osborne et al. used digital services as an example that involves less co-production; and wrote that digital public services "do not have the interpersonal immediacy of face-to-face contact between the service provider and the service user. Yet even such services do still exhibit coproduction from a services management perspective – even if the coproduction

of such 'e-services' is essentially minimal and passive (inputting financial data on yourself or choosing from a list of preset options)" [5]. Today, digital services have evolved to involve more coproduction on the behalf of the citizen. With current digital solutions (year 2022), digital services no longer merely involve 'minimal and passive' co-production. Recent research illustrates how digital self-service puts higher demands on citizens' co-production of the service [9]. Self-services shift tasks from public servants to citizens. Therefore, citizens must have knowledge about public services and administrative routines [26]. Citizens who lack this knowledge often seek help through other channels, which generate additional costs for the public organization supplying the service.

The channel choice (CC) and multichannel management (MCM) branches of digital government research focus on citizens' multichannel behavior (channel choice, use and evaluation) and how public organizations can orchestrate and manage interactions that occur across multiple analogue and digital channels [3, 27]. These studies have contributed important knowledge towards our understanding of citizens' interaction with public organizations. For example, they provide us with a useful classification of the various communication channels available for citizen-government interactions. However, recent research shows that while citizens have generally adopted digital channels, they still turn to traditional channels when problems occur, or when something important is at stake [3]. Finally, while these studies have explored how citizen interaction may occur and have presented exemplary user journeys, they have not provided mappings or illustrations which cover an entire application process holistically.

We see a gap in the literature and in the general understanding of public services, concerning how citizens continuously co-produce these service encounters by their choices of communication channels with public organizations. Based on our previous research on digitalization of public services [28], citizens' digital encounters with the public sector [9, 29] and multi-channel behavior [10, 30, 31], we see a need for combining insights from research on digital government, channel choice, and service management to gain new perspectives on how to investigate the citizens' perceptions of the interaction process and possibilities to co-produce the service in an efficient manner. As described by Osborne [21], service users "expect effectiveness as a necessary condition of services delivery – but invariably judge their satisfaction upon the basis of process issues" (p. 4). In this study, we wish to contribute to the further understanding of the citizens' journey through the service process.

3.2 Service design and blueprinting

With increased degree of digitalization of elements of the service process, digital technology plays an increasingly important role in the service system, and it is becoming apparent that public service systems can also be perceived as sociotechnical systems. Therefore, we can learn from classic sociotechnical design when discussing the design of public services. As a sociotechnical system, the public service system is composed by various social- and/or technical parts and elements that are intertwined and interdependent (cf. [32]). Some interdependencies may not be apparent during system design but only become visible when the system is in operation. For example, flaws in the design of an online form can lead to an increase in telephone calls [10]. Therefore, the system supplier should trace through possible impacts of design choices, across a broad range of system performance characteristics [33]. This highlights that the public service system is designed and must continuously be re-designed, based on continuous evaluation (cf. [34]). Key design choices include how the overall system will operate, how the work will be managed and organized, what form of technology will be required to support this work, and what other organizational systems are required [33]. In our setting, this includes the design of the various communication and interaction channels and their content.

Design choices are typically made by multiple stakeholders with various roles in relation to the system. These stakeholders may not be aware of their role as system designers; challenging the idea of the stereotypical system designer 'mastermind'. Also, understanding the user is central [33]; for a public service system to be useful, it must meet the needs of both the supplying organization and its users [35]. Here, we focus on the public organization supplying public benefit as the supplier and main designer of the system, and citizens as the main users of the system. According to the sociotechnical design tradition, the users of the system should furthermore be involved in its design [33]. This is however difficult to achieve for such a large and heterogeneous user group as 'citizens'; it is simply challenging for suppliers to involve a representative sample of users of public service systems and meet all possible and differing needs and demands [28, 35]. In addition to initial user-centric design methods when designing the service system, it is therefore important to find evaluation methods that allow for input from users to affect the continuous re-design and evolution of the system. This challenges public organizations to be context sensitive when designing public service systems and spurs a need for generic, yet scalable and adjustable, models and methods for designing and evaluating public service systems.

A service can be designed and continuously evaluated and developed in many ways. One technique that has gained increased attention is service blueprinting [19, 20]. Service blueprinting can be used to visualize the process of service delivery in a way that highlights the role(s) and relationship(s) of the service user within the service delivery system. Radnor et al. [22] suggest that service blueprinting can be used to better understand service systems and to illustrate the role of co-production in service delivery. Service blueprinting typically involves five main components [19]:

- user actions, at different stages of the service process, including their timing and relationship to other actions;
- the evidence and artefacts of service delivery;
- the 'front stage' of the service system, including its participants and actions;
- the 'back stage' of the service system, including its participants and actions; and,
- the support systems, actors, and processes required to enable the successful functioning of the service system itself.

This technique can facilitate a holistic view of the service, rather than focusing on discrete elements that make up the service [22]. However, given our interest in identifying the core citizen activities

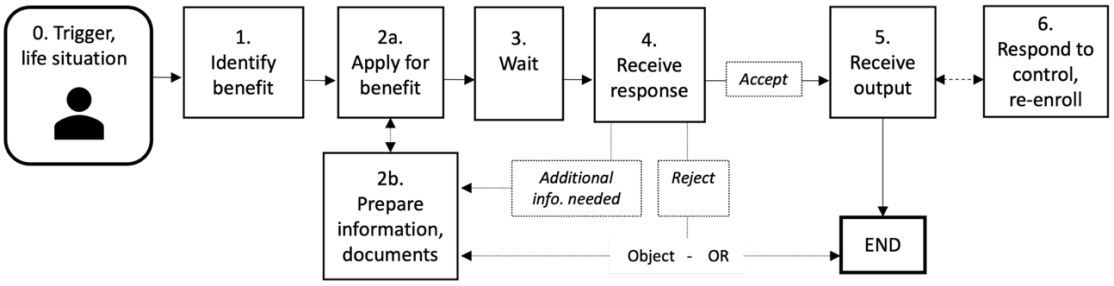


Figure 1: A generic model of the citizen's actions in the application process for public benefit

in the interaction between citizens and public organizations, we will focus on the first of these five components.

4 INTRODUCING A GENERIC MODEL OF CORE CITIZEN ACTIONS

In this section, we present a generic process model for understanding the user actions in public benefit application processes from the perspective of the citizen. This model, presented in figure 1, serves as an answer to our first research question: What are the core citizen actions in their interaction with public organizations during application for public benefits?

In the model, we make an important conceptual distinction between the service delivery process and the benefit application process. The first, service delivery process, refers to the overall public service as interpreted, designed, and delivered by a public authority. The second, benefit application process, refers to the part of the service delivery process that the citizen is actively involved in and hence co-produces. We furthermore use the term benefit, as this denotes what the citizen applies for, i.e., the output of the process in terms of some service or good that is intended to improve the life situation of the citizen, e.g., pension, parental leave, social security benefit, disability benefits/tools. Thus, our process model concerns the benefit applications process (i.e., the part of public service delivery that the citizen co-produces through its actions), where the benefit is the output of the process. In some cases, some other person is undergoing the process in the citizens' stead, e.g., a legal guardian, a next-of-kin [36], or a public official; it is therefore important to note that we focus on benefit application processes where the citizen in need of the benefit is also the one undergoing the process.

We use a generic process model for breaking down the benefit application process into a set of actions. Other scholars have also presented generic process models for understanding the various actions, or steps, in the process. For example, Scholta, and colleagues, present a model comprised of three general steps – preparation, application, and result – that, in turn, are unpacked into several subtasks and for each step, the citizen chooses a communication channel [15]. Similarly, Luna-Reyes, and colleagues, present a process including five stages; information search, form preparation, submitting forms and get a receipt, payment, and getting the results [16]. However, based on our previous research on this topic [9], we lacked steps in the process that deals with the *trigger* of the interaction. Furthermore, we also lacked the stage when the citizen is waiting for the result of the application process; during this time, many calls are made to make inquiries on the status of the application. Lastly, many benefit application processes feed into new application processes; hence, we saw a need to include a step at the end of the process related to control and re-enrolment. For many social services in the Scandinavian countries, citizens need to apply for services repeatedly. As such, our model is more holistic and elaborate, as it includes more steps throughout the process. In contrast to the model by Luna-Reyes et al., our process model does not include a payment step [16]. This is typical for the Scandinavian context; provision of public welfare service and benefit is typically tax funded and rarely involves payment on behalf of the citizen (although there are some exceptions).

Trigger and life situation. The need to apply for a public benefit is typically triggered by some change in the citizen's life situation. Roughly, the trigger of the process can be of different type and origin. These can be foreseeable events (e.g., coming of legal age, childbirth, pension) or more unforeseeable life events (e.g., death in the family, sickness, disability, unemployment, moving state, divorce). The trigger determines what benefits are relevant for the citizen. Personal factors, such as demographic and socio-economic factors, but also health-related factors [37], are also known to affect citizens' ability to understand the benefit application process [38], and in turn affect citizens' choice of communication channels when interacting with government organizations [39, 40]. The situation/trigger and the citizen's personal factors are likely to interact, e.g., a citizen who is suffering from sudden health issues is likely to be stressed by the situation. Increased stress levels may decrease the citizen's ability to fulfil the activities in the service process and can thus exacerbate vulnerable citizens' life situation [37].

Identify benefits and finding out about the benefit application process (action 1). The citizen's first task is to uncover what benefits the situation merits, the official names of the benefits, and which authorities are responsible for administering them. Part of this task is also to unveil the eligibility criteria for getting access to the benefit [26]. Some public benefits involve universal eligibility criteria, whereas others are means-tested; where means-tested eligibility criteria can be more difficult for the citizen to interpret and understand [41]. The task of identifying benefits and finding out about the benefit application process can be achieved through various channels, e.g., on the authority's website or e-service, through searching the web, through a personal meeting with a public official,

through (physical) information material, telephone, personal connections (e.g., friends and family), non-government organizations, and so on.

Apply for benefits (action 2a,b). The second activity covers the citizen's actual application for the benefit [9, 31]. The application process differs considerably for various benefits, and can be mediated through different channels, e.g., the authority's digital service, personal meeting with a public official, on paper forms that are handed in or sent by mail, through telephone, through a legal guardian, and more. The application includes submitting and endorsing personal information and related documentation. In some cases, all necessary information is already available to the public authority or can easily be submitted by the citizen. In other cases, the citizen must **prepare (2b)** and transmit documentation, e.g., medical certificates, receipts, salary statements, lease agreements, and additional materials. The preparation activities can require a lot of work for the citizen [38] and can also induce stress that negatively affects the citizen's ability to complete the process [37].

Wait for an administrative response (action 3). After the application is submitted, the citizen must await a response. The time the citizen needs to wait can be anything from minutes, to months, depending on the underlying administrative procedures and degree of automation [9, 31]. The citizen often does not have to take further action unless something goes wrong. If a caseworker discovers that the information is incorrect or incomplete, they can ask the citizen to submit additional details. The citizen can be requested to complement the application by preparing and submitting new information (action 2b).

Receive a response (action 4). The application process can result in three possible outcomes: the benefit can be accepted; the application rejected; or the citizen can be asked to complement the application with additional information. The response can be received in different formats and channels, and often require that the citizen must interpret and understand bureaucratic language and terminology [26]. If the citizen is still eligible for a benefit, they may re-apply if their application is rejected. The citizen may also object the rejection. If the citizen chooses to object, this starts a different process (not fully covered here), in which the citizen must prepare information and documentation and possibly re-apply for the service. The objection can be either accepted or rejected. If the citizen accepts the rejection, the process ends.

Output (action 5). If the application is approved, the citizen is entitled the benefit and will receive an output of the process. The output can take different shapes, e.g., payment, permission, service (e.g., personal assistance, free transport), or an artefact (e.g., wheelchair, safety alarm). For some of these outputs, the citizen does not need to take further action and the process ends. For re-occurring outputs, the process may however include a control mechanism (next activity).

Respond to control mechanisms and re-enrollment (action 6). Activities 1-5 concern the entry-process, the enrollment that the citizen needs to go through to receive a public benefit. Once the citizen is 'in', the process may continue. For long-term benefits with continuous output, there may be control mechanisms. For some services, re-enrollment is required with some regularity, such as if the conditions of the citizen changes [31], e.g., in the event of a salary increase or if they move in with a new partner, this may affect their entitlement to benefits or alter the amount they receive. Therefore, the citizen must report any changed circumstances to the authorities. At some point in time, either based on the nature of the benefit, or upon the suppliers' or citizen's request, the service process ends.

The activities in the model are presented sequentially, this order is likely to be followed for simpler services. However, more complicated service interactions are likely to be iterative; especially when control mechanisms and re-enrollment are present.

5 CAPTURING AND ANALYZING CITIZENS' CHANNEL BEHAVIOR

The process model above is simplified to reduce complexity. We now turn our attention to the second research question: How can the interaction between citizens and government organizations be captured and analyzed, from the citizen perspective? For several activities, the information elicitation and interaction between the citizen and the public authority can be mediated through various information and interaction channels [30, 42], e.g., see examples in figure 2 below.

Typically, the citizen must make an active choice concerning what channel they want to use to find information and interact with the public authority. This is thoroughly addressed in the channel choice literature and in literature on citizens' uptake of e-government services. However, previous studies have typically focused on the interaction taking place in the apply step (activity 2 in our model). Furthermore, it is often implied that these choices are consciously and rationally made by the citizen. What we want to show is that channel choices are made repeatedly during throughout the process. The choice is also likely to be made based on a perception of ease, but not necessarily a conscious choice. Previous research has shown that citizens' CC behavior is initially habitual. Only when people encounter problems, do they evaluate their options [43].

Let us illustrate with a fictional example (figure 3). A citizen has separated and become a single parent; this life situation triggers a need for additional income. Through a meeting with a social worker, the citizen is advised to apply for social benefits through the municipality self-service (1). The citizen goes home and finds the self-service online (2) and starts an application (3). When trying to fill in the required information, the citizen runs into problems understanding what documentation is needed for the application. To resolve this problem, the citizen makes a telephone call to the municipality call center (4) and talks to an employee at the call center. During the phone call, the issues are resolved, and the citizen can thereafter prepare the required documents and attach these to the application (5). The citizen then submits the application (6) and waits for a response. After some time has passed, without reply, the citizen becomes worried that something has gone wrong. The citizen calls the social worker to ask about the status of the errand (7) and is informed that a response will come shortly. After yet some time, the citizen finds an approval response in the self-service system (8) and after more time, an approval letter arrives in the post (9). Thereafter, the citizen receives payment to their bank account and finds a receipt in the self-service system (10). Also, the status of the application/errand in the system has changed to 'closed' (11).

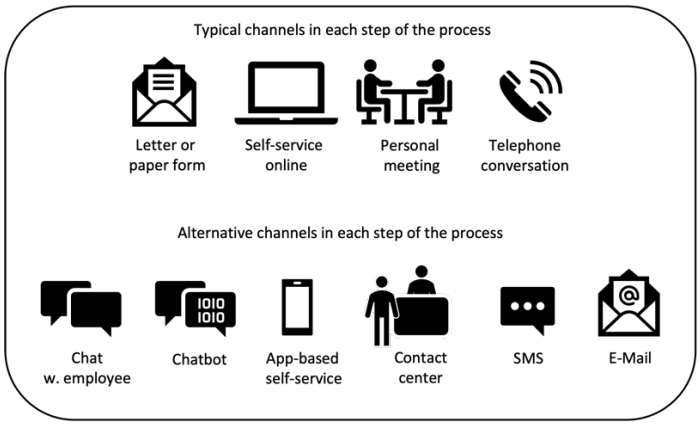


Figure 2: Typical, and alternative, communication and interaction channels available in the service process.

Citizen applying for social benefit

Trigger and life situation: Sudden separation from partner triggers need for additional income

	1 Identify benefits	2a Apply for benefits	2b Prepare information, documentation	3 Wait for response	4 Receive response	5 Receive output	6 Respond to control, re-enroll	END
Self-service online	2. Finds self-service online	3. Starts application 6. Submits application	5. Prepares digital documents		8. Receives approval	10. Receives payment to bank account and receipt		11. Errand status indicated as 'closed'
Telephone conversation		4. Asks for help to interpret what is required		7. Asks about status of errand				
Personal meeting	1. Social worker advises to apply through self-service							
Letter or paper form					9. Receives approval (letter format)			

Figure 3: Overview of citizens' possible multi-channel behavior in the application process for social benefits.

How the citizen moves across these actions, and what communication channels the citizen uses, is likely to vary substantially across different kinds of benefit application processes. Also, different citizens will use different channels for communication when moving through the 'same' benefit application process. However, although individual patterns will look differently, general patterns are likely to evolve for particular services if the citizens' interactions are captured using service blueprints like the one presented in Figure 3. The important take-away message is also that, for a particular service, the process can be completely manual and paper-based, it can be fully digital, but it can also be played out in multiple channels simultaneously as the citizen moves from action to action in the process. Furthermore, due to use and integration of digital systems, some activities might be automated and therefore 'invisible' for the citizen. Such invisible activities, such as automated application for benefits and data transfer may result in interesting patterns, e.g., the citizen might be asked to perform actions for benefits they have not personally applied for.

6 CONCLUSIONS AND FUTURE WORK

The intended contribution of this work is twofold. First, we present a conceptual contribution; a stepwise process model that depicts each action a citizen must perform to apply for public benefits. The model provides a holistic view of the benefit application process; i.e., the part of the public service delivery process that is seen and co-produced by the citizen. Second, we present a methodological contribution; a service blueprint template that can be used to capture and analyze citizens' channel behavior during benefit application. The service blueprint thus captures how the citizen co-produces the service delivery process through its interactions

with various communication and interaction channels (provided by the public organization designing and delivering the public service). Our work hence presents a step on the way of furthering our understanding of how citizens co-produce public service delivery through their channel behavior throughout the various steps of the benefit application process.

The process model and service blueprint can aid empirical studies and theory development for digital government research. If the process model is applied in combination with e.g., CC or MCM theory, it can illuminate citizens' multichannel behavior, the channels used and problems citizen face in an application process, and how citizens contribute to co-production of public services through the use of digital self-service applications.

For practitioners, the process model and blueprint template can be used as diagnostic tools during design and testing of service delivery to ensure that the entire process is covered, and to investigate bottlenecks and problem areas in service delivery.

Public service design cannot solely take a user-centric approach. It must adopt a multi-actor and multi-level approach to fully capture the system architecture and institutional arrangement underpinning user experiences [23]. However, in this paper, we have focused on the citizen perspective and the user actions of the citizens in the public service process. This is only a limited part of the entire service process. In our continued work, we intend to expand this work by including the front-stage part and support systems in this process. Finally, we intend to validate and modify the process model across multiple different public services.

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Applying User-Centered Design on Digital Transformation of Public Services: A Case Study in Brazil

Glauco Pedrosa
glauco.pedrosa@unb.br
University of Brasilia (UnB)
Brasilia, Federal District, Brazil

Marcelo Judice
marcelo.judice@unb.br
University of Brasilia (UnB)
Brasilia, Federal District, Brazil

Andrea Judice
andrea.judice@unb.br
University of Brasilia (UnB)
Brasilia, Federal District, Brazil

Leonardo Araujo
lfartedesign@gmail.com
Centro Universitário do Distrito Federal (UDF)
Brasilia, Federal District, Brazil

Fabiola Fleury
fabiola.mfleury@gmail.com
University of Brasilia (UnB)
Brasilia, Federal District, Brazil

Rejane Figueiredo
rejanecosta@unb.br
University of Brasilia (UnB)
Brasilia, Federal District, Brazil

ABSTRACT

This paper presents a case study of digital transformation in the public sector considering the participation of citizens on the identification and proposal of solutions. We conducted participatory design workshops applying ethnography and design thinking to conceive ideas and solutions to increase the availability of a specific Brazilian public service and guide its transformation. This paper highlights the importance of applying User-Centered Design as a key part on digital transformation of public services. The results indicated that this kind of approach not only motivates citizens to be committed and more active during the process of digital transformation, but also raises the citizens' awareness. Also, it provides recommendations to reduce the costs, time of interaction and use of redundant resources, improving the management of public policies, facilitating the decision-making process, and aiming at the well-being of citizens. In fact, User-Centered Design ensures that technology investments will meet user needs and usability standards, resulting in higher user engagement, greater system efficiency, and more satisfied citizens.

CCS CONCEPTS

• **Human-centered computing** → *Interaction design theory, concepts and paradigms.*

KEYWORDS

Digital Transformation, User-Centered Design, Citizen Engagement, Public Services, E-Government

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1 INTRODUCTION

The popularization of Information and Communication Technologies (ICT) has produced significant changes in the provision of public services. Considerable effort is being made by governments to adapt and incorporate new technologies to digitalize their services. However, these changes cannot be limited to the perspectives of the providers [20]; otherwise, citizens will remain discontent with the government's capacity to provide services [1, 25]. Citizens also play an important role in these changes towards a digital environment, encouraging the implementation of effective digital services in the e-government context [21].

E-government initiatives must be concerned with re-designing and re-evaluating the purpose of service delivery [6, 9]. In Brazil, the government has conducted several studies and has generated reports on the challenges and gaps that need to be addressed to help public organizations digitize their services, bringing them closer to citizens [8]. To this end, technological tools have been developed that can be adapted to the wishes and needs of the population and the government sectors involved.

The digitization of public services in Brazil, as in other developing countries, is affected by factors that increase the complexity of the digitalization project and its execution, such as social inequality, population ageing, high unemployment rate, and bureaucracy. To mitigate these factors, an effective approach is to include the citizens in the digitalization process. In fact, bringing citizens, as well as their needs and desires, to the spotlight when talking about e-government can improve the effectiveness of the public service and the democratic legitimacy of the government [18]. The citizen innovation is a new innovation paradigm that focuses on citizens' unique role as innovators, provinding an integrated framework that emphasizes both the "voice" and "duties" of individual participation in innovative activities [4].

However, some questions arise when including the citizen in the digitization process of public services:

- Are the users aware of the impacts and implications of the digitization of services?

- Do users of public services understand how they can contribute to the digital transformation process?
- Are public service users willing to participate and be involved in designing an effective digital service?

Answering these questions can contribute toward demonstrating that User-Centered Design (UCD) techniques are worth considering in the new paradigm of e-government. In this sense, we conducted a case study with UCD techniques, particularly ethnography and design thinking. The main goal was to conceive ideas and solutions to increase the availability of a specific Brazilian public service and guide its transformation.

This paper reports the case study on the digital transformation experience of Call-100, a public utility service of the Ministry of Women, Family and Human Rights, which receives demands related to human rights violations, especially those affecting the following populations: children and adolescents, the elderly, people with disabilities, the LGBT public, homeless people, quilombolas, gypsies, indigenous people, and persons deprived of liberty. Also, the service provides information on human rights and guidance about actions, programs, campaigns and services, protection, defense and accountability in Human Rights available at the federal, state and municipal levels. The complaints received are analyzed and sent to the organs of protection, defense and accountability in human rights within a maximum of 24 hours, respecting the competence and specific attributions, but prioritizing which body will intervene immediately in breaking the cycle of violence and protecting the victim. In addition to the telephone channel, the service Call-100 has digital channels, but these are much less used than the telephone channel, corresponding to about 10% of the total number of complaints made. Currently, about 1.4 million yearly calls are received on Call-100.

The main contribution of this paper is to highlight the importance of applying User-Centered Design as a key part on the digital transformation of public services. For this purpose, the following goals were used to guide our study:

- to understand the users' and stakeholders' perceptions about the service prior to transformation;
- to generate ideas and solutions that clarify the challenges caused by the digital transformation of the service;
- to understand how workshops can foster citizens' participation.

This paper is organized as follows: Section 2 presents some definitions and existing works in the literature. Section 3 shows the research methodology adopted to come up with solutions to improve the Call-100 service using User-Centered Design. Section 4 presents the results of our case study. Finally, Section 5 displays the final considerations of this paper.

2 THEORETICAL BACKGROUND

The theoretical background of this study is based on the design and governance fields. In the following, we present some definitions and correlated works that yielded the methodology adopted by our work.

2.1 Participatory and User Centered Design (UCD)

Empathic design was part of a larger movement toward context-sensitive design in the nineties. Researchers in Helsinki as [3, 10, 11, 17, 22], built a theoretical design approach in which it was important to study how people made sense of emotions, talked about them, and shared.

More important than theory was, however, a conviction that design research must be done in real life, with real users, based on methods that are visual and tactile, inspiration-enhancing, deliberately cheap and lo-tech, playful, and targeted at the fuzzy front end of the design process [24]. The user-facing parts of the service are not focused on functionality but in the psychology and behavior of the users [12].

Social, cultural and political aspects can also influence the user's experience. According to [14], it is important that applications that use interaction for cultural problem solving develop emotional impact, which is the component of user experience that influences user's feelings, so that users have emotional satisfaction.

The users of the service Call-100 (case study of this work) are vulnerable and stigmatized individuals with demands related to human rights violations, hence its digital transformation must be user-centered and have a positive emotional impact, making end users feel protected, relieved and supported. In addition, the service depends on the Protection and Service Network, with different government agents working on it, whose views also impact the service's experience, response time and quality.

2.2 Digital Transformation

The work of [25] defined digitization as "the transition from analog to digital services" and "digital transformation is a holistic effort to revise core processes and services of government beyond the traditional digitization efforts". The work also highlights that, in order to do so, it must be a continuous work, using feedback to improve public service delivery.

The term 'digital transformation' was adopted from the private sector, associated with the need to stay competitive in this constantly changing market [25]. In order to use it in the public sector, there must be adaptations because development models based on business and economics cannot be translated in order to achieve democratic e-governance [5]. With the unceasing arise of new technologies, it has became an activity to analyze and identify which ones could benefit existing processes in the public sector . Using ICT to digitize services can benefit both citizens when using public services, providing satisfaction, and government agencies, allowing them cross-departmental synchronization, reducing response time and financial expenses, and facilitating universal access to public services [19].

E-government initiatives are capable of improving the efficiency and effectiveness of public administration and the democratic legitimacy, making citizens more committed to participate and use public services [21] . Even though there are concerns around the inefficiency of mass participation, due to the use of ICTs, citizen engagement has proven to play an important role in the public sector, yielding a feedback mechanism and rising trust in those services [19, 21]. It is emphasized that those services are associated

with the citizens' perceptions and experiences, influencing them and also being influenced by them [28]. Those citizens have a socioeconomic, political and demographic context and this should be taken to account when promoting digital transformation [19, 28]. Factors such as gender, age group, educational level, economic situation, political attitudes, geographical location and access conditions to technological resources should be analysed in order to include different citizens' profiles, empowering them and meeting their specific needs [19].

The Call-100 service should be accessible to every citizen willing to report a violation of human rights or to get information about it. Users of the service may be people whose rights have been violated and may still be at risk, so they need quick action. They may also be neighbours, family members or other observers who witnessed the situation of violation. Brazil has continental dimensions, which widens the variety of user contexts, and part of its population lives in rural areas and has limited access to technologies. Also, vulnerable groups have specific needs, such as the elderly, people with disabilities, and indigenous people.

Taking a further step, the work [2] employed a stakeholder-centered approach to develop public e-service in their work, coming to the conclusion that this kind of service cannot have only two stakeholders mapped, agencies and citizens, but should be profiled in more detailed groups. Including stakeholders in the digitization process is considered a good practice [19], which has impacts on these different stakeholders and is also affected by them [13]. These groups have different needs and, by visualizing and pursuing them, the service can be adapted to the complex interactions and relations presented.

Call-100 is a service aimed at citizens and is composed by employees trained to receive those sensitive calls. The Protection and Service Network articulates which government agency should be contacted in each situation and respond to the person who made the complaint. For example, a complaint may be directed to the tutelary council, the civil police or other public services. Each of these groups is a participant in Call-100 and their views give different and relevant perspectives about the service.

2.3 Ethnography

The use of ethnographic techniques and procedures has the objective of examining the activities carried out by an individual or a social group, observing the relations among these activities and understanding how they take place [27, 30]. That is, ethnography involves the study of people carrying out daily tasks that interact in complex social environments. The result of this method is qualitative information on these interactions [23]. An ethnographic analysis is pertinent when new technologies are studied, for it helps to find out and explain why many products are not welcome or used.

In the context of the digitization of Call-100, this technique allowed to profile the current use of the service and understand its main problems. It should be emphasized that the service is extremely linked to the social context, as it works to assist people in vulnerable situations.

According to [15], there are a few restrictions on the use of ethnography in the design of new technologies. One of them is the scale problem. Ethnography is better applied in relatively confined environments or in small scale, in which it is easier to concentrate the attention in the participants, who generally are in a smaller number, and to visualize the differences among the tasks. Other problems are time pressures, and the designers' understanding of the results produced by the ethnographic study, which many times may be cut on the bias.

2.4 Design Thinking

The term Design Thinking (DT) is recognized for generating empathy and proposing innovative solutions that can be identified at points of intersection between technology, people and business. DT places the user as a participant guide in research and is based on three main points: (1) gaining empathy in/or from the context from which the demand arises, through ethnography; (2) developing creative thinking to achieve a greater variety of insights guided by the users' needs; and finally, (3) producing tangible insights by creating prototypes that can be quickly tested, chosen, or discarded by users. This process is not linear, and learning takes place in action [29]. Besides ethnography and prototyping, DT provides other tools that can be adapted according to the stakeholders' context, such as brainstorming, users' journey map, personas, storyboards, storytelling, blueprinting and co-creation [29].

Another important aspect of DT is the process, based on the Double Diamond co-design process, in which divergent and convergent stages discover, define, develop and deliver are mapped using users' engagement and consensus [7]. This allows to test different ideas early on and find errors in early stages, and can be iterated as needed and financially possible. The four stages are summarized as follows:

- Discover: The main objective of the project and the users' primary needs are identified
- Define: The users' needs are interpreted and aligned with business objectives
- Develop: Solutions are developed, iterated and tested by stakeholders
- Deliver: Results are presented, and a final test is made and approved

3 RESEARCH METHODOLOGY

This study was designed to come up with solutions to improve the Call-100 service. A case study was conducted to describe how the service worked and stakeholders interacted with it; then, we sought new insights and generated ideas and hypotheses for further research and service transformation, using a qualitative approach as it is more inductive, constructivist and personal, allowing a holistic view, being descriptive and lexical [16]. According to [26], qualitative research is used to better understand people and their experience in a particular context.

Following this perspective, User-Centered Design (UCD), which emphasizes ethnography and design thinking, was chosen to conduct this study. UCD allows researchers to have a holistic understanding of complex scenarios, increasing the effectiveness of innovation, as it encourages the target audience to participate in the development of the project. Therefore, a deeper understanding of the problem is reached and research strategies are developed that

create opportunities and reflections and transform the perception of the quality of the digitized services.

3.1 Actions in context: a case study

To understand the context and issues related to the Call-100 service, a four-stage approach was designed, using primarily Design Thinking and Ethnography, as visualized in Figure 1. The first activity was (a) a Planning Workshop to define the project's main problem and to understand its challenges and awareness, the second was (b) the ethnographic interview, the third was (c) an Ideation Workshop, and the forth involved (d) Evaluation and consensus building.

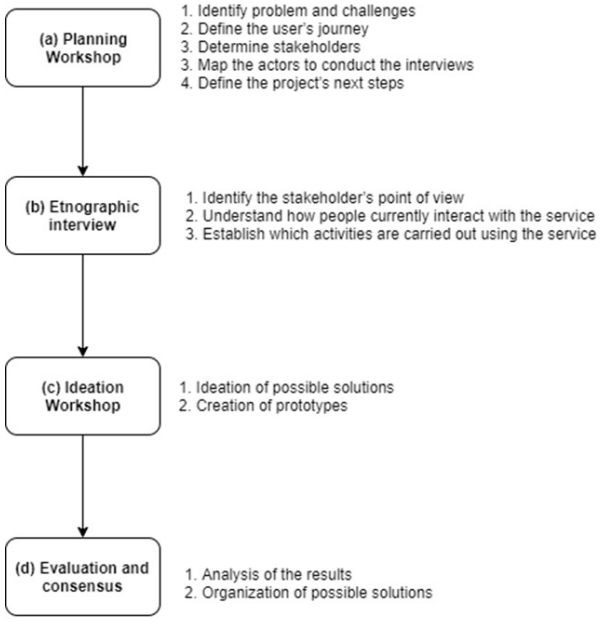


Figure 1: Research activities

3.1.1 Planning Workshop. This first activity aimed to map actors involved in Call-100 service and focused on defining the real problem and understanding challenges and awareness. The workshop was attended by 6 participants, 1 person from the Ministry of Women, Family and Human Rights, 4 from Ministry of Economy and 1 from our university. The journey of the user was explored to understand the trajectory, feelings and problems faced by the citizen when interacting with the service. The following activities were carried out: Definition of the problem; Journey of the User; Mapping of actors to conduct interviews; and Definition of the next steps of the project.

3.1.2 Ethnographic interview. To further understand the point of view of stakeholders, in-depth interviews were conducted with 7 women and 5 men aged between 17 and 50 years old who had previously interacted with the service: 6 former attendants of Call-100, 1 victim of human rights violations, and 5 members of the Protection and Service Network, being:

- 1 Delegate of the Civil Police of the Federal District for the Protection of Children and Adolescents;
- 1 District attorney of Justice of the Nucleus for Confronting Violence and Sexual Exploitation of Children and Adolescents of the Public Ministry of the Federal District and Territories;
- 1 Ombudsman of the Public Ministry of the Federal District and Territories;
- 2 tutelary counsellors of the Federal District. The diversity of participants is essential to allow for a deeper understanding of the context based on distinct points of view. The interviews were semi-structured and conducted one-on-one by 2 researchers, one as a note taker and the other as an interviewer. Researchers stimulated storytelling from interviewees. The main point was to understand stakeholders' behaviours while they interacted with Call-100 service.

The interviews were done where the interviewees interacted with artefacts related to the service, either to provide it or to use it. The researchers were at every workspace to understand the interviewees' performance interacting with their routines regarding the service.

3.1.3 Ideation Workshop. The ideation workshop was developed aiming to create alternatives to the issues diagnosed, enabling creative thinking and validation by sharing those ideas with an interdisciplinary team. That led to a critical-reflexive analysis, making the alternatives proposed viable for an effective change in Call-100.

Given the outcomes, the inputs and outputs from the interviews and the workshop, the third research activity was an event held to generate alternatives to increase the availability of the service, based on the previous diagnosis. The 16 participants of the event were engaged on collaborative methodology, mainly using DT activities such as brainstorming and prototyping. They were 4 people from MMFDH, 4 from ME, 3 representatives of the Rights Councils, and 5 researchers from our university.

The ideation workshop had the following steps:

- Planning the workshop, considering people's profile and the research's main objectives;
- Warming up, which consisted of a breakfast where participants were able to meet each other and share experiences and expectations. In this moment, participants could relax and understand the situation and goals of the activity. During the warm up, the mediator encouraged team work;
- A kick off, in which the main goals of the workshop and the context of the research were presented. Also, insights and figures from the interviews and Call-100 data gathered in 2017 were approached;
- Discovery and understanding: Mapping and framing the context, based on the presentation of a video about the situation of human rights violation in Brazil, to provoke the participants and to arouse empathy. Then, there were a series of actions:
  - What I do not want for Call-100: this was an exercise where researchers asked people to write down what they did not want for the service. The answers were framed with various issues to be avoided, and grouped by subject affinity;
  - Picture Trigger (visual brainstorming): each member of the group wrote on post-its the first thing that came to

mind when they saw the images that were presented on the slides as a way to stimulate thinking for digital transformation;
- Insights Template: following a pre-defined template, participants were instructed to individually think of a problem that they thought was a critical point in the flow of Call-100's attendance, dismantling it in Fact, Source, Challenge, and If. In a second moment, the groups were instructed to choose one of the problems proposed by each member and develop it together.
- Ideation – 5 spectacular proposals: based on the main question identified by the groups in the previous activity, each participant was asked to think about 5 outstanding ideas, even radical ones, to improve Call-100 regarding digital transformation. Then, each group should again choose one of the solutions proposed to develop a presentation of how the flow would be in case their idea was implemented.
- Synthesis prototyping – success headline: as a last activity, the groups were asked to create a newspaper cover in which the highlight would be the success of the solution chosen in the previous activity, showing how it would be seen by the general population one year after its implementation. This moment is very important to share solutions and reflect about them based on the context and user's needs, dreams and wishes. Also, it helps to focus on the digital transformation process and impact on the users' lives.

3.1.4 Evaluation and consensus. This stage was focused on debriefing previous stages and analyzing results. The results from this stage helped to create a holistic vision of the problem; understand the outcomes based on the research questions and the goals of the service; organize ideas by predefined categories; and identify the most relevant ideas, based on desirability, viability and impact on the context.

4 RESULTS AND DISCUSSIONS

During the Planning Workshop, the journey of the user was designed, as illustrated in Figure 2. The user's interactions with the service made it possible to define the main problem to be addressed, and what should be considered as priority. The problem was defined as "how to increase access to 'Call-100' to reach all citizens in need?". General and specific interactions were also mapped, prioritizing critical and essential activities.

During the building process of the journey map, the emotions of users and their attitudes facing problems related to Call-100 access was clear. Users' experience when they manage to complete the call is amazing, but unfortunately, nowadays only 10% of the calls can be completed. Digital transformation and its possibilities to offer other channels (chat, sms, etc.) bring users hope and trust in government digital transformation.

For the second activity, three interviewee profiles were defined. Some questions were asked for all groups, to better understand the social context of the person, their experience with digital media, their profile and also how they saw the ideal human rights protection service. Other questions were asked according to these three profiles and approached the following topics:

- Service agent responsible for receiving calls: employee experience with the service, putting themselves in the user's shoes;
- Citizens: their experience using the service;
- Members of the protection and service network: experience being in the network, putting themselves in the user's shoes, and the agencies' interaction with the service.

This research contributed to highlight positive aspects, like the maintenance of citizens' privacy, the humanized reception, and the seriousness of the service. According to the interviews, the privacy of Call-100 is one of the most important assets, followed by the attention given by the service agent during the call. Interviewees believe that the government will keep the privacy and seriousness of the service after the digital transformation. Regarding the link between citizen and government, there were some concerns with citizens' lack of clear understanding about the aim of this service, stressing the absence of communication with them. Interviewees think that it would be easier to have a better clarification and publicity of the service after the digital transformation.

The interviews generated some relevant insights categorized in four main axes:

(1) Availability of the service
   - The service is time-consuming, for it takes 30 to 40 minutes per call to enable reception. Some people try for hours and days to get care;
   - The channel is unstable. The connection drops and the user has to go through the whole process again;
   - The telephone channel needs to be improved, in order to be free and easily accessed;
   - Other channels are underutilized.

(2) Communication clarifying the role of Call-100
   - Many users do not understand that Call-100 is a reporting channel;
   - Citizens often do not file a lawsuit (they believe that Call-100 is sufficient to solve the situation);
   - Reporting channels (telephone and online services) have different names, which confuses the user;
   - It is necessary to carry out marketing campaigns about the service (including through social networks);
   - Other channels should be enabled that support the submission of evidence such as images and videos.

(3) Flow and procedures through different authorities - several entities from different government agencies;
   - There is a lack of communication between the service and the authorities receiving the complaints;
   - Reports sent to various agencies generate several lines of work and investigation of the same fact;
   - Contacting the network of authorities to discover the steps taken by each one leads to rework;
   - The forwarding flow of complaints slows down the process of resolving the violation;
   - Multiple referrals disperse the complaints, bringing a feeling that the case is not performed properly;
   - Reporting information needs improvement: attendants should be trained, and addresses should be registered more correctly.

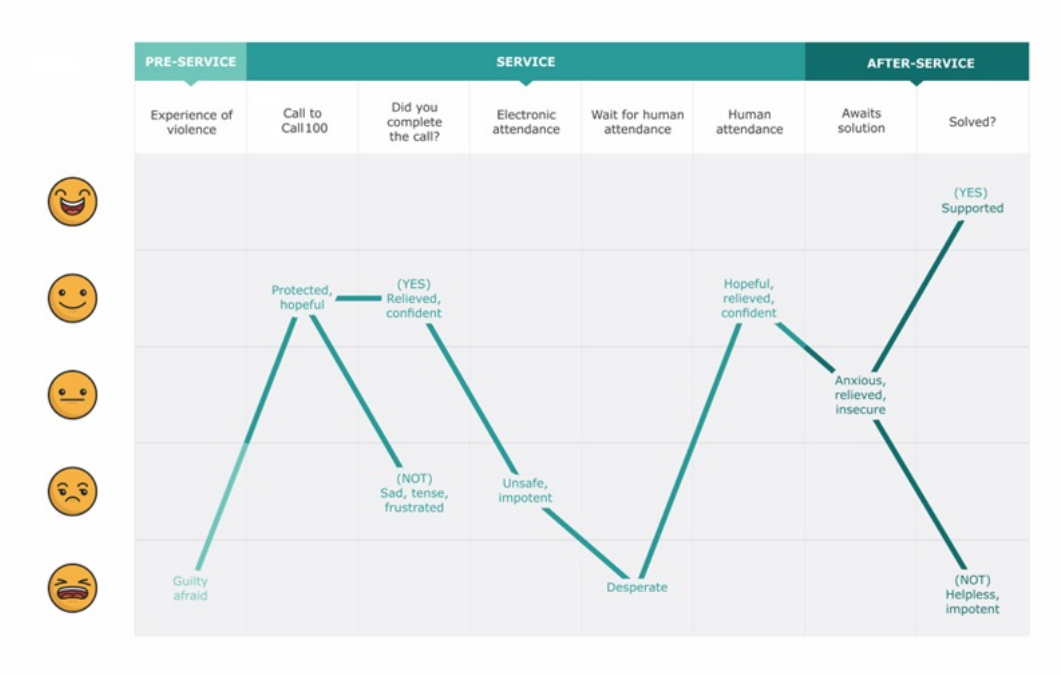


Figure 2: Journey of the user in the Call-100 service

(4) Complaint response
- There is lack of articulation among network actors to solve simple problems;
- Network is unable to resolve infringement and data control of complaints;
- Complaints are often sent to archive due to lack of information;
- Hoax calls and false reporting generate unnecessary expenses;
- Negligence of the network: some situations are not considered as urgent or even as violations. In this case, the system protects the denounced;
- Data are not produced about the complaints, for instance, regarding the veracity of information, or the rate of resolution.

The interviews also arose valid suggestions to improve the system from the user's point of view:

- To create a uniform service identity, including marketing campaigns about the service and its purpose, beyond the phone channel.
- To come up with digital solutions for different audiences, using well-known solutions available on the market (i.e. WhatsApp) and not just the online form and application.
- To improve the selection and training of attendants (since the job requires a specific profile) and offer them a lighter workload.
- To invest in the training of the network (training and awareness raising, from promoters to tutorial advisers).
- To redraw the flow of referrals along with the different actors.
- To organize the data of the service to enable the analysis of demands by region (for the network to adequately meet each situation) and generate relevant information on human rights in Brazil.
- To design itinerant care actions (such as global action) in places with large flow of citizens.

During the interviews with service agents, it was noted that some attendants were likely to make complaints, being engaged in their communities and aware of human rights, due to their knowledge of the service. As one of the interviewees described, "We really felt as a human rights defender". There is concern about the attendants' mental health, as they deal with sensitive cases and don't have access to the outcome of the cases they work on, which also contribute to not persisting in the job for long.

The participation of several institutions on the ideation workshop contributed to understand some issues related to lack of communication among governmental agencies, since numerous workflow processes are not adequate to give transparency to the activity. As a result, there is no follow-up of the case. Figure 3 illustrates one of the activities developed in this workshop, which consisted on writing newspaper front pages.

The main ideas raised in the ideation workshop were:

- To strengthen the telephone service team;
- To improve the Automatic Response Unit (ARU) and make waiting more enjoyable and empathic;
- To collect basic information while waiting;
- To implement other digital formats, such as chatbot;
- To humanize the digital service;
- To create a uniform identity for all channels;
- To ensure accessibility for people with disabilities;



Figure 3: Ideation Workshop

- To invest in communication and marketing campaigns;
- To inform the population about the purpose of the service;
- To act in the prevention of human rights violations.

Two lines of action were explored by the teams. The first one was the creation of a uniform service identity for all media communication-phone, application and online based form, which would allow the better identification of the service by the citizen. It was found that it is not reasonable for the same service to have more than two names. The other idea explored was the creation of more options in ARU, so that those who wish to follow the progress of a complaint do not need human attention. A technological solution could be provided to link ARU with the complaint registration system, so that one dials or speaks their protocol number and is automatically informed to which bodies the complaint was forwarded, and may be able to access the telephone number of such entities. Also, there could be an option to receive a text message to follow up the report (for the user who gives up anonymity).

Regarding the availability of digital channels, the following were suggested:

- To use an automation tool provided by Ministry of Planning, Development and Management for online complaints.
- To place the digital channel on the Services Portal of the Federal Government in order to increase disclosure and expand the use of the digital channel.
- To humanize online care, for example, by means of welcome videos and instructions on how to use the channel.
- To allow video uploads across the app and over the internet to make it easier to report violations.

5 CONCLUSION

This study presented a practical implication of applying low cost User-Centered Design techniques on digital transformation of public services.

Bringing citizens to activities planned by a multiple disciplinary team allowed to improve the competencies to develop an efficient digital transformation. As a result of these efforts, citizens came up with their real needs and experiences, and governmental servers were able to have an emphatic understanding of the context.

Among the project's main findings, important points of the service were highlighted, such as anonymity, reception, humanized care and seriousness. It has also been pointed out that for most users it is not clear what the service is and what it is for; a presence of problems, in flows and communication, in the links of the Protection and Assistance Network; and a lack of information on service effectiveness. A need was also signalled: to promote campaigns about the service; promote stability and update of the application; standardize the names of reporting channels (telephone and digital), which have different names, that confuses the user; and enable other digital channels and solutions that allow images and videos to be uploaded (for example, chat, Whatsapp, and Facebook).

At the time, two main lines of action were suggested: the creation of a unique service identity for all media (telephone, application and email); and the creation of more options in the Automatic Response Unit, for those who want to follow the progress of a complaint does not need human attention. Project findings are helping to define strategies for improving care and digital alternatives to broaden and facilitate access to Call-100.

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An Overview of Rede.gov.br as a Federative Mechanism for Digital Government Development in Brazil

Beatriz, B. B. Lanza
IDB, Center for Technology in Government SUNY Albany
beatrizlanza@gmail.com

Thiago, J. T. Ávila
FGV-EAESP, Fundação Getúlio Vargas
thiago.avila@fgv.edu.br

Daniel, S. Valotto
UFPR, Universidade Federal do Paraná
danielvaloto@gmail.com

ABSTRACT

Federations form a way of governing nations. The decisions are taken impact all constituent units, where Brazil is among the 28 nations that adopt this model of government. Among the federative relations it presents in the country, actions for the modernization of public management and for Digital Government have been evolving after the Constitutional Amendment 19/1998. In this sense, one of the main current initiatives is the National Digital Government Network - Rede gov.br, which promotes Digital Government initiatives in the Brazilian public sector. The objective of this article was to present the current stage of the process of integration of the States and the Federal District (FUs) to the Rede.gov.br. The main results indicate that 73% of the analyzed FUs followed the Rede.gov.br. As a result, the functionalities available on Rede.gov.br are quickly diffused among these entities. Still, among the federative ones that are not yet being implemented as solutions, there will be joining and a good part of the FUs moving in this direction. On the other hand, some FUs still face problems such as the essential need for public services, lack of qualified personnel or infrastructure for implementation as functionalities. From the information identified in these, specific ones can be directed to the federated units to overcome the challenges pointed out and advance the Digital Transformation objectives among the federated actions in Brazil.

KEYWORDS

Digital Government, Federative Mechanisms, Subnational Governments

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1 INTRODUCTION

As a federal nation, Brazil has consolidated national public policies in several areas. For example, in Health, through the Unified Health System; Social Assistance, through the Unified Social Assistance System; and national programs that work through integrated mechanisms between the Federal Government, states and municipalities, such as the Child Labor Eradication Program (PETI). On the other hand, since the enactment of Constitutional Amendment 19/1998 [34], Brazil has been developing several actions aimed at modernizing the state, including the Electronic Government, such as the Program for Modernization of the Federal Executive Power (PMPEF) and the National Program Support for the Modernization of Management and Planning in the Brazilian States and the Federal District (PNAGE). However, the federative challenge of coordinating the management modernization and digital government persists despite such initiatives.

The Brazilian Federal Government has established a Digital Government Strategy that focuses mainly on federal Digital Government efforts in recent years. This strategy has a relevant action aimed at subnational governments, proving that, by 2022, all Federative Units (FUs) have joined the National Network of Digital Government - Rede gov.br (Rede gov.br)
[1]. This network, coordinated by the Secretariat of Digital Government of the Ministry of Economy (SGD/ME), aims to promote collaboration, exchange, articulation and the creation of innovative initiatives related to the theme of Digital Government in the Brazilian public sector, being formed by all federated entities [1].

Understanding the Rede.gov.br as one of the relevant mechanisms to articulate digital government in Brazil in national and subnational governments, this research diagnosed the current stage of integration of the FUs to the Rede.gov.br as a federative mechanism for the development of the Digital Government in Brazil, identifying possible obstacles faced by the FUs regarding the adhesion and implementation of the Network's solutions.

Understanding the complexity of a federative country of continental size with equally continental social, cultural and economic challenges, information and communication technologies (ICT) play an essential role in facilitating the management of the country. Hence the importance of coordinated and integrated actions by the national and subnational government so that the benefits of Digital Government reach citizens. Therefore, it is justified to document the adhesion of subnational entities to Rede.gov.br since its inception, making it easier for all FUs to become aware of and benefit from actions promoted by the Federal Government aimed at citizens and society in general.

This article has four sections in addition to this introduction. The following section explains the complexity of public policies in federative nations as the main federative relations and mechanisms for the public management modernization and Digital Government in Brazil. Then, section 3 presents the research methodology, and

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section 4 shows the main findings of the analysis carried out, highlighting the status of adherence of the FUs to the main resources provided by Rede.gov.br. Finally, the last section concludes the article by resuming the questions that motivated the analysis, and the findings produced and the contributions, limitations and a future research agenda

2 BACKGROUND

2.1 The complexity of public policies in federative nations

A federation is defined as 'an institutional arrangement, taking the form of a sovereign state, and distinguished from other states solely by the fact that its central government incorporates regional units in its decision-making procedure on some constitutionally established basis [4].

Federal systems usually exist through agreements negotiated between their constituent members, guaranteeing existence for all members as a central element. Formal compromises are also established, arranged around a balanced distribution of powers and existential guarantees [2]. Furthermore, it is essential to federalism the existence of at least two constitutionally instituted government orders, each one endowed with genuine autonomy about each other and responsible to the respective electors [3].

We deduce that a federation brings together a set of interests and powers that must be balanced for the maintenance of the federal nation, considering: the characteristics of federations, especially regarding the existence of at least two instituted government orders [3]; the accommodation of the constituent units in the decision-making process [4]; the plural distribution of powers among the different orders of government [2]; and the aggregation of hitherto separate constituent units into a single nation.

In federations, significant decisions that impact the constituent units are the units' consent and the federal government
[5]. Therefore, the conciliation of interests, proposals, perspectives and divergences are intrinsically linked to the nature of a federation. Federative coordination is a fundamental element for the success of federations. In this sense, the balance between the constituent units is characterized by a federation. Thus, to qualify as, all integrated systems are marked by the plural distribution of powers as different from the government [2]. Such factors distinguish federal systems from unitary systems.

Among the 28 nations in the world that choose a federative arrangement for the organization of the state in Brazil. The country is considered a federal nation, for other reasons, for having three levels of autonomous government, a competent authority concerning the Federal Republic, representation of FU in the Federal Senate, a balanced Judiciary, conciliation and decisions around disputes as well as existing processes for the relationship between governments, especially federal governments with the governments of other federated entities (adapted from [3]).

The characteristics of federalism influence the development of public policies, where the reciprocal is also true [6]. The time factor influences the relationship between federalism and public policies. Over the years, policies incorporate inputs from federative relations, and federalism in nations adapts and improves in the face of the effects of such public policies [7].

In the Brazilian case, public policy systems grow as a federative innovation for developing public policies, especially in the field of health, social assistance, education, environment, water resources, and other areas. Such systems, more structured in the areas of health and social service, respectively with the Unified Health System (SUS) and the Unified Social Assistance System (Suas), have contributed to increasingly cooperative federalism in Brazil [6].

Classifying the scope of public policies that have central government protagonism [9] divides them between national and federal policies. National policies imply the participation/consent of all and instruments of joint action [8]. On the other hand, despite also covering the entire national territory, federal policies are elaborated and focus their decisions on the central government. Therefore, the participation of the subnational entities generally depends on the adherence of these spheres of government to the policy presented, but without their legitimate power to interfere in the design of the policy. Examples are the Child Labor Eradication Program (PETI), the National School Transport Program (PNATE) and Rede.gov.br - on the topic of digital government [9].

2.2 Federative relations for the public management modernization and Digital Government in Brazil

The evolution of the New Public Management movement has increased pressure on state bureaucracies to treat citizens as customers. The measures implemented by governments to make the administration more focused on the citizen contemplated specific and non-integrated actions to improve the quality, efficiency and accessibility of service to citizens and the provision of public services [10].

In Brazil, the Master Plan for the Reform of the State Apparatus (PDRAE) is considered a milestone in public management modernization. This initiative contextualized the main models of public administration in force in history and directed its actions towards a model of public administration guided by efficiency and quality in the provision of public services and by developing a managerial culture in organizations [11]. Among the main consequences of the PDRAE, there was the creation of the Ministry of Administration and State Reform - MARE; the implementation of managerial public administration focused on the control of results, decentralization, flexibility, participation, social control and transparency, managed competition, focus on the citizen; Constitutional Amendment No. 19/1998; and the structuring of several federal state modernization programs [12, 33].

In the evolution of the relationship between the government and society, the Integrated Service Centers (CAIs) had great importance at the end of the 20th century, on the one hand, presenting a modernizing proposal, importing the concept of "one-stop-shop". [13] for Brazil and, on the other hand, for materializing the efforts to modernize the State advocated especially by the Master Plan for State Reform and Constitutional Amendment 19/1998 [14].

It is essential to highlight that the CAIs policy, despite having been formulated at the state level, especially with the experience of SAC Bahia, was promoted by the Federal Government within the scope of the Federal Executive Power Modernization Program (PMPEF) [15, 17]. The PMPEF had a bold goal of implementing CAIs

in all Brazilian states and the Federal District by 2003, with financing from the Inter-American Development Bank - IDB [15]. The PMPEF had four sub-programs, among them the "Atendimento ao Cidadão", structured to support a set of projects aimed at transforming the citizen as the main focus of attention of the state, with its main activities being the implementation of Citizen Assistance Services in the Brazilian states [11].

Oliveira explains that the PMPEF established the following guidelines for the CAIs: (1) provision of high-quality, efficient and quick service at a reduced cost; (2) simplification of bureaucratic obligations; (3) proactive response to citizens' complaints and suggestions; (4) welcoming, orienting and informing the population about the requirements necessary to obtain the available services; and (5) multifunctionality and flexibility to adapt CAIs to the provision of services that have fluctuating demands. At the end of this period, the PMPEF was responsible for the implementation of 12 new CAIs and the 13 units that already existed at the time [15].

In addition to the PMPEF, the National Support Program for the Modernization of Management and Planning in the Brazilian States and the Federal District - PNAGE was another relevant federative action aimed at supporting the modernization of Brazilian states through the leadership of the Federal Government. The PNAGE aimed to "improve the effectiveness and institutional transparency of the public administrations of the States and the Federal District to achieve greater efficiency in public spending" [16].

Composed of seven components, the program allocated approximately U$S 150 million to modernize management in Brazilian states. Each FU had a state project containing several products distributed to some or all of the Program components. In addition, the PNAGE financed management modernization actions aimed at training, consulting, IT systems and equipment, support and communication material, and physical facilities.

It is observed that in both programs mentioned, the components of improving service to citizens and the use of information technology for public management have been part of the federative plan for the modernization of the Brazilian State in recent decades. This movement dialogues with the understanding of [18], who points out that digital transformation (DT) has been fundamental for governments to become more efficient and offer better services to citizens. Concepts such as transparency, interoperability and citizen satisfaction are part of governments' discussions in the quest to transform their analog services into more effective and citizen-centered services [19–21].

In this new way of management where governments are looking for ways to become more efficient, effective and coordinated, information and communication technologies (ICT) have become a critical component. Increasingly, government agencies are exploring emerging technologies to help improve their internal operations and relationships with citizens and other social actors [22].

E-Government in many countries currently aims to achieve efficiency in creating and delivering services to the citizen. Therefore, most governments start with automation to minimize costs and implement effective governance and efficient administration. Governments use multiple channels to offer their services and develop capabilities to network with different departments to provide a seamless and personalized service to their citizens [10, 23]

Since the first official initiative of Electronic Government in Brazil, in 2000, until the present time, the Digital Government has been gaining prominence in the public policy agenda of the federated entities. As a result, several relevant normative acts have been published with an impact on Digital Government and aimed at simplifying the State-society relationship and rationalizing public administration. As a examples, Federal Laws 12,527/2011, 13,460/2017 and 14,129/2021, respectively known as "Access Law to Information - LAI", "Public Service User Defense Code - CDU" and "Digital Government and Public Efficiency Law - LGD" [24–26]. These Laws are national in scope, generating mandatory conditions for modernizing public services within the Union, States and Municipalities

2.3 Federative mechanisms for the development of Digital Government in Brazil

Faced with the complex challenge of structuring the Digital Government in a country like Brazil, the institutional instances of articulation and convergence of the Digital Government agenda are highlighted. At the subnational level, states benefited from a movement created in 2019 to integrate and accelerate actions aimed at digital government, going beyond.
technological elements and acting on institutional, cultural, and political factors. The Grupo de Transformação Digital dos Estados e do Distrito Federal (GTD.GOV) is the first Brazilian initiative that brings together Digital Transformation (DT) efforts at the state level of government, with the mission of accelerating the TD of public services in the 27 state governments from Brazil [27]. It is a horizontal interstate arrangement created and maintained by two institutions with a solid performance in the states, in favor of the same agenda, the Digital Government. It acts as a collaborative national network that brings together around 200 DT specialists from the 27 FUs, with priority given to users' experience of public services at the state level. It was established by the National Council of Secretaries of State for Administration (CONSAD) and the Brazilian Association of Public Entities in Information and Communication Technology (ABEP-TIC) [33]. GTD.GOV is also supported by academic and Third Sector members and is institutionally sponsored by the Inter-American Development Bank.

The GTD.GOV contributes to the digital transformation in Brazil through actions of articulation of institutions and stakeholders and production of unprecedented diagnoses on Digital Government in the FUs. As a result, GTD.GOV has been recognized nationally and internationally as an essential forum for articulating the issue in Brazil. The results that show this recognition are published in the paper "Impacts of an articulation group for the development of the Digital Government in the Brazilian Subnational Governments [27].

This Group works on lines of action to (1) articulate partnerships to enable the financing of Digital Government projects in the states - supported the IDB for the approval of the "Brasil Mais Digital" credit line, which includes the funding of governance for DT, modernization and simplification of procedures and services, tools and technology platform, policy and data management [27]. The states of Alagoas and Ceará made Consultation Letters regarding the financing of TD programs approved, while other Brazilian states and

Table 1: Reasons for not joining the Rede gov.br. Source: GTD.GOV

	Research	Period
1	Public Service Portal Loading Speeds	April 2020
2	Telework in State and District Governments	May 2020
3	Electronic Process in State and District Governments	July 2020
4	Impact of GTD.GOV Actions on State and District Governments	September 2020
5	State and District Government Mobile Applications - Service Channels	October 2020
6	Public Service Delivery Capabilities of State and District Governments and the Enterprise Architecture Resources that support them	November 2020
7	Reference Architecture of the Digital Government Platform of the States and Federal District	February 2021
8	On-site Service Channels of State and District Governments - Call Centers	February 2021
9	Diagnosis of State and District Government Citizen Services Portals - Citizen Services Portals	February 2021
10	Governance Capabilities for Readiness for Digital Transformation	February 2021
11	Diagnosis of the use of Rede.gov.br solutions by State Governments	August 2021
12	Reference Model for Interoperability between Entities in the Provision of Government Services	August 2021

municipalities are adhering to the credit line; (2) strengthen the monitoring and evaluation of State Digital Government actions - where it supported ABEP-TIC in the development of the first edition of the "Digital Services Offer Index". The Index measures the capacity to provide and offer public services by state and district governments through digital means, as well as their regulation [32]; and (3) deepen the diagnosis of Digital Government in the states - developed 12 surveys and 24 virtual events, resulting in a wide body of knowledge about the advances, results and challenges of DT in Brazilian FUs, as shown in Table 1

In parallel with the FUs initiative with the creation of GTD.GOV, and inspired by other public policies of national scope, the Federal Government established the National Digital Government Network - Rede.gov.br. This network, of a collaborative nature and voluntary adhesion, within the range of the Union, the States, the Federal District and the Municipalities, aims to promote the exchange of information and the articulation of joint measures related to the expansion of the Digital Government Strategy [28], currently comprising 19 states and 79 municipalities [29].

It is a system formed by Brazilian federated entities. It makes it possible to integrate and coordinate Digital Transformation initiatives, bring federated entities closer to the citizen, reduce costs and increase the efficiency of public services by promoting collaborative solutions. The Rede.gov.br is led by the Digital Government Secretariat (SGD) of the Ministry of Economy of the Brazilian federal government [28].

Rede.gov.br is responsible for integrating and coordinating joint digital transformation initiatives in the Brazilian public sector. It facilitates the approximation of the State and the citizen, as well as companies and civil society, by prioritizing the provision of digital public services according to the interests and needs of the community; facilitate the reduction of costs and the increase of agility in the provision of public services; and articulate the development and reuse of collaborative solutions and digital platforms [28]. To join the Network, the highest authority of the Executive Power at the state, district or municipal level must sign a Term of Adhesion.

Among the solutions offered by Rede.gov.br, the methodological support for the digital transformation of subnational public services stands out; availability of digital platforms, with single-user authentication, centralization of public services offered by the various entities that make up the Network; Priority access to Capacity Development programs; Sharing solutions to address common problems, where reuse and collaboration will favor the quality of public spending; Indication of Cost Model to measure the economic impact of the transformation of each service to the digital model; Support for funding with national and international development agents, to raise the possibility of offering special lines of financing aimed at digital transformation actions [28].

The Rede.gov.br, given its scope and penetration in all governmental spheres (Federal, State and Municipal) is an experience that allows us to understand the current stage of development of federative mechanisms for the development of Digital Government in Brazil.

3 METHODOLOGICAL PROCEDURES

The general objective of this research was to diagnose the current stage of the integration process of the States and the Federal District (FUs) to the Rede.gov.br as a federative mechanism for the development of Digital Government in Brazil. Therefore, the research is a qualitative study with a descriptive purpose and transversal temporality [30, 31].

To achieve the proposed objective, qualitative research was carried out using the Survey technique [32], based on a semi-structured online questionnaire on the Microsoft Forms platform, with 21 questions related to the use of Rede.gov.br features by the FUs. Data collection took place from June 14 to July 1, 2021. The questionnaire was answered by analysts, secretaries, managers and directors of strategic areas of State Governments. Access to these respondents was through GTD.GOV. The questions used for data collection specifically addressed the following topics: Adhesion to the Rede.gov.br; Use of the Rede.gov.br Single Login; Integration of the FUs Services Portal with the Rede.gov.br; and Use of Advanced Electronic Signature; Use of other gov.br services.

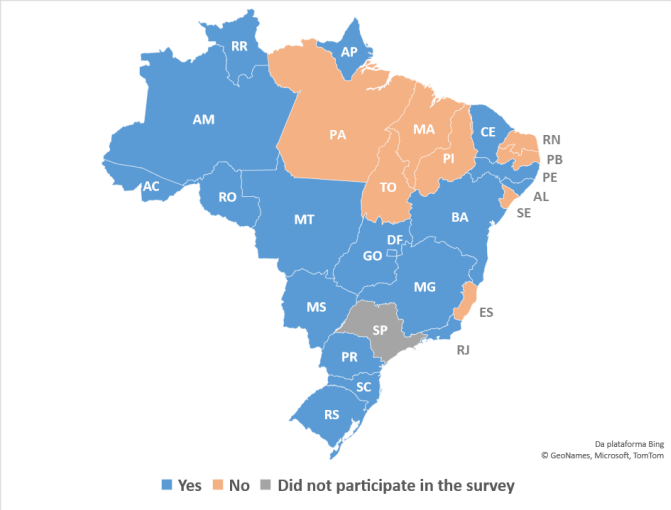


Figure 1: Adhesion to the Rede gov.br. Elaborated by the Authors.

All 27 State/District Governments (FUs) were invited to participate in the survey in the initial collection. 26 of the 27 FUs responded to the questionnaire, namely: Acre (AC), Alagoas (AL), Amapá (AP), Amazonas (AM), Bahia (BA), Ceará (CE), Federal District (DF), Espírito Santo (ES), Goiás (GO), Maranhão (MA), Mato Grosso (MT), Mato Grosso do Sul (MS), Minas Gerais (MG), Pará (PA), Paraíba (PB), Paraná (PR), Pernambuco (PE), Piauí (PI), Rio de Janeiro (RJ), Rio Grande do Norte (RN), Rio Grande do Sul (RS), Rondônia (RO), Roraima (RR), Santa Catarina (SC), Sergipe (SE), and Tocantins (TO). However, only the state of São Paulo (SP) did not participate in the research. Therefore, for this article, a new data collection was made specifically about the adhesion to Rede.gov.br, on January 12, 2022, together with the Network's coordination. The data from the responses were tabulated, summarized and analyzed using the content analysis technique [34].

4 RESULTS AND ANALYSIS

In this section, the main results obtained from the research are presented, including the stage of adhesion to the Rede.gov.br; the use of the Rede.gov.br Single Login; the integration of the Services Portal with the Rede.gov.br; the use of Advanced Electronic Signature; and the use of other services of the Rede.gov.br.

4.1 Adhesion to the Rede gov.br

The initial prerequisite to take advantage of the solutions provided by the Brazilian Federal Government is to join Rede.gov.br. This topic aimed to verify which FUs had entered Rede.gov.br. The results indicate a predominance of network used by the FUs: 20 FUs revealed having joined the Network, representing 73% of the total, while 8 FUs, or 27%, have not yet joined. The detail of the adhesion of each FU is shown in Figure 1

The 19 FUs that have already joined the system had been using the Rede.gov.br functionalities for an average of 12 months, with a range of 1 to 28 months of use. Specifically, eight FUs had been using the Network's functionalities for six months or less (AC, AL, BA, CE, MT, PA, RO and SC); seven FUs had joined between 10 and 24 months (AM, AP, DF, GO, MS, PE and RR) while four FUs had been linked to gov.br for more than two years (MG, PR, RJ and RS).

The 12 FUs that had not yet joined Rede.gov.br up to the date of the first collection of this research were asked the reasons and justifications for non-adherence. The answers are highlighted in three groups:

Three FUs (ES, MA and SE) stated that they are being analyzed or in the process of joining. And they also justified that they are structuring their platforms for integration, articulating with other sectors of the state government to start the implementation process. A response that drew attention in this group is the relative cultural difference pointed out among the users: the respondent indicated that part of the possible users of public services is digitally illiterate, that is, they do not know how to deal with digital tools, which would make it difficult to register with the gov.br and, therefore, could make access to public services more difficult.

Another three FUs are still planning to join the federal government's Network. The state of PB, PI and TO justified that they are carrying out feasibility studies or have already sent an email to the Digital Government Secretariat showing interest in joining. In this group, one respondent indicated that, despite the interest, there was still no authorization for implementation, while another highlighted that internal (unspecified) factors prevented adherence.

Finally, the state of RN expressed that it does not plan to join gov.br, at the moment, due to the impossibility of internal factors (without specifying which they are). The following table details the reasons and justifications for the non- adherence of the seven FUs to the Rede.gov.br.

4.2 Use of Rede gov.br Single Login

The Single Login is a tool that allows access and identification of the same user on various platforms and public services, aiming to facilitate user access by using a secure environment without bureaucracy [35]. This topic observes the use of this tool from the Rede.gov.br by FUs. Among the FUs participating in the research, 38% of them, or ten governments declared that they already use the tool, while 62% or 16 FUs still do not use Single Login (see Figure 2).

For the ten FUs that have already implemented the tool (AL, CE, DF, GO, MG, MS, MT, RO, RS and SC), it was asked how they use Single Login. Seven of the ten states FUs use the solution as an authentication alternative, indicating the existence of other forms of user authentication. The GO uses the gov.br Single Login as the primary source of authentication, although it is not the only one.

The state of MG uses the Federal Government's solution as the only source for some applications but not for others. Only the state of RS uses the solution as the only source of authentication in its services. Figure 3 shows how the 10 FUs are using Single Sign-On.

As for the time of use of this solution, the FUs of AL, CE, MS, RO and SC responded that they had used the solution for six months or less. The Federal District, GO and MT joined between 12 and 15 months. The MG and RS responded that they adopted the tool more than two years ago.

Table 2: Reasons for not joining the Rede gov.br. Elaborated by the Authors

F.U.	Reasons for not joining the Rede gov.br	Detailing the reasons
3	Under review or in progress to join	· Analyzing the possibility of joining; · Structuring its own platforms to subsequently join; · Analyzing aspects such as the existence of digital illiterates and other cultural dimensions; · Articulation with the State Government for accession;
3	Plan to join	· Conducting studies and analyzes on the possibility of joining; · Impossibility due to internal factors [unspecified]; · E-mail sent to Digital Government showing interest in joining; · There has not yet been authorization to join, but there is interest;
1	Do not plan to join	· Impossibility due to internal factors [unspecified]

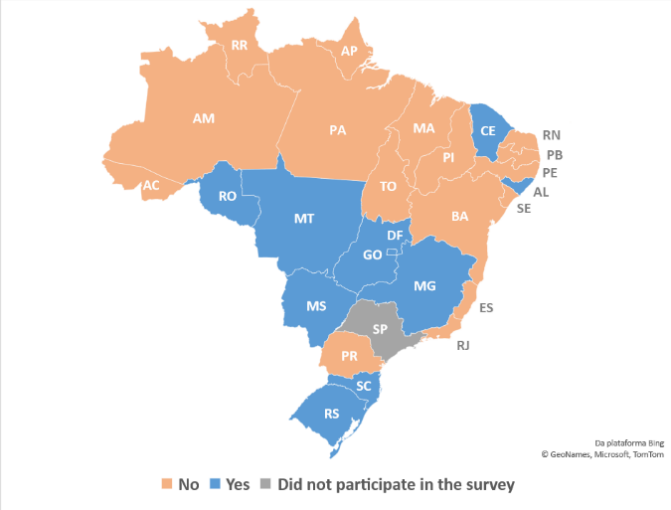


Figure 2: Use of Rede gov.br Single Login. Elaborated by the Authors.

Still, these ten federative units were asked which public services used authentication by gov.br. The primary services that adopted Single Login are the Citizen Portal services, protocol services and business services, as shown in Table 3. The GO stand out - with more than 79 services with authentication and the state of RS claimed to have all services that use authentication being done by the Federal Governments Single Login.

The FUs that stated that they had not adhered to the gov.br Single Login were asked about the reasons and justifications for non-adherence. The details of the answers can be found in Table 4The main reason, pointed out by AC, AM, AP, MA, PA, PE and RJ (seven of the 16 FUs), for not having adhered to the Single Login is that the entities are in the process of analyzing or implementing the tool, more specifically, technical issues are being explored for the adhesion, implementation of the digital services catalog or the implementation is scheduled to occur in 2021. On the other hand, for four FUs, PB, PR, RN and TO, there are technical obstacles to the feasibility of the solution, motivated due to a high volume of adaptations necessary to implement the tool, lack of specialized technical staff to implement the functionality or the need to digitize the services offered.

Three FUs, BA, ES and PI, stated that they had already made efforts to create their Single Login solution as a justification for not adhering to the gov.br Single Login. On the other hand, the FUs of RR and SE pointed out obstacles such as lack of definitions of legal aspects, absence of systems and infrastructure. Furthermore, the state of SE also indicated that the presence of digital illiterates is a matter of concern, since these people would not be able to register in the Federal Governments system and needed the assistance of third parties that may not be reliable.

4.3 Integration of the Services Portal with the Rede gov.br

The integration of the Citizen Services Portals (PSC) of the FUs with the Rede.gov.br, showed that 65% of the 17 FUs did not have their PSCs integrated into the federal government system. In comparison, 35% (9 FUs) indicated have already integrated (see details in Figure 4).

The type of integration implemented was asked for the 9 FUs that indicated that they already had the PSC integrated into gov.br. Four FUs (DF, GO, PR and RS) indicated that they used bidirectional integration, that is, the FU's PSC and the gov.br Portal receive and provide information to each other. Another four FUs (AC, BA, RO and SC) only integrated the services of the gov.br Portal into their PSC. Therefore, only the PSC services in MG are connected to the Federal Government Portal. Figure 5 summarizes these results.

The reasons for not having their PSC integrated into the Federal Government Portal were also investigated with the 17 FUs. Seven FUs (AL, AM, CE, MA, MS, PA and SE) that do not yet have integration are in the planning or structuring process for sharing with the federal government network. In this sense, the FUs are still implementing or structuring the PSC itself or the available services. There are also FUs that are first implementing other features such as an advanced subscription to later integrate their Services Portal with gov.br.

Four FUs (PI, RN and RR) identified technical or infrastructure problems as a justification for non-integration. Specifically, the problems translate into the lack of specialized personnel or technical staff for the activity and legal issues at the state level. Another aspect that draws attention is the absence of systems or infrastructure

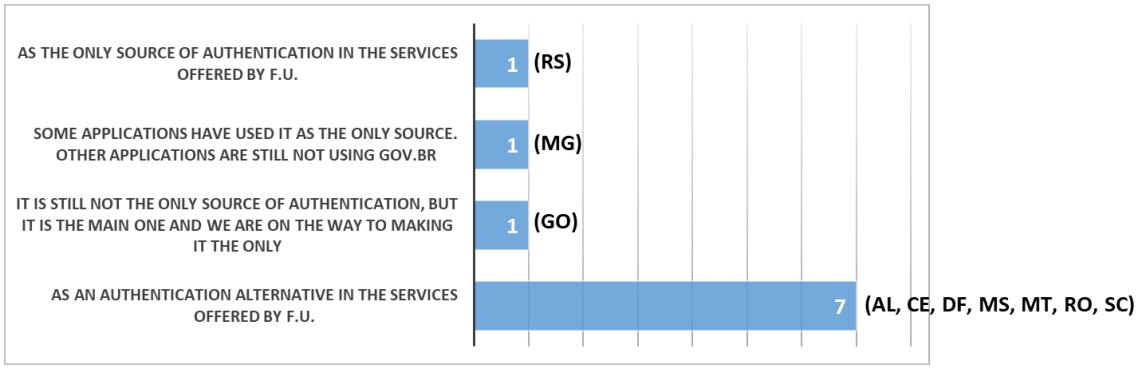


Figure 3: How FUs use the Rede gov.br Single Login. Elaborated by the Authors.

Table 3: State services that use the Rede gov.br Single Login. Elaborated by the Authors.

FU	Services used
AL	interactive police station
CE	It will be used in the State Services Portal and in the authentication solution
DF	Automatic installment of debts; Debit credit card installment
GO	It currently has 79 services from various state agencies
MG	Cidadao.mg.gov.br; MG Apps Citizen App / MG Companies app / Board of Trade / Secretary of the Environment
MS	Digital Record; Withdrawal of Documents; Document Validation; Consultation of Protocols; Digital Book; Basic entry document cancellation; Trust seals
MT	MT Citizen Services, Server, Business, Services Portal
RO	Citizen portal, company subscription
RS	All UF services that use authentication
SC	Public Security, Protocol, Services Portal, among others in use

Table 4: Reason for not using the Rede gov.br Single Login. Elaborated by the Authors.

F.U.	Reasons for not joining	Detailing the reasons
7	Under analysis or implementation	· Process is still under analysis by technicians; · Implementation phase of the state's digital services catalog; · Forecast to migrate the state's single sign-on solution to the gov.br single sign-on; · Implementation forecast still in 2021; · Analysis step to define the use of Single Login;
4	Depends on technical activities for feasibility	· High volume of changes in systems to implement this functionality in addition to having Single Login; · Lack of sufficient technical staff to dedicate themselves to such activity; · Need to hire a specialized company to start the Digital Transformation work of public services;
3	UF has its own Single Login	· It already has its own single login for the citizen to access the services; · It does not yet have integration with the Federal Government bus.
2	Obstacles to Implementation	· There is a lack of definitions related to legal aspects at the state level; · Lack of systems and infrastructure for systems; · Lack of service transformation and digitalization project; · Presence of digital illiterates that make it difficult to register on gov.br

for the systems in specific federative units and the lack of Digital Transformation projects for services. Finally, one state indicated a lack of initiative for non-integration.

Another three FUs (PB, PE and RJ) maintained that there is no provision for integration into the gov.br Portal. This position is justified because a position from the Digital Government Secretariat (SGD) is awaited regarding integration or a direction from the State

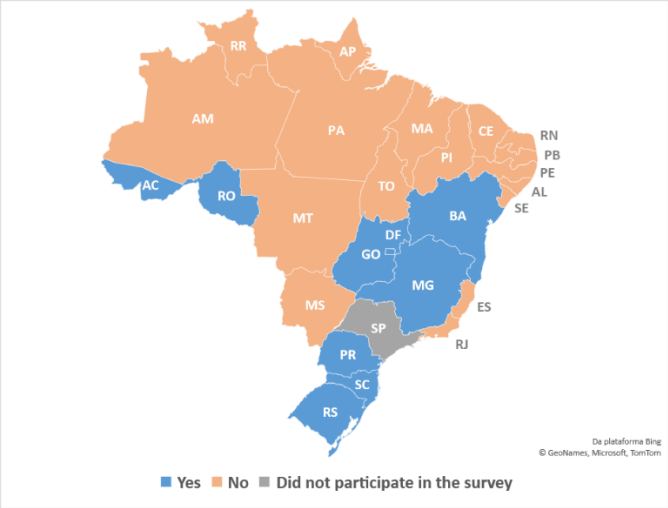


Figure 4: Integration of the PSC to the Rede gov.br. Elaborated by the Authors.

Government itself. One state highlighted that its PSC was created before gov.br and that, for this reason, possible integrations with other portals were not foreseen.

Still, three FUs (AP, ES and MT) indicated that they first need to start or complete the process of joining the gov.br to proceed with the integration of the portals. The following table details the reasons and justifications indicated by the respondents.

4.4 Use of Advanced Electronic Signature

According to Brazilian Law 14.063/2020, an Advanced Electronic Signature requires verification and data protection technologies that guarantee a person's association with their information reliably through a signature. The FUs participating in this research were consulted regarding the use of this functionality. In 14 FU the Advanced Electronic Signature was not implemented, while 12 already use it.

Among the 12 FUs that already use the solution, five acquired or built the tool: AM, CE, PB, PI and SE, indicating that the solution cannot be shared. In addition, the FUs DF, GO, RO, RS and SC use the Advanced Electronic Signature solution provided by gov.br. Finally, the ES and PR FUs use their own Advanced Electronic Signature system, indicating that this solution cannot be shared. Figure 6 summarizes the information.

The 12 FUs that joined the Advanced Electronic Subscription have already used this solution for an average of 13 months. Six of these FUs have been using it for six months or less (AM, CE, GO, PR, RO and SC), the DF, PB and SE have adopted the solution between one and two years. The ES, PI and RS have been using the functionality for over two years.

Ainda em relação às FUs que utilizam esta funcionalidade, foi consultado em quais serviços a Assinatura Eletrônica Avançada era utilizada. A Table 6 indica todas as respostas. Os principais serviços se referem a sistemas de tramitação ou gestão de documentos. Também é utilizada em sistemas de protocolo, pagamentos, contratos, entre outros

Subsequently, the 14 FUs that do not use the solution were consulted about the reasons for this situation. As a result, three main motivations were identified: the functionality implementation is

Table 5: Reasons for non-integration of the state PSC to the gov.br Portal. Elaborated by the Authors.

F.U.	Reasons for not integrating	Detailing the reasons
7	Under analysis or implementation	· Integration in the planning phase; · UF PSC implementation phase; · Recent adhesion to gov.br, but expected to start integration soon; · Structuring the state PSC; · API implementation for advanced signing; · Structuring phase of services to citizens for later integration; · Integration forecast in the next semester;
4	Technical or infrastructure issues	· Lack of staff for implementation; · Lack of technical staff to dedicate themselves to the service; · Lack of definitions of legal aspects at the state level; · Lack of systems and infrastructure for systems; · Lack of a digital service transformation project; · There was no initiative;
3	Unforeseen	· PSC created before gov.br, no integration with other portals was foreseen; · Awaiting definition from the SGD as to the form of integration; · Awaiting definition regarding the use of integration by the government;
2	Did not join or waiting to join the Rede gov.br	· Waiting to join the Rede gov.br; · Analyzing the possibility of joining the gov.br; · Finalizing the process of joining the network to later proceed with the integration;

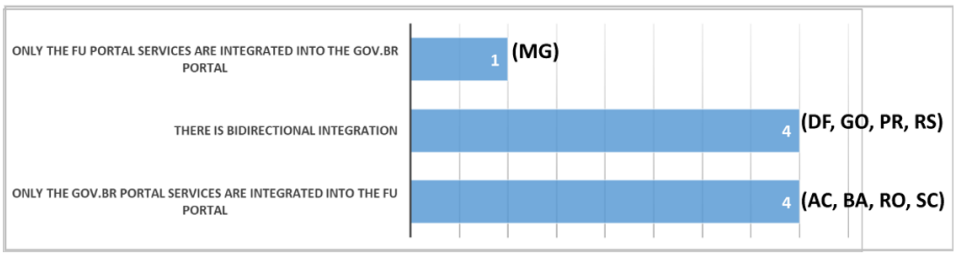


Figure 5: Direction of inte gration between state and federal PSC. Elaborated by the Authors.

Table 6: Services that use Advanced Electronic Signature. Elaborated by the Authors.

UF	Services used
AM	Electronic Document Management System (SIGED)
CE	Services related to the Payment of Public Accounts
DF	Electronic Information System (SEI)
ES	Electronic Process System
GO	Traffic Accident Certificate; Change of Vehicle Address; Second copy of Driver's Licence;
PB	Definitive Driver's License; Recycling Course; Agro defense; GTA issue
PI	Digital document processing system.
PR	Electronic Information System; Internal Control System; SIAFE; SIAPE
RO	electronic protocol
RS	Signing contracts with companies
SC	All UF services that require advanced electronic signature authentication

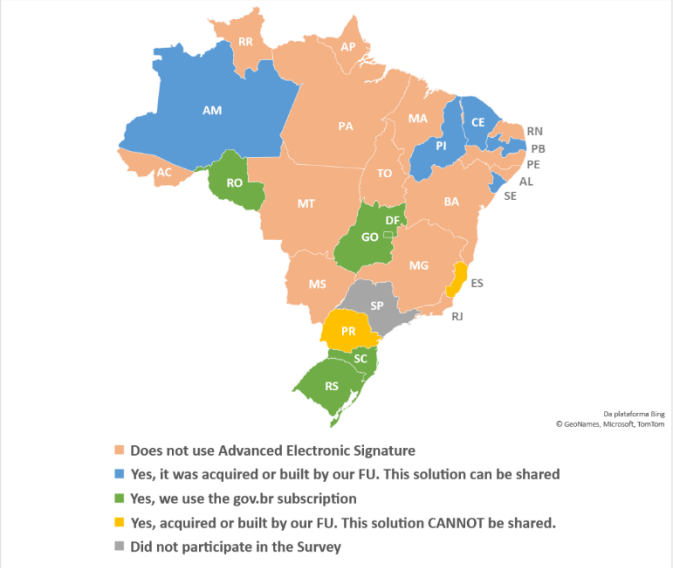


Figure 6: Use of Advanced Electronic Signature. Elaborated by the Authors.

in the development or adoption phase; there are technical problems faced in adopting the solution; or there is still no forecast to implement.

For the FUs that are developing or adhering to the functionality (AP, BA, MA, MG and MS), they justify that they are still carrying out studies for adoption, need to technologically structure their systems or are still evaluating the functions of the Advanced Electronic Signature.

On the other hand, the FUs that alleged technical problems (AC, RR and TO), translate into incompatibility or difficulty of integration, absence of legal definitions of the FU itself, lack of systems or infrastructure to support the functionality or still lack of digitization of public services for later implement the solution. Three FUs (AL, MT and PA) did not indicate a forecast to carry out the integration, claiming that they are still getting to know the tool, are developing their solution or have given priority to a qualified and straightforward signature. Table 7 details the results.

4.5 Use of other services of the Rede gov.br

Only four FUs (AC, MG, PI and RS) indicated using the solutions offered by gov.br. Among the services adopted by these four FUs are the use of resources from the +Brasil platform, training and capacity development services, issuance of digital certificates, sharing of problem solutions to favor the quality of public spending and access to the partner network of the Federal Government (see Table 8).

The state of PE showed interest in using other solutions offered by gov.br, such as Taxi.Gov, evaluation of services, training in digital transformation and methodology for calculating the costs of services.

Table 7: Reasons for not using Advanced Electronic Signature. Elaborated by the Authors.

F.U.	Reasons for not integrating	Detailing the reasons
8	Under development or in the process of joining	· Study phase for the adoption of advanced subscription; · Technological structuring phase; · Solution evaluation; · Implementation forecast soon;
3	Technical issues	· Integration incompatibility by downloading tabulated data from Agreements; · There is a lack of definitions of legal aspects at the state level; · Lack of systems and infrastructure for systems; · Lack of service transformation and digitalization project; · Difficulty implementing;
3	Unforeseen	· Phase of knowledge of the technology and its challenges; · Development of own solution; · Simple, qualified subscription prioritization;

Table 8: Use of other services of the Rede gov.br. Elaborated by the Authors.

UF	Serviço utilizado
AC	Integration of downloading tabulated data from Agreements (Plataforma +Brasil).
MG	Training services provided by Digital Government Secretary
PI	Issuance of Digital Certificate (SERPRO)
RS	Capacity Development Program; Sharing solutions for solving common problems; WhatsApp network of Rede Gov.br partners.

5 CONCLUSIONS

This research aimed to present a diagnosis of the current stage of adhesion and integration of the FUs and Federal District (FUs) to the National Network of Digital Government (Rede gov.br) and some of its functionalities. As for joining Rede.gov.br, 19 of the 26 FUs are already part of it, seven have not yet joined the Network. However, six FUs plan to join, are in the analysis phases, are in the process of signing up for membership, or are already using the Network's services (but without signing the membership term). Only one FU indicated that it does not plan to join due to the impossibility of internal factors.

Regarding the use of the Rede.gov.br Single Login, 16 have not yet adopted it. The justifications that deserve more attention are those of the FUs. They pointed out insufficient technical staff to dedicate themselves to such implementation, the need to change many internal systems to implement the functionality and the lack of systems and infrastructure for performance.

The integration of the FUs Services Portal with the gov.br Portal has not yet been implemented by 17 FUs. Of these, four indicate technical problems such as lack of personnel, legal definitions or infrastructure; and three FUs showed that they do not have a forecast for implementation. In addition, the advanced electronic signature is not present in 14 FUs, six of which also have technical problems or are not expected to be adopted. Only one FU that has not yet adhered to the researched features showed particular concern with digitally illiterate citizens, who cannot use the digital services offered.

This research did not explore the impacts of using such resources by the FUs to implement digital government and the generation of public value for the citizen. It was also not explored whether Rede.gov.br will evolve into a consolidated system for coordinating public policy on digital government, subjects for future research. Also, as future work, it is recommended to investigate and discuss whether Rede.gov.br can evolve from a federal public policy to a national public policy.

The results suggest that, among the FUs that have not yet implemented the solutions, there is an interest in joining and most FUs are already moving in this direction. However, some FUs still face problems such as digitizing public services and a lack of qualified personnel or infrastructure to implement the functionalities. Based on the information provided in this research, specific actions can be directed to overcome the challenges identified and advance the goals of Digital Transformation among the federated entities in Brazil

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The Implementation of a Digital Strategy in the Austrian Public Sector

Noella Edelmann
University of Continuing Education Krems
noella.edelmann@donau-uni.ac.at

Ines Mergel
University of Konstanz
ines.mergel@uni-konstanz.de

ABSTRACT

The European Commission's eGovernment report states that "eGovernment in Europe is characterized by a "virtuous circle": public administrations develop better and better digital services because user demand is high; and more and more users access government services online because these services are available and easy to use" [1]. In this report, Austria ranks among the top five in the delivery of public services, high on indicators such as transparency and the key enablers that facilitate digital interactions between governments and users, help to standardize process flows and thus help both citizens and businesses in their dealings with the government. Yet in the most current Digital European Society Index Austria ranks only 10th and is described as being slow in improving the use of digital services, connectivity and integration of digital technology. In this study, we aim to investigate the strategies implemented for the digitalization of services and processes in Austrian public administrations in order to explain such incongruous scores.

CCS CONCEPTS

• **Social and professional topics** → Computing / technology policy; Government technology policy.

KEYWORDS

public administrations, digital strategy

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1 INTRODUCTION

The widespread adoption of new information and communication technologies (ICT) has led organizations to develop strategies in order to take advantage of them for manufacturing, service delivery, customer relationships and human resource development. These strategies usually include the explicit transformation of important business processes in order to create impact on product development, internal work processes, organizational structures and the values and concepts of the organization. Blackler and Brown [2] have argued that when implementing technology, a strategy must contain four phases: an initial review of possible opportunities, exploration and prior justification, design of the system, and implementation. Matt, Hess and Benlian [3] identify four dimensions that digital transformation strategies have in common, independent of industry or firm: the use of technologies, the changes accruing to value creation, the changes in organizational structure, and the financial considerations driving digital transformation. According to Lember [4], this requires public administrations to develop new practices and gain new competences to serve the public more efficiently and more effectively. Digital transformation though requires "a comprehensive organizational approach rather than one that merely makes forms available online or the transition from analog to digital public service delivery" [5]. The majority of digital transformation initiatives though fail to produce the anticipated results regardless of changes in policy and governance [6, 7].

In this study we therefore investigate the strategies implemented for the digital transformation of public administrations and reasons why these efforts still fail. In order to investigate this issue, we picked a particularly interesting case to study – the digital transformation of the Austrian public administration at the municipal, regional and national levels. The reason for selecting Austria for this study is that although the 2020 eGovernment benchmark report ranks Austria ranks high in the delivery of public services [1], it is low in the Digital Economy and Society Index (10th) and is described as only slowly improving in the use of digital services, connectivity, and integration of digital technology [8]. We therefore aim to answer the following research questions: What are the targets of the digital strategies and how are these monitored in Austria? What are the phases or elements that characterize digital strategies in the Austrian public administration? What are the preparatory steps taken for the implementation of a digital strategy? To answer these questions, 41 digital transformation experts from the Austrian public sector were interviewed between 2018 and 2019. Some of the experts identified the phases of a strategy, such as ensuring the availability of certain tools, developing solutions, enabling the technology, and others see the development of a digital strategy itself as part of an overall strategy and achieving the digital transformation of public administrations in Austria. Preparatory steps play an important role, just as much as the need for digital leadership. The results gained show the lessons learned in Austria that could be useful for public administrations in other countries in the process of developing and implementing a digital strategy for their digital transformation.

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2 BACKGROUND

Since the 1990s, information and communications technology (ICT) has played a central role in reshaping and transforming public administrations. The use of ICT as a tool for change in the structures and processes of governmental organizations enables the exchange of information between citizens, businesses and government in order to achieve results such as improved efficiency, convenience as well as better accessibility of public services [9]. The effective integration of services and processes represents the transformation of structures, processes and management culture as well as new forms of cooperation between public authorities, organizations and society [10]. In order to achieve these aims, organizations have to develop and implement strategies that focus on the transformation of those processes that will have an impact on product development, internal work processes, organizational structures and the organizational values.

In a business context, Blackler and Brown [2] have argued that when implementing technology, a strategy must contain four phases: an initial review of possible opportunities, exploration and prior justification, design of the system, and implementation. Berman [11] distinguishes between three digital transformation strategies in the private sector that focus on as: redefining the customer value proposition using information and analysis, redesigning the customer value proposition, and increasing, expanding or redefining the value of the customer experience; redesigning the business and operating model by building on the existing infrastructure and adding new digital functions; and combining these two approaches by simultaneously transforming the customer value proposition and organizing the delivery processes. Bharadwaj, El Sawy [12] instead, argue that given that as digital technologies and digital platforms are enabling cross-boundary industry disruptions, new forms of business strategies are necessary that address "(1) the scope of digital business strategy, (2) the scale of digital business strategy, (3) the speed of digital business strategy, and (4) the sources of business value creation and capture in digital business strategy" (p.1). More recently, [13] note that "IT strategies usually focus on the management of the IT infrastructure within a firm, with rather limited impact on driving innovations in business development" (p. 339), but that digital transformation strategies require a different perspective and different goals. They identify four dimensions that all digital transformation strategies have in common, independent of sector: the use of technologies, the changes accruing to value creation, the changes in organizational structure, and the consideration of the financial aspects driving transformation. These dimensions represent the "Digital Transformation Framework (DTF)" model, where the use of technologies is understood both as an organisation's attitude towards new technologies as well as its ability to exploit these technologies. The use of new technologies, Matt et al. argue, implies changes in value creation such as the opportunities to expand the products and services offered, but also the development of relevant competences. Structural changes in the organizational set-up will be necessary, but financial aspects play a central role, these are both a "driver" and a "bounding force" (p. 341). They argue that a successful digital transformation relies on aligning the four dimensions, but also aligning the strategy with other functional and operational strategies. It is this alignment that is particularly difficult and requires additional coordination efforts.

Digital is clearly seen as a transformative driver whether dealing with products, services, or processes, and many are experimenting with digital technologies, trying to make use of their potential and evaluate their impact for value creation and competitive advantage [7]. Graham and Dutton [14] argue that the development of technologies and the social implications associated with it are shaped by policy and regulations – governments "encourage technological innovation through investment in computing and telecommunications" (p.14). In addition, they add, if the next two decades are as transformative as the previous two, "it is likely that that many of us will be living in a very different technologically, informationally, and algorithmically mediated world" [14]. In public administrations, digital transformation can be understood as the transformation of internal and external processes and structures supported by ICT "in order to provide services that meet the goals of the public sector such as efficiency, transparency, accountability and closeness to the citizen" [15]. Public administrations are therefore under pressure from political leaders and citizens to digitally transform and adapt their organizational strategies [6].

The majority of digital transformation initiatives fail to produce the anticipated results regardless of changes in policy and governance, sometimes as a result from controversies [16]. There may be several reasons for this. Digital transformation strategies used for the public sector are often based on experiences and expertise from the private sector [17] although the aims and responsibilities of the public and private sector differ and may even be at odds [18]. Weerakkody, Sivarajah [19] note that the aim of digital strategies in the private sector focus on reducing costs and increasing profits whilst the public sector addresses reducing waste, improving citizens' service outcomes and experience. Strategies for digital government are often imprecise and may refer to formal policy documents implemented by local or national governments [20]. Some digital strategies may also be too specific, addressing individual cases or specific digital aspects of digital government or focus on the use of social media [21] rather than adopt a holistic approach or address the whole organisation. Another reason may be that digital transformation processes are rarely clean, linear progressions [22] and that the public sector may follow a different logic and longer paces [23].

The strategic document that has shaped the efforts in the last years is the eGovernment Action Plan 2016-2020, it focuses on engaging, connecting, digitising and enabling digital public services [24]. Other policy documents and agreements such as the European Interoperability Framework [EIF, 25] (European Union, 2017), the Tallinn Declaration [26] and the Berlin Declaration [27] also play an important role in the digital transformation of the public administrations (European Commission, 2020a). The digital challenges and opportunities public administrations face differ according to the country's political and public administration context. European benchmarks for digitalisation and e-government monitor the implementation of technology and digital measures in the member states, e.g., the Digital Economy and Society Index (DESI, European Commission, 2021a), or the eGovernment Benchmark (European Commission, 2020c). In the European context, countries that achieve high rankings in the digital government context are,

for example, Denmark, The Netherlands, Finland, Estonia, the UK, Luxembourg, Belgium and Austria [28].

In the 2020 eGovernment benchmark report [1], Austria ranks high in the delivery of public services, the digitalisation of front- and back offices and indicators such as transparency and key enablers. The Austrian Digital Roadmap [29] urges the implementation of digital strategies in all sectors. The public administration plays a central role in these national digitalisation efforts: „The public sector also sees itself as an innovation driver for Austria. Citizens and businesses have the right to convenient, simple and barrier-free electronic communication with the public administration." (p. 5). Digital services are increasingly used by citizens and businesses to find information, complete official procedures electronically with the mobile phone signature or pay fees online. Mobile and digital services are understood as official channels to be used electronically by citizens and businesses 24/7 and public administrations process the electronic files (ELAK) as part of a digital workflow [30], There are also digital strategies at the regional level, for example the "Digitalisierungsstrategie NÖ" in Lower Austria [31] that focuses on three goals in particular on securing jobs, strengthening the rural regions and improving the quality of life. Municipalities and cities also have their own digital agenda and strategy, e.g., the Digitale Agenda Vienna [32].

Austria's digital strategy has been criticized for its lack of quantified targets and monitoring [1]. In this study we aim to investigate the implementation of digital strategies in Austria to answer the following research questions: What are the phases or elements that characterize digital strategies in the Austrian public administration? What are the preparatory steps taken for the implementation of a digital strategy? What are the targets of the digital strategies and how are these monitored in Austria?

3 RESEARCH DESIGN

A qualitative approach was chosen as this allows the analysis of real-life phenomena and to understand the context and significance of the viewpoints of those involved [33]. Expert interviews were used to collect the data and, as the aim is not to simply report the frequency of codes, but to find significant meaning in the data. A narrative interpretative approach was chosen for the analysis. A narrative analysis allows the integration of different viewpoints and to identify similarities and differences in the experiences and actions [34, 35].

3.1 Case selection

This case was chosen as the Austrian digital strategy urges the implementation of digital strategies in all sectors, in particular in the public administration. To achieve the aims set out in the digital strategy, the political responsibility for Austria's e-government strategy has been moved from the Federal Chancellery to the Federal Ministry for Digital and Economic Affairs, which has set up the online platform Österreich.gv.at to provide information and select digital services for citizens, the Mobile App Digital Public Office [30], the online platform Unternehmerserviceportal for businesses [36], and a digital post box for users [37]. Further objectives include a greater use of ICT tools, the implementation of e-payment systems, digital delivery and digital signatures, but also fostering citizen participation and involvement in the overall digital transformation of the country. The development of the vision Digital Austria in 2050 includes several strategic action plans on select priority topics [38].

The legal basis for the digital strategy is the implementation of the Austrian E-Government Act [39]. It includes three central principles: free choice of communication channel with public administrations, secure and data-protection-compliant implementation of electronic communication, and barrier-free access to public administration.

3.2 Method

The data was collected using expert interviews [40]. 41 experts from the Austrian public sector were interviewed 2018-2019. The sampling strategy followed a purposive sampling approach [41]. First, a small sample of international experts in the public sector digital transformation field was identified. The selection of the first sample of experts was based on the criteria derived from the study's aims and the knowledge about the study's population. In a second step, a snowball approach was applied to the individuals identified through these activities [42]. 33 interview participants stem from the Austrian government sector, six from organisations from the private sector and two from the non-profit sector that either work with or advise public administrations on digital transformation projects and strategies. The number of interviewees lies above the suggested 20–30 interviews and the sample can therefore be deemed as large enough in order to answer the research questions set [43].

The questions for the interview guideline were developed using theoretical concepts of digital transformation and e-government (the interview guideline is described in detail in Mergel, Edelmann [5]). In the interview guide, these questions specifically address digital strategies in Austria:

Why do you think public administrations embark on digital transformation processes?

What does a strategy for digital transformation look like in your opinion?

What are the main elements of a strategy?

What are the implementation phases for digital transformation?

What does the public sector need to do to prepare public administrations for the transformation processes?

The interviews were conducted by phone or Skype and recorded for data analysis purposes. Prior to recording, the interviewees were asked for permission, and the interviewees' names and affiliations were anonymized to protect the identities of the interviewees.

4 ANALYSIS

The memos and the transcripts were analyzed using thematic analysis to identify the "what" of the narrative (the content of stories) and involves searching and identifying common threads by breaking down the text into smaller units of content and then analyzing them in order to achieve a rich, detailed and complex account of the data [40]. The initial coding list in Table 1 was derived from the literature on digital strategies.

The data analysis phase consisted of a first-cycle and second-cycle [34]. Using the initial list, the data was first categorized into larger data chunks and then, in a second step, analyzed in-depth

Table 1: Initial coding list

Phases that characterize digital strategies
• The use of technologies
• Changes accruing to value creation
• Changes in organizational structure
• Financial aspects driving transformation
Targets set out in digital strategies
• Transformation of the back-office business processes
• Complete transaction and service delivery online
• Shift citizens and businesses to digital channels for economies of scale
• Sharing infrastructure, processes and standards and working together to develop solutions across government departments
• Exchange of information between authorities and citizens, companies and partners
Monitoring change
• Adopt appropriate time horizons for change, set priorities and measure progress
• Develop the necessary leadership, incentives, attitudes, skills, guidelines, and culture within government to initiate and sustain change

by adding and refining the categories. The themes identified in the literature review guided the first step of the analysis of the experts' views, experiences and activities [40]. In the second stage of analysis, the data was re-analyzed and grouped into a smaller number of categories. During this cycle, the analysis helps to explain how the phenomena investigated develop patterns, relationships, and processes, and the differences and similarities between them [34].

5 RESULTS

This section contains the results gained from the analysis of the data of the 41 experts interviewed. They are supported by quotes from the interviews as this illustrates the experts' different perspectives, helps to enhance the transparency of the research process and enables other researchers to follow the reasoning [44].

5.1 Digital Strategies

We asked the experts what they believe a digital strategy should look like. Many noted that above all, that a digital strategy must be comprehensive, holistic and be implemented across departmental, organizational, federal and sectoral boundaries:

In general, with the strategic approach, I think it is important to look at the whole picture. (AT16)

For me, it would definitely be a comprehensive strategy. I don't think much of strategies where each economic sector, each ministry does something for itself in a quiet chamber, I think it requires a broad approach. You can see that in many areas. Especially in areas where many levels are involved. The municipal level or the EU level or even the national level, I think we need to take advantage of synergy effects and really look at what we already have. Where is there potential, what can be used, what is going well? [. . .] It's no use if I have a strategy for digital transformation for Vienna, but in the best case I have it for the whole of Austria and in the optimum I have it for the EU public sector (AT13).

A strategy has to serve the whole of society, so the public administration's own role as well as that of the stakeholders becomes important. Not only must the public administration develop a new awareness about what digital transformation is (9), but stakeholder participation is central for the development of a strategy (13). The need for a new awareness or mindset was highlighted by several interviewees:

Well, some people might want a strategy for the whole of society that someone or some small group comes up with. I think this must be approached in a different way. In this area, it is a matter of grasping the challenges that exist for society, which are formed with the digital transformation. And that is a dimension that is always of enormous importance for our coexistence in a state. (AT12)

Whilst some highlighted the importance of having a digital strategy (3), it is important not to see this as an IT project (5), but as an opportunity to assess the IT that is currently being used (1) as well as the digital competences currently available in the organization (1). Further central elements of a digital strategy are the need to link it to an organizational strategy, thus, to consider its impact on financial resources (7) as well as increasing efficiency (5). New areas may also need to be addressed (4), in particular citizens orientation, and emphasizes the need for public administrations to be more participatory and take on the role of the listener:

For me, a classic strategy process is always: listen, understand, act. [. . .] I have to have a dialogue with many people to find out where

Table 2: Results from the data analysis

Phases that characterize digital strategies	Experts
Analysis of the business model	11
Set aims	4
Changes in organizational structure	3
Generation of ideas and collection	2
Stakeholder involvement	2
Financial aspects driving transformation	1
The use of technologies	1
Changes accruing to value creation	1
Preparatory steps	
Leadership	25
Address known barriers	15
Digital Leadership	10
Agile Management	9
Allow mistakes	9
Communication	9
Change Management	7
Organization	
Competences	26
Mindset	18
Organizational culture	6
Organizational development	6
Financial aspects	4
New methods	3
Stakeholders	3
Participation	14
Infrastructure	8
Targets	
Digitalization	24
Values	11
Customer focus	10
Transformation of the back-office business processes	10
Complete transaction and service delivery online	7
Reduce costs	7
Infrastructure	5
Exchange of information between authorities and citizens, companies and partners	4
Set aims	4
Window of opportunity	4
Competences	3
Sharing infrastructure, processes and standards and working together to develop solutions across government departments	3
Mindset	3
Security	3
Shift citizens and businesses to digital channels for economies of scale	2
Digital resources	2
Increase quality	2
Monitoring	
Adopt appropriate time horizons for change	4
Set priorities	3
Measure progress	2
Develop leadership, attitudes, skills, guidelines, and culture within government to initiate and sustain change	0

I stand and then analyze that so that I then take the right steps. (AT10)

The main goals of the strategy are citizen orientation, strengthening the business location, trust and security, for example, the topic of data protection and data security, which is very important. New compared to previous strategies is probably the topic of transparency, openness, participation, the topic of innovation and Viennese specifics are, of course, also the topics of inclusion, gender equality and one must not forget the topic of flexibility and learning of the people involved. (AT11)

5.2 The implementation phases of digital strategies

In their digital transformation framework, Matt et al [3] note that across all sectors, digital strategies are characterized by the following phases: the use of technologies, changes accruing to value creation, changes in organizational structure, and the financial aspects driving transformation. In the interviews, the phases from the digital transformation framework were rarely mentioned. Only the phase regarding the changes in organizational structure was mentioned more than once (3):

That would also be a step to say, if I now act with a strong digital focus in the future, I have to adapt my organizational structure, I have to create new departments and areas, new responsibilities, new roles. (AT1)

The phase most experts pointed out was the analysis of the business model (11), and then, albeit to a lesser extent, the need to set out the aims (4), generate new ideas (2) and ensure stakeholder involvement (2). The business model and what can be achieved is central to the digital transformation in public administrations:

Very few administrations know what services they currently offer. [. . .] And only when I have worked that out can I think about what I can digitize or where are the individual levels of difficulty in digitization? What is easy to digitize because it is used by many or because it is not very complex, or what is difficult to digitize because it is very complex or because many, many different administrative bodies have to be digitized? (AT15)

5.3 Preparatory Steps

The two most important preparatory steps for the implementation of a digital strategy are leadership and the development of competences (25):

if I act with a strong digital focus in the future, I have to adapt my organizational structure, I have to create new departments and areas, new responsibilities, new roles. How can I further develop the current employees in order to meet these requirements? What know-how might I need to bring in? What might I have to deliberately throw overboard, because it weighs on me, because I keep thinking in silos that have existed up to now, but which have to go. (AT1)

If you take the digital transformation and really live it in the workplace, in the environment, then I think we need a different kind of leadership behavior (AT14).

Leaders need to adopt a new mindset (18) and be able to address known barriers to change (15). Using principles of digital leadership (10), agile management (9) and change management (7) can be useful:

In the agile process that goes hand in hand with these changes, it is essential to bring in a certain error culture. That is clearly a leadership task. (AT36)

Several other preparatory steps are related to the organizational culture of public administrations: the development of a new organizational culture (6), one that allows mistakes and errors (9), the ensures the use of new methods (4), participation (17) and strengthens the communication between the stakeholders (9). Further preparatory steps should consider the infrastructure required (8), the financial impact (4), the re-organization of the IT department (3). Preparatory steps may also may also focus on ensuring political support for the implementation of a digital strategy (5), showing the success or quick-wins that can be achieved (1) and ensuring transparency from the beginning (1). The political support must have awareness and knowledge about digital transformation processes:

It won't work without political will, which means that we simply have to ensure that there is a political climate that recognizes the value of digitalization for the administration and for society as a whole. Politicians who live it themselves, in their private lives, and who may have already had it in their professions before. (AT4)

5.4 Targets

The analysis of the business model is important in order to set the targets and aims to be achieved. The most important target is that the digital strategy should achieve or support digitalization and a modern way of working that reflects changes in society (24):

In general, we will have to move with the times, and if everything else is modernized, then the administration will not be able to stay behind. (AT18)
because we want to work more efficiently, more modernly and better as a city administration, and digital transformation is above all a rethinking and reworking of processes and we also try to make the work easier for the city administration. (AT23)

There is a clear need to use the window of opportunity currently offered (4) and to use it to new aims such as digitalization of back-office processes (10), develop customer-centered approaches (10), to reduce costs (7), and provide online transaction and service delivery (7). Further aims mentioned are to support the exchange of information (4), develop competences (3), increase the quality of the services offered (2), develop a new mindset (3), ensure secure services (3), share the infrastructure, processes, standards and solutions (3), to use digital resources (2) and to shift or encourage the use of digital channels (2).

5.5 Monitoring

Monitoring the implementation of a strategy is important in order to know whether the set targets are being achieved. The implementation of the strategy must therefore be monitored by setting

the priorities (3), defining the time horizons (3), and measuring the progress of the implementation (2). This can be supported by implementing agile projects and pilots, and learning from the outcomes:

we have taken such implementation steps, such transformation steps, to go into piloting relatively quickly, into trial operation again with the staff, so that they can also imagine and be involved in how these first steps will be, collect feedback and accompany it here again quite decisively and thus also a continuous improvement process, these feedbacks, which must also be ensured here in a cycle. So this phase after the actual transformation is also very, very essential in order to a) stabilize the process and b) make it more effective and efficient. (AT37)

6 DISCUSSION

In this study we aimed to investigate the digital strategies implemented for the digital transformation of public administrations in Austria and the reasons why the digital transformation of public administrations may still fail. In order to answer the research questions, 41 digital transformation experts from the Austrian public sector were interviewed about what they believe a digital strategy should look like, including the preparatory steps and the implementation phases, the targets to be achieved and how these targets are monitored.

Because of its government and political structure, there are many different digital strategies in Austria – at the federal, regional, municipal and organizational level. Many experts though noted that a digital strategy should be broad and serve the different levels of government and public administrations, rather than develop several strategies for different needs, government levels and even organizations in the public sector. A digital strategy should be able to cut across the public administrations, and efforts should be put into developing a strategy that is useful to all public administrations, regardless of type of organization, focus of the services offered or level of organization. This follows the argument put forward by Bharadwaj, El Sawy [12], who argue that digital technologies and digital platforms must be cross-boundary. Central aspects of a digital strategy are the need for a type of leadership, a new mindset or awareness of the impact of digitalization in society and the participation of the stakeholders, including citizens, in its development. Engagement and user-centricity is important, and can be supported by tools that allow continuous interaction with participants helps to appreciate their needs, but also their values, norms and practices [45]. This acknowledges that a strategy needs to have a customer or user focus, a central element repeatedly found in European policy documents such as the Tallinn or Berlin Declaration or the European Interoperability Framework. This emphasizes the importance of ensuring stakeholder involvement to help generate of new ideas. Identifying their needs can be achieved by knowing who the stakeholders are, and then involving them in the development of the strategy as can be seen, for example, in the development of the Digital Agenda of Vienna [46].

Several experts highlighted how important it is to have a digital strategy, one that is linked to an organizational strategy as well as an IT strategy, although a digital strategy should not be seen as either being or driving an IT project. This reflects the issue raised by Matt et al [3], who emphasize the need to align a digital strategy with other functional and operational strategies. What are the phases or elements that characterize digital strategies in the Austrian public administration? In their Digital Transformation Framework (DTF), Matt et al [3] identify four dimensions that all digital transformation strategies have in common. Although to a limited extent the Austrian experts pointed out these phases, the phase related to changes in organizational structure was seen as the most important one. But the experts identified other elements as more being more important. In this study, the financial aspect and the financial impact of a digital strategy were mentioned only by a few experts, but most experts pointed out was the analysis of the business model to identify the changes necessary and set the aims to be achieved. Whilst Matt et al [3] argue that the financial aspects play a central role in developing a digital strategy, both as a driver and a limiting aspect, the focus on developing a business model is more in line with the phases described by Blackler and Brown [2] who argue that when implementing technology, a strategy must contain the phase of an initial review of possible opportunities. Weerakkody, Sivarajah [19], has described this issue before, noting that whilst the aim of digital strategies in the private sector focus on reducing costs and increasing profits, public sector organizations address other issues such as stakeholder participation and public administration values such as efficiency.

The lack of broad management knowledge about the potential and requirements of new technologies is seen as one of the main reasons for failed ICT investments in public and private companies. A new organizational direction cannot be achieved through technology alone, but requires changes in attitudes, skills in the organization and to encourage cultural change. Preparatory steps are therefore central to strategy implementation. The results gained here reflect this: the two most important preparatory steps for the implementation of a digital strategy are a new type of (digital) leadership and the development of competences. Management and leadership practices vary significantly and have an impact on the success of companies using new technologies, on productivity and workers. As e-government and e-business applications continue to spread, managers need to deepen their understanding of the potential of ICT and administration. Leaders tend to isolate and delegate ICT leadership to technologists and ICT managers and are unaware of the critical role they have to play in integrating ICT. Instead, leaders need to draw on agile management, be able to support change management and be able to address known barriers to change. As noted by the experts, digital leadership requires an understanding of how technology interacts with other factors, such as organizational policies and strategies, organizational structures, and organizational practices. Changing the culture of an organization is difficult and needs to allow for testing and piloting, the use of new methods, but also for mistakes. As public organizations are under pressure from political leaders to digitally transform the provision of their services [6], one of the preparatory steps that experts recommend is to engage the support of politicians who are also knowledgeable about digital transformation.

The literature shows that the results that digital transformation in public administration can be achieved by including the transformation of back-office administrative processes, new and attractive customer-centric practices, complete transaction and service delivery online, and shifting citizens and businesses to digital channels.

However, the majority of digital transformation initiatives still fail to reach the targets and produce the anticipated results [6, 7]. One of the main criticisms made by the European Commission [47] is that the Austrian digital strategy urges the implementation of digital strategies in all sectors, but lacks quantified targets and monitoring A digital strategy therefore needs to include the targets or aims that are to be achieved, such as ensuring that organizations make the necessary adjustments to their business and IT strategies, change their organizational structure as well as their processes. What are the targets of the digital strategies and how are these monitored in Austria? The aims of the Austrian federal government include the greater use of ICT tools, the implementation of e-payment systems, digital delivery and digital signatures, fostering citizen participation and their involvement in the overall digitalization of the country. The "Digital Austria in 2050" strategy is to update and harmonize different outdated strategies, fostering the digital transformation and improving user-centric, modern e-government services. In this study, the answers given by the experts reflect these aims: the most frequently-mentioned target of a digital strategy is digitalization per se. Leadership plays a central role in digital strategies, it helps to not only lead employees and the organization, but also to support collaboration, organizational change, and developing an organizational culture that helps to achieve the targets. Further targets are upholding the values of public administrations, digitalization of back-office processes, a focus on the customer or user, reducing costs and to achieve online transaction and service delivery.

Why are digital strategies implemented for the digital transformation of public administrations not achieving their goals? Digital transformation processes are rarely clean linear progressions [22] and different agencies may follow different and longer paces [23]. Monitoring includes setting up appropriate time horizons for change, setting priorities and measure progress as well as developing the necessary leadership, incentives, attitudes, skills, guidelines, and culture within government to initiate and to sustain change. All the experts pointed out several targets, but only a few of them highlight the importance of monitoring, assessing and evaluating the implementation of the strategy by setting the priorities (3) and time horizons (3), as well as measuring the progress of the implementation (2). In addition, some of the targets set, such as digitization, upholding public administration values or developing a customer focus can be hard to measure, assess or quantify numerically for the indexes preferred by the European Commission.

7 CONCLUSION

Digital transformation can lead public administration from a closed, hierarchical and inward-looking organization to an open, decentralized, service-oriented and networked organization. In order to help public administrations' digital transformation, digital agendas can set the target and steps necessary to achieve them. In Austria, and in other countries too, a new direction cannot be achieved through technology alone, but requires digital leadership, changes in attitudes, skills in the organization, often seen as preparatory steps. By setting targets and goals, monitoring can be improved, although the aims which cannot be quantified numerically would certainly require a qualitative rather than a quantitative assessment.

This study shows the benefits of a qualitative assessment of the Austrian public administration's digital transformation. There are several lessons that can be learned from this analysis that can be of benefit to Austrian and other countries aiming to digitally transform. A digital strategy needs to be holistic and comprehensive and be broadly applicable. It requires a new type of (digital) leadership, one that is agile and able to engage the users. The digital strategy should not be a stand-alone implementation but be linked to other important strategies and changes in organizational structure. When preparing the digital strategy, it is useful to develop it on the basis of a business model, the aims that need to be achieved and the political support by politicians who are knowledgeable in this area. As the implementation of such a strategy will lead to change, it is important to ensure the development of an organizational culture that allows experimentation, piloting and making errors. To learn from the implementation, it is necessary to monitor it. In a next step, this evaluation could be extended by assessing to what extent the experts think that the set goals and targets have been achieved, how to identify changes in organizational culture, especially in the context of the impact of the Co-VID-19 pandemic on the efforts to digitally transform public administrations. Whilst a qualitative assessment of the topic is important, the political context of Austria (a federal republic) plays an important role on digital strategy development but has not considered extensively here.

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Existence and Intentionality of Digital Transformation in Public Organizations: A Phenomenological Perspective

Yi-Fan Wang
School of Public Administration, University of Nebraska at Omaha
yi-fanwang@unomaha.edu

ABSTRACT

With the development of information communication technology, digital transformation has gradually become a significant research issue in public administration. Most scholars utilize positivism as the research paradigm to investigate digital transformation-related issues. The research mainstream identifies the reasons for digital transformation adoption as the variables and tries to establish causations. However, these studies can rarely explain how public employees and governments develop their intention for digital transformation. Phenomenology can address this gap by applying the concepts of existence and intentionality to analyze the governmental digital transformation. Phenomenology is one of the research paradigms in public administration and focuses on the subjective world of individuals. The paradigm investigates the interaction between the internal world and social phenomena. One advantage of phenomenology is to deeply understand how people understand the meaning of objects in the social world. It can explain why individuals and organizations decide to adopt digital transformation. This study utilizes theory-based literature analysis to explore the theories of digital transformation adoption. Research results indicate that six clusters of drivers and barriers can affect how individuals and organizations develop their intentionality on digital transformation. By integrating theories of digital transformation and phenomenology, this study proposes an initial conceptual framework to explain how and why public organizations decide to conduct digital transformation. This study expects to introduce another perspective to analyze digital transformation adoption and provides potential research agendas for digital governance issues.

CCS CONCEPTS

• **Social and professional topics**; • **Computing / technology policy**; • **Government technology policy**;

KEYWORDS

digital transformation, public organization, phenomenology, intentionality, existence

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1 INTRODUCTION

Digital transformation captures attention from both public administration scholars and researchers. Digital transformation refers to the cultural, organizational, relational changes resulting from Information and Communication Technology (ICT) adoption in the public sector [1]. This definition indicates that public organizations will experience significant adjustments, changes, and even reforms as governments decide to conduct digital transformation. Given the significant impacts of digital transformation, scholars are interested in why governments decide to take this action. The mainstream of these studies adopts positivistic approaches to identify affecting factors and variables of digital transformation adoption. Scholars also propose or apply many theories relating to digital transformation, such as policy innovation theory, enacted technology framework, and technology acceptance model [2-6]. Although positivistic research has investigated causations between variables, phenomenology can add value in understanding why and how public organizations take action on digital transformation. Hence, this study utilizes phenomenology to analyze the reasons for digital transformation and how public organizations develop their intentions and take action at the theoretical level.

Phenomenology is an academic paradigm to study the interaction between the internal world and social phenomena. Unlike positivists, phenomenologists hold more subjective approaches to realizing individuals' experiences and intentions. At the ontological level, phenomenology argues that the truths do not exist in the material world but are socially constructed in human societies [7]. Instead of exploring causations and developing universal principles, phenomenologists emphasize the importance of an in-depth understanding of people's thoughts and their stories. From the perspective of epistemology, this paradigm utilizes existence and intentionality to analyze the interaction between individuals and phenomena. Existence refers to everything people can capture, including their experiences, cultures, contexts, and situations, while intentionality describes the process that individuals give objects with their subjective meaning and understandings [7, 8]. So, the early development of phenomenology focuses on the individual level. Although phenomenology can be applied to explain the sense-making process at the organizational level, connecting the individual's intentionality with the organizational one requires more illustration [9]. Therefore, the objectives of this research are (1) to analyze the theories of digital transformation adoption from the phenomenological perspective, and (2) to explain how individual intentionality can develop the organizational intentionality of digital transformation.

This study adopts theory-based literature analysis to identify the existence of digital transformation adoption for individuals and propose the conceptual framework explaining the organizational decision-making process. Research findings suggest six clusters of drivers and barriers. Also, these findings support this study to develop the conceptual framework integrating individual and organizational intentionality to explain digital transformation adoption. Finally, this article discusses several research agendas for future studies with the conceptual framework.

The structure of this paper is designed as the following sessions. First, this study discusses the concept of digital transformation and its relationship with bureaucracy and public organizations. Second, this study introduces phenomenology and how to analyze organizational actions based on this paradigm. Third, the research approaches are discussed as well. Fourth, this study presents the reasons for digital transformation adoption from the phenomenological perspective. Fifth, based on the research findings, this paper proposes a conceptual framework integrating the existence of digital transformation, individual and organizational intentionality, and organizational action and its impacts on the current existence. Finally, the discussion and conclusion of this study are presented.

2 DIGITAL TRANSFORMATION

Digital transformation includes three levels. Mergel, Edelmann and Haug [1]argue that scholars may need to use different concepts to illustrate different levels of digital transformation. First, digitization is the lowest level of transformation and describes the analogous transmission from manual work to digital processing. Second, digitalization, the medium level of transformation, means that organizations do not merely change the existing procedures but extend the impacts to other organizational dimensions. Third, transformation, the highest level of digital transformation, focuses on substantial evolution on organizational cultures, norms and traditions [1].

As table 1 indicates, the three levels of digital transformation echo the concepts of street-level, screen-level, and system-level bureaucracies. First, public organizations and employees regard ICTs as the supportive instrument for delivering public services in the street-level bureaucracy. Bureaucrats still have most discretion, and organizational structures and boundaries are strictly defined by laws [10]. Governments only use ICTs to replace routine manual tasks, such as data entry and categorization. The ICT usage in the street-level bureaucracy can be described as digitization. Second, screen-level bureaucracy means organizations have developed systems for public employees to process applications and documents. As public employees utilize the systems, computers can make most decisions in service delivery. In other words, the role of ICT is leading, and employees lose most of their discretion. However, although organizational structure and boundaries are still organized and clear, they need to modify internal processes to integrate the impacts of ICTs [10]. At this level, the changes are not only on a single procedure but also on other dimensions: the digitalization of public services. Finally, system-level bureaucracy describes that the public employees lose entire discretion because machines and computers can automate all public services. ICTs are decisive in the decision-making process, and organizations need to respond to this new practice by revising laws, changing processes and routines, and creating different cultures and norms [10]. In other words, system-level bureaucracy means that organizations experience substantial changes due to ICTs. So, these bureaucratic and organizational forms are the outcome of the highest-level digital transformation.

3 PHENOMENOLOGY AND PUBLIC ORGANIZATIONS

This section illustrates how phenomenology can collaborate with action theory to explain how individual intentionality shapes organizational intentionality. This study introduces the development and crucial concepts of phenomenology and then discusses how phenomenology and action theory can investigate the development of organizational intentionality. In other words, this section firstly presents the concepts of intentionality and existence at the miso level and then connects the concepts to action theory at the meso level to show the development of organizational intentionality. Phenomenology can be expected to help academia explore why governments have intentions to conduct different levels of digital transformation.

3.1 Phenomenology: Intentionality and Existence

3.1.1 Subjective World. Phenomenology has been developed based on the argument of the subjective world. Like interpretivists, phenomenologists consider that it is impossible to obtain truth through pure objectivity. All objects are not independently existing in the material world but are perceived and situated by humans. In other words, the meaning of objects in the world is given by individuals and communities rather than entirely natural. Immanuel Kant proposes the two-world argument to explain the subjective world. Kant distinguishes phenomena, where we can understand things by empirical investigation, and noumena, where we cannot know the pure knowledge or concepts [11]. Based on the inaccessibility of noumena, researchers can only study the things that we can perceive and realize. Once humans understand things, the objects are socially constructed rather than entirely objective. Because of the social construction of objects, the meaning of the things can be various and contextually dependent. The diversified meanings result in no universal principles in the world. Also, the objects and concepts are perceived by humans so that researchers can rarely study the events and knowledge with natural, detached, and value-free manners. Therefore, phenomenologists consider that social scientists need to shift and move their research focuses from pure objectivity to subjectivity and phenomena.

Phenomenology regards the world as a phenomenon and emphasizes the importance of meaning. Kant analyzes the world from the perspective of idealism and proposes intuition as the starting point to realize phenomena [12]. Humans utilize their sensibility to perceive things in the world and use these feelings as the basis to take action. As humans have long-term experiences in responding to the events with the same feelings, they develop the intuitions to tackle the things in the world. These intuitions can construct the phenomenon for individuals. However, the intuition of things cannot be systematical for empirical study. Wilhelm Dilthey proposes the concept of verstehen (understanding) to articulate the

Table 1: Levels of Digital Transformation and Types of Bureaucracy

Transformation levels	Bureaucratic Forms	Role of ICT
Digitization	Street-level bureaucracy	Supportive
Digitalization	Screen-level bureaucracy	Leading
Transformation	System-level bureaucracy	Decisive

relationship between intuition creation, experiences, and related outward actions [7]. The way of understanding can realize how humans develop their intuition based on their experiences and how the intuition triggers them to take actions for events. This approach implies that the construction of phenomena depends on minds instead of emotion and mental status. Max Weber further develops this method and focuses on the understanding of social actions [7]. The Weberian argument attempts to integrate positivism and idealism to build causations between meaning and phenomena. Although he tries to bridge these two philosophies to investigate social reality, Weber still suffers from the shortage of positivism—it cannot adequately answer "why" humans take social actions. As researchers want to explore causations between variables, they need to simplify complex events to the operationalizable items. In this process, some components are disregarded and ignored. Even his argument is limited by positivism, but the most significant contribution is to focus on the way humans interpret objects. Therefore, these thoughts of phenomenon and meaning lay the groundwork for phenomenology.

3.1.2 Transcendental Phenomenology and Intentionality. Along with these statements, transcendental phenomenology utilizes the concepts of intentionality and intersubjectivity to study social phenomena. Edmund Husserl contributes to the development of phenomenology with the subjective position to explain the social world. He considers that all objectivity is from subjectivity, so that the natural attitude is suspicious. His approach tries to reduce the level of analysis to individuals, especially to human minds. Intentionality focuses on understanding the intentional interaction between minds and objects [7]. His philosophy indicates that consciousness is meaningful when humans have the intention to construct objects in their minds. This argument also echoes with Weberian thought of the subjective meaning of social actions.

However, if researchers strictly follow his logic to analyze social phenomena, they will face the isolation of an individual's intention without any external influences. Husserl's argument cannot answer why people have fundamental consciousness shaped by their parents, families, and communities. In order to address this issue, Husserl proposes the concept of intersubjectivity to describe "how the transcendental ego constitutes other egos as equal partner partners in an intersubjective community, which in turn forms the foundations for the objective world [7]." In his philosophy, the subjectivity and interaction between other egos construct the social phenomena. Intersubjectivity is the so-called objectivity in the world. It means that there is no pure objectivity but intersubjectivity in the world. Based on this discussion, the cognitions of objects are shared concepts resulting from the interaction of subjectivity, so that researchers should investigate how and why intentionality develops intersubjectivity in communities.

3.1.3 Existential Phenomenology and Existence. Existential phenomenology develops its arguments of experience and existence based on intersubjectivity. Intersubjectivity shows the interaction between an individual's mind and other egos in society. The implication of intersubjectivity is that humans can understand the meanings only through experiencing events and objects. Alfred Schutz articulates that consciousness is meaningful when humans think back to their experiences [7]. His argument is different from the perspective of Husserl on when consciousness is meaningful. Husserl believes consciousness can be meaningful as humans have intentionality to interpret objects, while Schutz considers that experiences give meaning to consciousness. Moreover, Martin Heidegger utilizes "being" to illustrate "how people perceive and make sense of their experiences [13]." The statement implies that shared concepts can be a research target to understand the influence of experiences. Researchers can understand "being" for individuals by interpreting the texts and languages from people. This nature emphasizes the more objective way to realize perceived realities rather than to human minds in transcendental phenomenology. However, "being" cannot be defined in a universal manner [8]. "Being" shows in various existence for different people. It means that existence can be observable concepts and objects in human minds. Even Heidegger takes a relatively objective approach to realize phenomena, but his position is still on the subjective end of the subjectivity-and-objectivity spectrum.

This study integrates the perspectives of transcendental and existential phenomenology to use intentionality and existence to analyze social phenomena. All social actions are triggered by intentionality. The intentionality can be shaped by existences, which are intersubjectivity in the current situation. As people take action, they may change shared concepts and understanding in intersubjectivity. Social phenomena can be affected by their actions. In other words, this study proposes that the application of phenomenology in research is a loop. Existence (existing intersubjectivity) can affect consciousness to develop intentionality. Intentionality determines what types of actions humans will take and construct a new intersubjectivity. The new intersubjectivity will be the existence of subsequent social actions in the future.

3.2 Phenomenology and Action Theory in Public Organizations

Action theory aligns with phenomenology to develop theoretical statements from social practices by investigating human intention and motivation. Although action and behavior are usually regarded as synonyms, the two nouns are used in different ways. The difference between action and behavior is that "actions are the things we do, and behavior is the things have done to use [14]." Action means behaviors plus subjective meaning [9]. In other words, from the

perspective of phenomenology, people take action only when they understand and interpret targeted objects. Individuals are active rather than passive and determined as taking action [15]. These arguments echo with the emphasis of Weberian statement: scholars need to understand the meaning of social actions. So, actions are associated with intentionality. Based on the discussion of phenomenology and action theory, the initial unit of analysis in the study of public organizations is managers and public employees. After realizing their existence, intentionality and action, we can try to explain why public organizations decide to take any actions.

Human relation is the key to the connection between employees and organizations. One of the earliest works discussing the relationship between employees and organizations is "The Giving Orders." In this article, Mary Pollett emphasizes the mutual understanding between managers and employees to achieve consensus on work objectives and contents, which can enhance the performance of workers [16]. The active orientation of humans can foster communication between group members to develop consensus. Active listening can alleviate and minimize the distortion of communication among members in organizations and can understand others' thoughts to form a consensus [9]. It implies that even managers have more substantial power to influence organizational intentionality and action, but they still need to have interactive and effective communication with employees to develop the consensus of organizations. This process can develop a shared understanding of organizational goals among members. So, Follet also considers that the organization is a platform for group members, including managers and employees, to exchange their experience and thoughts [17]. As the group members collectively make sense of objects, the used language expresses the shared world [8]. According to the discussion, each member can bring their intentionality to the discussion within organizations, and their interaction can develop organizational intentionality. As people have a shared understanding of goals, organizational intentionality will be developed and transformed into action.

Individual intentionality can be shaped by the existence presented in front of people, and their intentionality develops the organizational one. Action theory illustrates how people develop their intentionality and action. As people bring their intentionality to the discussion within organizations, they can develop the organizational intentionality by exchanging their thoughts. If they can achieve a consensus, the organizational intentionality and action are finally formed. This process is described as organizing and defined as "organizing is a process of collective sense-making about what people have been doing, what they might want to do in the future [9]." Moreover, because humans are active and self-determined, the intentionality and action of both individuals and organizations include personal and public values into consideration [18]. Therefore, the role of individuals in developing organizational intentionality is active and mutual, and the process of this development is open and diversified. On the other hand, organizational intentionality can be another existence for public employees to develop their intentionality. In other words, individual and organizational intentionality can mutually affect each other.

4 RESEARCH METHOD

This study utilizes the theory-based literature analysis as the primary research method. Although conceptual articles do not analyze empirical data, scholars use various approaches to conduct theoretical research. Conceptual research regards theories as to the targeted data for analysis [19]. Specifically, this research adopts theory synthesis and model-building approaches to develop the conceptual illustration. Theory synthesis refers to the integration of existing theories and concepts to offer new perspectives on specific issues, while model building focuses on establishing theoretical frameworks to describe the relationships between concepts [19]. Phenomenologists adopt the two approaches to explore digital governance issues. For instance, Zingale [20] uses the theory synthesis approach to discuss social media networking issues. Also, Piccorelli and Elias [11] use both theory synthesis and model building to study the application of video technology in policing. Therefore, this study identifies the theories related to digital transformation adoption and has potentials to explain the reasons that organizations and individuals take action on modifying governmental structures and practices.

5 DIGITAL TRANSFORMATION ADOPTION

Based on theory-based literature analysis, this study identifies six clusters of drivers and barriers to digital transformation. This section integrates theories of digital transformation adoption and public administration to illustrate the meanings of the existence for public employees, managers, and organizations in the decision-making process of digital transformation actions. The six existences include salient issues, organizational characteristics, experiences of digital governance, external pressures, the acceptance of managers and employees, and political objectives.

5.1 Salient Issues

Public employees and organizational leaders can only capture the salient social issues or substantial crises with limited attention. The concept of bounded rationality emphasizes that humans have a limited capacity to process all information and realize every issue in society [21]. Similarly, although public employees and managers can receive much information, they can only pay attention to very few issues. In other words, organizational agendas can only include the policy issues that individuals capture and realize. The limited attention results in punctuated equilibrium: policies evolute substantially in a short period but remain the same or change slowly most time. As a result, public employees and organizations can only spend their attention and resource on resolving significant policy issues [22, 23]. Hence, governments attempt to change regulations, rules, and routines because significant issues or crises occur and capture their attention.

Public employees or managers have intentions to conduct digital transformation when they perceive salient issues or crises requiring ICTs to be addressed. As public employees and organizations capture some social issues, they evaluate the significance and potential impacts on society. When they define these problems as important issues, they may take action on revising or enacting policies. For example, the local governments adopt smart city projects based on how they define and understand cities' emerging problems [24].

Also, the government creates online service systems when they pay more attention to e-government policies or regard digital governance as an efficient instrument to resolve economic issues [25]. Likewise, the federal government decides to utilize artificial intelligence to detect health insurance fraud because the overpayment issue captures public organizations' concerns [26]. Although these governments conduct different levels of digital transformation, the commonality is that they capture crucial social issues and define ICTs as essential instruments to address these problems. In other words, the significant social issues can be existences for public employees and managers to shape their intentionality of digital transformation. On the other hand, when they pay attention to the other social issues, they may not have the intentionality to conduct digital transformation. Therefore, the salient issues can be the first cluster of the existence of digital transformation.

5.2 Organizational Characteristics

Organizational characteristics shape the perception of technology and then affect the adoption of digital transformation. Fountain [3] proposes the distinction between objective technology and enacted technology in the enacted technology framework: "Objective technology includes the Internet, other digital telecommunications, hardware, and software; enacted technology consists of the perceptions of users as well as designs and uses in particular settings [3]." The concepts of objective and enacted technologies echo with phenomenology. Only when people perceive the usefulness or disadvantages of technology, it becomes meaningful. At the organizational level, the members need to understand the meaning of technology for them, and they know how to include in or exclude from organizations. Fountain [3] further argues that organizational forms and other characteristics can shape the enacted technology. However, this framework does not explain what organizational characteristics can affect the perception of technology in public organizations. Scholars attempt to fulfill this theoretical gap and propose many affecting factors. This study regards these organizational characteristics as existence to shape the intentionality of digital transformation and discusses them in the following sections.

Organizational culture is one of the critical existences for digital transformation. Organizational culture can affect public employees' and managers' mindset to promote and enforce digital transformation [1]. Chatfield and Reddick [2] define open data policy adoption timing as innovators, early adopters, early majority, late majority, and laggards in Australia. They find that the early adopters have a solid citizen-centric culture in the organizations, but the delayers are reluctant to innovate [2]. Also, the organizations have a strong tendency of innovation, risk-seeking, and dynamic interaction encourages public organizations to increase the transparency of policy information online in the U.S. [27]. In Norway, Germany, and Finland, city governments with a history of innovation are more likely to adopt artificial intelligence to improve service quality [28]. The more interactive organizations have more incentives to include new technology in their public services in Mexico [29]. These studies highlight the importance of organizational culture in digital transformation, including citizen-centricity, innovativeness, risk-seeking, and dynamic interaction. However, if the organizations tend to avoid risk and innovation, they are less likely to include ICT in their policy implementation. Further, when members within organizations perceive a more positive culture, they can shape their intentionality to adopt new technology.

Perceived resources for technology use can affect organizations' intentionality to conduct digital transformation. Organizations with a strong technology capacity have a stronger intention to include new technologies to improve public services [30]. For instance, if the governments disclose job application information and create the system for e-service, they have better performance in open e-government [27]. Similarly, the organizations with higher capacity to use technology can use clouds to provide services more comprehensively and faster than the others in China [31]. On the other hand, the limited financial resources foster local governments to use e-government to serve citizens. Due to the restricted finance, the government needs to utilize creative ways to reduce costs but provide the same even higher quality services [30]. However, Liang, Qi, Wei and Chen [31] indicate that the local governments funded by more budgets from the central government in China have a stronger intention and better performance on the use of clouds. The contradictory findings from the two studies imply that perceived financial resources can either encourage or discourage the government from conducting digital transformation. The differences may rely on the contexts. Some technology can reduce costs, but others increase the expenditure. Thus, the impacts of perceived financial resources on the intention of digital transformation depend on the types of ICT. Therefore, the existing research provides technical capacity and financial resources as two existences for public organizations, but the types of ICT influence the perception of resources.

In this section, this study identifies organizational culture and perceived resources as the two significant existences for public organizations. Organizational culture includes innovativeness, risk-seeking, dynamic interaction, and citizen-centricity, and perceived resources refer to technology capacity and budgets. These existences can supplement Fountain's (2001) framework, especially the organizational forms. These factors shape the perception of technology and then develop the intentionality of digital transformation.

5.3 Experience of E-government and Digital Governance

Experiences, one of important existence from the perspective of phenomenology, play an essential role in digital transformation. Organizations that have experience in big data collection, processing, and maintenance are more likely to accept new technology and enforce e-government innovation [32]. In the U.S., city governments with a history of data-driven decision-making tend to use new technology to improve civil services. They can include smart sensors to provide service with their experience to maintain and utilize the new system for their citizens [33]. These results imply that public organizations are path-dependent. If they have previous experiences and outcomes of technology adoption, they are more familiar to be more innovative and creative and take a positive manner on digital transformation. In other words, these agencies are on the way to digital transformation, so they do not need to change the directions of their policies substantially. The experience of digital governance and e-government adoption is the existence of public organizations.

The interaction between public employees and citizens can shape their perception of digital transformation. One purpose of digital transformation is to include citizens in the decision-making process. Public organizations can realize citizens' demands by using online platforms to collect opinions. For example, city governments utilize online 311 services to receive complaints and requests. They can analyze the collected data to improve public services. In this situation, public employees have more opportunities to serve citizens so that the experience can affect the perception of citizen participation in digital governance. As citizens are not familiar with ICT, citizens may need to spend more time explaining how to use these tools. Some citizens may complain about unusefulness and inconvenience. Thus, public employees regard digital governance as a lousy instrument for the government [34, 35]. Similarly, if local governments consider that citizens cannot access information by ICT, they have a lower intention to conduct digital transformation [36]. On the contrary, when public employees perceive the positive responses from citizens, they will be more active in accepting ICT in public organizations [37]. These articles indicate that the perceived outcomes of digital governance can affect the manners toward digital transformation.

Organizational and individual experiences can shape the intentionality to use ICT in public tasks. The previous application of ICT can be regarded as the organizational-level experience, and the interaction between public employees and citizens is the individual-level experience. The experiences can be either positive or negative. A positive experience can increase the intention to conduct digital transformation, while the negative one makes the governments stay at the status quo and reject to include more ICT. Thus, the two experiences are the existences in considering whether to conduct digital transformation in public organizations.

5.4 External Pressure

Origins of external pressure are various and involve different stakeholders. First, legal pressures encourage the government to conduct digital transformation. The government needs to follow the rules and procedures for public participation, asking governments to collaborate with the private sector and nonprofit organizations [28, 30, 31]. For example, the U.S. government enacts regulations and rules for public participation so that local governments utilize online open government to meet the legal requirements [27]. For public organizations, the legal requirement of public participation and digital transformation comes from the federal or central governments, so they regard it as external pressure. Pressure is one of humans' sensibility and needs to be perceived. Hence, this pressure can be one existence to public employees and organizations.

Second, the demand of change from citizens and other public agencies is another external pressure for governmental organizations. Citizens are the audience of public policies and services, so their requests and demands are one of the most important goals for the governments to pursue and achieve. The government includes citizens in the decision-making process by the online platform, which can increase the value of democracy [38]. The collaboration between the governments and citizens can generate more public values. However, the citizen-and-government cocreation brings challenges to the public organizations. The governments need to change the organizational and system design to include citizens in the policy process. Moreover, the cocreation even transforms organizational cultures [39]. As citizens ask the governments to change their services, more than one public organization needs to collaborate to respond to these demands. So, the organization may perceive the collaborative pressure [40]. The demand of change from citizens and other agencies put pressure on the public organizations. However, it is unclear how the demand of change can become perceived pressure in public organizations. The governments may receive substantial requests for changes from citizens, and it is almost impossible for them to respond to all demands. Thus, how they perceive and interpret these requests as the external pressure of digital transformation is an important research issue, but the existing studies cannot explain. Phenomenological research can understand the experience of public employees, managers, and organizations by interviewing them. Therefore, the demand of change is the existence but requires more theoretical investigation and study.

5.5 Acceptance of Managers and Non-Managers

The technology acceptance of public employees and managers can shape the intentionality of the whole organization to digital transformation. Although the technology acceptance model (TAM) is primarily used in citizens' use of e-government, this framework can explain why public organizations utilize ICT to provide public services. The technology acceptance model (TAM) provides a clear framework to analyze how humans recognize technology and their attitudes. When individuals receive a stimulus from the technology, they perceive the usefulness, the degrees to which a person believes the technology enhance their performance, and the ease of use, the levels to which a person considers that the system is easy to use, decide the humans' responses to the new technology. In other words, higher perceived usefulness and ease of use increase the trust in technology and the intention to use it [4, 5]. The unified theory of acceptance and use of technology (UTAUT) emphasizes the impacts of perceived usefulness and ease of use on people's attitude and intention to use technology [6]. Therefore, the perceived usefulness of and ease of use of new technology can shape the intention to conduct digital transformation.

The intention of managers in public organizations has a stronger influence on the adoption of ICT in digital transformation. Chen and Gant [30] argue that the supports of heads and managers of organizations can foster digital transformation. For example, in the adoption of clouds in China, the managers' support affects whether local governments use this technology to provide services [31]. Compared with non-managers, managers have a stronger intention to use artificial intelligence in public organizations in Taiwan [41]. It may be associated with the nature of work. Therefore, the manager needs to consider the development of digital transformation at a higher level than non-managers. According to the existing studies, managers have a greater influence in shaping the intentionality of digital transformation, and they also have stronger intentions to include artificial intelligence in the public sector. Hence, the technology acceptance of managers can be a critical existence for public employees. However, if managers have the negative perception of

technology, the organizations can rarely conduct digital transformation [40]. So, in this section, the perceived usefulness, ease of use, and managers' support are the existences in public organizations.

5.6 Political Objectives

In the practical community, political objectives can motivate governments to conduct digital transformation. Chen and Gant [30] indicate that top officials launch e-government and e-services to receive and acquire political credits quickly. The support of top managers and officials can shape the other employees' recognition and perception of digital transformation. Moreover, digital transformation can be used as an instrument of political control of bureaucracy. For instance, in South Korea, the city mayor of Gangnam utilizes e-government as a tool to increase his control on bureaucracy. The city mayor considers it difficult to change and influence the culture of bureaucracy, so he decides to increase transparency and citizen participation by e-government. By being transparent to citizens, he can gain people's support and use this power to control bureaucracy. Bureaucracy perceives pressure from citizens and the city council, so they need to modify and adjust their culture and commitment to the city mayor [42]. Political objectives can be a solid motivation to adopt new ICT and organizational operations. As digital transformation receives support from the elected heads and officials, the other organizational members may develop a positive perception and manner on this issue. Therefore, the political objective and intention of elected or top officials can be an influential existence to public employees and organizations.

6 INDIVIDUAL AND ORGANIZATIONAL INTENTIONALITY OF DIGITAL TRANSFORMATION

The existing theories and concepts provide several existences of digital transformation, but the research does not clearly explain how existences can shape organizational intentionality. From the perspective of phenomenology, existences and intentionality can be explored at the individual level and then aggregated to the organizational level. This section develops an approach to describe the development of intentionality of digital transformation at the organizational level.

As seen in Figure 1, this study identifies the drivers and barriers of digital transformation as the existence of public employees. First, salient issues can shape public employees' intentionality on digital transformation [24-26]. Second, organizational characteristics, including culture and perceived resources, can shape employees' intentionality. Cultures and resources are not objective numbers and descriptions but subjective feelings and perceptions. The perceived organizational characteristics affect how people recognize ICT and digital transformation [3]. Third, the experiences of e-government and digital governance can be a basis for public employees to deliberate the meaning of digital transformation [33]. They may depend on the path of e-government to develop their intentionality. Fourth, external pressure, such as legal requirements and the demand for change, can shape organizational members' attitudes toward digital transformation [30, 38]. Fifth, technology acceptance affects the managers' and non-managers' manners on digital transformation. As they perceive usefulness and ease of use, they are more likely to conduct digital transformation [4, 5, 41]. Finally, political objectives can influence the people's intention to adopt e-government [42].

However, phenomenology and action theory do not seek the causation between existence and intentionality. In the most reviewed articles, scholars regard these existences as variables affecting ICT adoption and digital transformation. The tendency cannot explain how public employees develop their intentionality. This study argues that people initially develop a general feeling and intuition of these existences and then transform it to their intentionality. As Kant [12] mentions, "Objects are therefore given to us by means of sensibility, and it alone affords us intuitions; but they are thought through understanding, and form it arise concepts (p. 155)." Public employees realize the meaning of existence and develop their feeling and intuition of digital transformation. They have various feelings and intuitions at different times but finally, formulate an overall perception of digital transformation. This perception then becomes their intentionality. In other words, every existence cannot directly result in intentionality. So, we cannot regard intentionality as the dependent variable and define existence as the independent variable. Instead, the impacts of each existence can be summarized to a general feeling for the development of intentionality. Therefore, this study rejects using the variable-oriented approach to consider the development of intentionality but adopts the phenomenological way to analyze this issue.

Public employees can make sense of the intentionality of digital transformation within their organizations. Harmon [9] considers the organization a place where people can make sense of what their organization and others have been done and their future direction and actions. With this logistics, public employees can bring their intentionality to organizations and exchange their thoughts with other members. As they perceive others' thoughts, they may change or adjust their intentionality of digital transformation. This process is dynamic and iterative rather than closed and static. Individuals and others can continuously develop their intentionality. Also, the top officials' and managers' thoughts involve at this stage. Finally, after long-term discussion, they may have a similar sense of the policy directions. The sense of whole group members can become organizational intentionality. The intentionality determines the degree of digital transformation the organization will have in the future.

After public organizations make decisions on digital transformation, the outcomes or results of their action can be the existence of the subsequent actions. Public organizations may be either successful or fail in these actions, but these results become the experiences and affect the existence. For instance, public employees may understand how policy natures affect the results to have new perceptions and interpretations of public tasks in digital transformation. Similarly, the outcomes of action can affect the other five clusters of existences. These existences will shape the general feelings and then individual intentionality when the organizations plan to adopt new ICT-related actions. Therefore, the proposed loop for intentionality in digital transformation is a dynamic process and open system to include other existences.

On the other hand, every step from overall feeling and organizational actions mutually affects each other. From the perspective of phenomenology, the development of intentionality is not linear but back-and-forth. For instance, although individuals have thoughts of

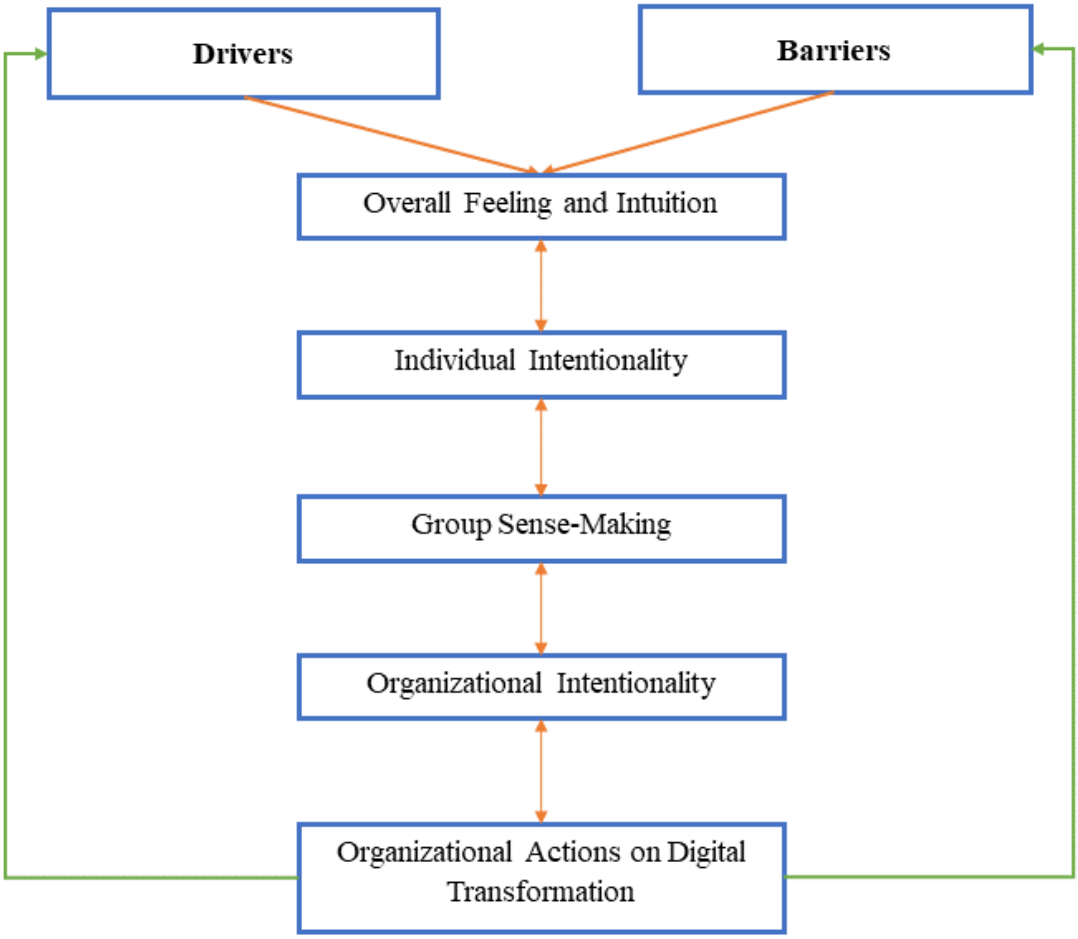


Figure 1: Development of Intentionality in Digital Transformation

digital transformation, they may have new intentionality after the group-sense-making process. The discussion and interaction within organizations can also change individual intentionality. In other words, this conceptual framework regards the development of organizational intentionality as an interactive and mutually affected process.

However, this study has several limitations, and future research may address these issues. First, the framework has not been supported by empirical data. Although this study provides the framework to identify affecting factors and the development of intentionality of digital transformation, it does not use empirical data, such as an interview or participatory observations, to support the conceptual framework. Hence, future research can use this framework as a sensitizing concept to explore real-world experiences. Empirical studies can examine whether this framework can be used, and which contexts are more appropriate to apply this loop.

Second, this study uses theory-based literature analysis to identify the drivers and barriers of digital transformation but may not include all factors. Although this study reviews many digital-transformation-related theories, it is not possible to cover every related concept. Future research can identify the other potential drivers and barriers to improving the proposed framework. Also, future studies can use systematic literature review analysis to explore affecting factors. Moreover, scholars can utilize content analysis on official documents to figure out the drivers and barriers.

Finally, this study only analyzes journal articles published in English, so it may potentially exclude affecting factors of digital transformation adoption in other contexts. This study uses English as the primary language to search journal articles and theories. The context of most research is the western countries. In other words, this study does not include the potential barriers and drivers in the context of the eastern or middle east countries. Hence, this study encourages future research to focus on digital transformation in the different countries and regions.

7 DISCUSSION AND CONCLUSION

Digital transformation has been one of the vital research issues in recent years. Digital transformation includes three levels and is associated with bureaucracy and organizations. The mainstream research adopts positivistic approaches to investigate this issue and provides abundant findings. Additionally, this study utilizes phenomenology to analyze digital transformation issues. Phenomenology uses subjective approaches to understand why public employees and managers intend to conduct digital transformation. The two crucial concepts of phenomenology are intentionality and existence. Intentionality can illustrate how public employees situate and realize the meaning of digital transformation in their minds, and existence can explain how people develop their intentionality. However, digital transformation cannot only rely on individuals but depend on organizations. Public organizations are the key actor to enforce digital transformation strategies. Although phenomenology traditionally focuses on the individual level, this study considers that this paradigm has the potential to explain organizational actions. Phenomenology can collaborate with action theory to investigate how organizations interpret digital transformation and develop the action using this strategy. Individuals can interact with other members with personal intentionality to seek organizational consensus. Through the group sense seeking, organizations can have the intentionality on digital transformation and then take action. On the other hand, organizational intentionality can reshape individual intentionality. Therefore, phenomenology considers that decision-making and sense-making is the mutually interactive process and provides an opportunity to analyze digital transformation adoption.

Along with phenomenology, this study reviews the theories of digital transformation adoption and proposes the conceptual framework for future research to examine. By analyzing the theory-based articles, this study identifies six clusters of drivers and barriers to digital transformation, including salient issues, organizational characteristics, experiences of e-government, external pressure, technology acceptance of managers and employees, and political objectives. These drivers and barriers are the existence, the crucial concept in existential phenomenology, and can affect the development of intentionality, the core of transcendental phenomenology. Also, this proposes the conceptual framework to illustrate the development of individual and organizational intentionality. Organizational intentionality can decide their action on digital transformation. The outcomes of digital transformation can create the existence of public employees and organizations. This study expects future research to examine and use this framework by conducting empirical studies in various and broader contexts.

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Cross-Boundary Information Sharing Flows in Emergency Management:

Proposing a Conceptual Framework

Tzuhao Chen
Center for Technology in Government and Rockefeller College of Public Affairs and Policy, University at Albany, State University of New York, Albany, NY, USA
tchen9@albany.edu

J. Ramon Gil-Garcia
Center for Technology in Government and Rockefeller College of Public Affairs and Policy, University at Albany, State University of New York, Albany, NY, USA, & Universidad de las Americas Puebla, Cholula, Puebla, Mexico
jgil-garcia@albany.edu

Mila Gasco-Hernandez
Center for Technology in Government and Rockefeller College of Public Affairs and Policy, University at Albany, State University of New York, Albany, NY, USA
mgasco@albany.edu

ABSTRACT

Given that information plays a decisive role in emergency management, scholars have been interested in how government agencies, first responders, and the general public could effectively acquire and disseminate emergency-related information. Existing research has made significant contributions in distinguishing various types of information-sharing flows (i.e., Citizen to Government, Government to Government, Government to citizen, and Citizen to Citizen). However, a holistic understanding of who the main actors are, why they share information, what specific content is shared, and what some of the main results are is lacking. This study contributes to fill this gap by proposing a framework that identifies and characterizes the critical components of information sharing in emergencies as well as some of their relationships. By analyzing the literature, we found that the characteristics of the actors, the phase of the emergency management life-cycle, and the communication channels are factors shaping information sharing activities, including willingness to share and the specific content being shared. In addition, information sharing could have a heterogeneous impact on the effectiveness and efficiency of emergency management practices, depending on the quality of the information being shared among multiple actors. The short-term results could also affect the satisfaction of the involved stakeholders and further influence information sharing in the long run. Finally, a few questions that deserve further investigation are identified.

CCS CONCEPTS

• **Applied computing** → Computers in other domains.

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1 INTRODUCTION

Information sharing, understood as disseminating and exchanging information among involved individual and organizational actors, plays a crucial role in emergency management, encompassing the preparation before, response during, and recovery after natural or human-caused emergencies. In particular, the way stakeholders share information has been fundamentally reinvented due to the advancement of information and communication technologies (ICTs), such as information systems and Web 2.0 applications. Previous literature has investigated the type of actors who exchange information and the content of the shared information on emergency response and recovery. In terms of actors, existing emergency management studies have identified different types of information interactions and flows among different actors [23, 27]. In general, four categories of information flows are apparent: (1) government to citizens, (2) citizens to citizens, (3) citizens to government, and (4) government to government. In addition, studies focusing on a specific information flow have revealed its specific content and how useful each flow is during emergencies [8, 22, 32].

However, the current knowledge of information sharing flows in emergency management is limited in several ways. First, why the actors share and receive information is not well-understood [10]. The willingness of actors to participate in information sharing determines whether the critical information will be transmitted among relevant actors and thus is as important as the shared content. Second, the results of each information flow on emergency management capacity and the underlying mechanisms of how these results take place are far from clear. Third, most of the existing studies only focus on a single flow of information sharing or a single

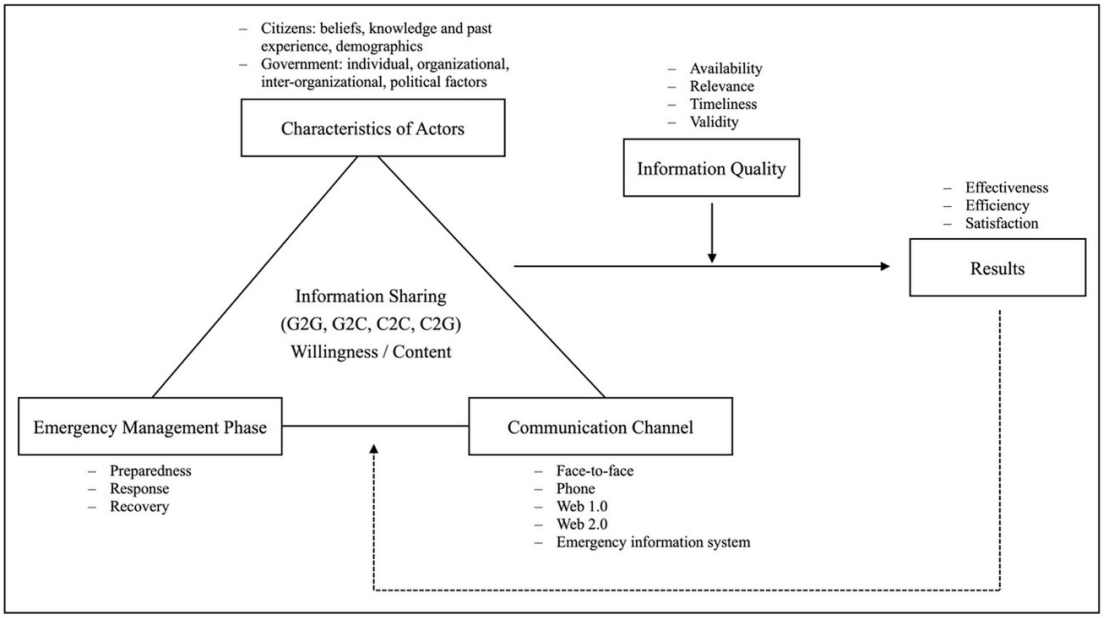


Figure 1: A Framework of Cross-Boundary (Individual and Organizational) Information Sharing in Emergency Managements. (Source: Authors)

stage of emergency management, resulting in a fragmented understanding of cross-boundary information sharing over the course of a crisis.

Given these gaps, this paper aims to build a framework that explains the flows of information among actors in emergency situations with the ultimate goal of informing future empirical studies and practice. We seek to generate a comprehensive understanding of the critical components of information sharing flows in emergencies to explain (1) the role of different actors, (2) what specific information is being shared as well as how it is being shared, and (3) how all information flows taken together contribute to a better understanding of the emergency situation and improve coordination among different actors.

The remainder of this paper is structured as follows. Section 2 briefly describes our methodological approach. Section 3 illustrates the proposed framework of emergency management information-sharing flows, including the main components and relationships among them. Section 4 proposes a few implications for future research and practice. Finally, Section 5 provides some concluding remarks and suggests ideas for future research.

2 METHODOLOGICAL APPROACH

A narrative literature review was conducted to answer our research questions because it enables us to examine the current state of knowledge, identify research gaps, and contribute to the current conversation [15]. In terms of the procedure, we first used keyword combinations such as ("information sharing") AND ("emergency management" OR "disaster management") to search for related literature, including journal articles, book chapters, and conference proceedings, via the Web of Science (WoS) search engine. Thirty-one publications were found after the search. Then, we paid close attention to each article and documented the key information presented in the empirical or conceptual studies, including the main actors, the stage of the emergency management cycle, the form used for interactions, the primary results of information sharing, as well as the determinants of those results. We then organized the findings into a systematic cross-boundary information-sharing framework that illustrates the main factors influencing various information-sharing flows in the context of emergency management. The findings are described in the next section.

3 THE CROSS-BOUNDARY INFORMATION SHARING FRAMEWORK

Our proposed framework is illustrated in Figure 1. We identified three major components – characteristics of the involved actors, emergency management phase, and communication channel – that may influence the actors' willingness to share information as well as the actual content they share. In addition, cross-boundary information-sharing may lead to different results for emergency management. In the following paragraphs, we further explain these components and some of their interrelationships.

3.1 Characteristics of the Actors Involved

Research indicates that the characteristics of the actors involved – including some cognitive and behavioral aspects of participants as well as the context they are situated in – play a vital role in exchanging crisis-related information. Recognizing the involved parties' characteristics is important because it helps avoid making incorrect assumptions about the expected behavior of people,

which may cause emergency management planning to fail [1, 29]. Regarding the citizens or general public, their beliefs, knowledge and past experience, as well as certain demographics are crucial aspects to consider.

- **Beliefs**: When facing emergencies, it is noted that individuals are interested in their own well-being, safety, and security as well as their family, friends, and neighbors [10, 11, 13, 19]. This could be the result of different reasons such as rational egoism, the social connectedness with the community, or altruism [8]. In addition, residents consider that they have exceptional information about emergency conditions that may be useful to governments [11]. Accordingly, citizens wish to engage in information-sharing activities with other citizens and government authorities to reduce their concerns and help others [10, 11]. Motivated by these beliefs, studies find that the public will comment on the government's plans and actions, seek answers to questions, provide information about resources available in the community, report first-aid needs and damage conditions, and find missing relatives and friends [12, 13, 16, 31]. Nevertheless, successful communication between governments and citizens depends on citizens' level of trust in government agencies [25].
- **Knowledge and past experience**: It is suggested that citizens are the first responders in any emergent situation, and thus their knowledge of the conditions could be conducive to improving government agencies' situational awareness and actions [8, 11]. In addition, the public can be further categorized into different roles, each of which may possess various kinds of knowledge to help the community manage disasters [19, 20]. Díaz et al. [8] argue that, depending on the reliability and experience of the information producer, citizens can become trusted sensors by having experience and credibility accredited by emergency management authorities. Furthermore, those with specialized knowledge of an event can serve as nodes, providing detailed and precise information. Lastly, experienced citizens can also be potential agents, who can execute some actions under government's supervision. Studies show that some government agencies find it helpful to develop and train observers, leaders, or field workers, within a community so that they can be essential and credible human resources when dealing with emergencies [32].
- **Demographics**: Citizens' demographic characteristics affect their information-sharing behaviors too. Considering that technology has gradually become a dominant means for receiving and transmitting information in recent decades, the geographic and educational digital divides may prevent certain populations from participating in information exchange. For instance, remote and less developed places and less affluent and less educated people face more challenges in accessing information technology, thus being potentially excluded from the circulation of critical disaster information [12]. Also, it is indicated that women and younger people communicate more frequently via phone or text and social media messaging than men and the elderly in extreme weather events [28], which could also affect the information they receive.

As for the government, multiple studies show that its information-sharing behavior is influenced by individual, organizational, inter-organizational, and political factors.

- **Individual factors**: Studies find that first responders prefer to reduce information overload by avoiding things unrelated to dealing with the crisis, given the high uncertainty and time pressure of an emergency [2, 31]. Also, first responders find it challenging to decide what needs to be shared, how to access and precisely interpret information, and how to confirm and maintain information quality [2] in a way that can help minimize risks and maximize efficiency [1]. Research indicates that first responders recognize the value citizens can bring to the decision-making and execution process, thereby being more open to citizens' involvement [32]. Another reason for first responders to communicate with citizens is to show how their efforts generate value for the community [10]. Hence, depending on their perceptions toward other stakeholders and evaluations of the value of information sharing, first responders' willingness to share and seek information may vary significantly.
- **Organizational factors**: The organizational behavior in exchanging crisis information is considerably affected by values and norms. Research finds that the values of efficiency, expertise, and control are highly prioritized over the course of emergency management [1, 4, 16]. To these ends, first responders rely on a command-and-control system and organizational procedures to articulate the roles, tasks, and responsibilities of each person, as well as standards and rules that need to be followed [2]. Such features will impede the organization's capability to share information with other agencies and external actors, including citizens [14].
- **Inter-organizational factors:** As emergencies may involve multiple agencies within the same government or across jurisdictions, the interconnectedness among agencies will impact their joint capability to address emergencies. Numerous elements that may influence inter-organizational collaboration have been identified. One factor is that the organizations simply do not have a sense of the overall operational dependencies among the agencies [2], and thus do not understand which parties they should contact. Another is that each agency's goals, roles, and responsibilities may be in conflict with each other [2], making it difficult to exchange and coordinate information for better decision-making. Besides, even when there is a cooperation agreement, the organization may still feel hesitant about collaboration since a misalignment could happen between the cooperation procedures and its own practices, resulting in the loss of autonomy, control, and efficiency [1]. Finally, the fact that each organization may own a different system or structure for information exchange may pose a challenge related to standardization and interoperability, which serve as a bedrock for inter-agency information sharing [2, 23, 29]. In sum, the knowledge, level of alignment, and degree of interoperability

collectively contribute to the inter-organizational dynamics, which, in turn, affect the sharing of information among government agencies in emergencies.

- **Political factors:** Since government organizations are embedded in a more extensive political system, politics will have a direct impact on public authorities' decisions. Research finds that a political leader's perception of citizens' role in emergency management determines whether and to what extent the government interacts with citizens [16]. In addition, political leaders may be unwilling to receive input from the citizens because of political party competition [16]. Furthermore, it is found that politicians often feel inclined not to lose any autonomy in their decisions [1], which would make the organization less likely to communicate with other involved parties. Lastly, political support for emergency management, for example, in the form of programs and funding, is vital for establishing a plan for exchanging useful information with different stakeholders. In short, a political leader's viewpoint, political competition, and political support are crucial elements underlying information sharing between one agency and other government and non-government actors.

3.2 Emergency Management Phase

Research also indicates that the phase of emergency management influences cross-boundary information sharing. There are three stages in a typical emergency management cycle [24]: preparedness, response, and recovery. Each stage has a set of activities performed by various stakeholders [29]. Research suggests that, depending on the stage of an emergency, governments may place varying weight on the decision of whether and to what extent governments and first responders should engage in information exchange activities with citizens [32]. Such variation results from the fact that the government usually adopts a command-and-control system to prepare and respond to an imminent threat and expects citizens to passively receive information and closely follow its directions. In contrast, recovering from a disaster requires more input from the local communities, thereby leading the government to interact with residents and engage in two-way communications more frequently.

Besides the willingness to share information, the distinct goals and tasks in each stage also imply different information needs. For example, in the preparedness phase, citizens can share with each other useful information to help the community develop a preparation plan through meetings, newsletters, and emails and set up communication channels for exchanging information during an emergency event [19]. As for the government-citizen interactions, it is suggested that residents will share their household situation and personal information with the authorities so that the government can better understand who lives in the area and their potential needs. On the other hand, the government can disseminate multiple types of information to the community, such as instructions for individual and family preparedness, guidance on how to take care of special populations, the contact information of community emergency response teams and neighborhood watch, the tools available for communication, the survival guide for local businesses and nonprofit organizations, and guidance on how to donate and volunteer when an emergency happens [25].

In the response phase, the communication among the governments and first responders mainly involves the data on risk, resources, roles, and responsibilities, which are conducive to enhancing situational awareness and inter-organizational coordination [7, 23]. Additionally, the citizen-to-citizen and citizen-to-government information-sharing flow usually encompass such information as local resources, first-aid needs, the status of the event, fears and concerns, questions, and comments on the government's response efforts [5, 9, 11, 12, 23]. Regarding the communication from government to citizens, the information usually includes the status of the event, necessary actions that citizens need to take, the responses made by the government, community appraisal, rumor prevention and clarification, and seeking information [21–23, 26]. During the recovery stage, the communication channel found in the literature is primarily between government and citizens. It is suggested that citizens in the affected communities would comment on the government's activities, express gratitude, and raise questions or concerns, and the government would seek communities' needs and regularly provide the latest updates on the recovery [13, 16, 32].

3.3 Communication Channel

An abundance of research has been devoted to examining the exchange of information among actors through various channels in emergencies. Studies identified that citizens and governments share and access information in a broad spectrum of ways, such as face-to-face, phone calls, text messages, web pages, social media, and emergency information systems [17, 18, 28]. In particular, as Web 2.0 technology becomes increasingly popular, social networking has facilitated government-to-citizen, citizen-to-government, and citizen-to-citizen communications. Research finds that, in general, a majority of citizens use social media, like Twitter and Facebook, to seek information instead of a web page [18]. Besides, when receiving an emergency warning alert from the authorities, citizens are more likely to share information via a phone call, text messaging, and Facebook than an in-person conversation [18].

On the government side, social media has made it convenient for public authorities to share with and collect information from citizens instantly [4, 21, 22]. Nevertheless, social media also generates new challenges for the government, mainly the circulation of incorrect information and the exposure to an excessive amount of data [4]. Concerning inter-organizational cooperation, establishing an information system with a proper design can help involved organizations better coordinate their efforts [3, 14]. It is found that the user's intention to use a disaster management information system is determined by the expected value of how the system can contribute to the teamwork and support one's tasks [3, 17]. In a nutshell, an information system for emergency management should support multi-directional communication, ensure information richness and timeliness, and help link relevant data [31]; it should also help avoid information overload, inaccuracy, and conflicts [29].

3.4 Results

Research indicates effectiveness and efficiency in the preparedness, response, and recovery stages are two of the most important results of information sharing for emergency management. Effectiveness can be understood as the degree to which information sharing activities successfully produce the desired result, such as detecting and mitigating risk, increasing situational awareness, securing personal and property safety, and building up community resilience [4, 6–8, 19, 30]. As far as efficiency, it could be conceived as the ability to produce good outcomes without wasting time and physical resources [4, 7, 26]. In the longer term, the efficiency and effectiveness achieved by collaboratively sharing information will be translated into citizens' and government officials' perceptions and satisfaction [16], which, in turn, will influence the decisions on whether to participate in exchanging information and what specific content to share again in the future [25, 32], as captured by the feedback loop in Figure 1

Existing studies propose several criteria that the information should meet in order to manage emergencies effectively and efficiently. Within a wide variety of data quality standards identified in the literature, four dimensions are most mentioned: availability, relevance, timeliness, and validity. Availability concerns whether a critical piece of information can be accessed by the actors [4, 30, 31]. Relevance refers to what degree the information can help inform actors of the characteristics of a specific situation [29, 31]. Timeliness is whether the provided information is up-to-date and received when it is the most useful [4, 30, 31]. Finally, validity can be defined as the accuracy of the data [12, 31]. It seems clear that the four information quality criteria are relevant for all types of information-sharing flows and are directly or indirectly affected by the identified variables related to the participant's characteristics, the specific phase of the emergency management cycle, as well as the communication channel or channels being used. Furthermore, the quality of information contributes to effectiveness and efficiency. In addition, as information can be freely exchanged among parties and is relevant, up-to-date, and valid, situational awareness and coordination can be significantly improved, leading to a successful design and implementation of emergency management plans.

4 IMPLICATIONS FOR RESEARCH AND PRACTICE

First, we find that the characteristics of involved government and non-government actors impact information sharing. In particular, we added insights into the citizens' role in emergency management, showing that citizens are not identical entities but could be heterogeneous based on their knowledge and experiences. While a similar nuanced differentiation in the government actors was not presented within the literature, we believe that the roles and functions of government organizations could be diverse too. For instance, first responders should be different from emergency management agencies coordinating their efforts or other government agencies involved in a response. Moreover, the patterns of local businesses and non-profit organizations in sharing information with other entities are also underexplored. The insights pave a new way for considering a multiplicity of actors engaging in exchanging information in emergency situations. Instead of viewing citizens and the government as homogeneous categories. Future scholars and practitioners should acknowledge the diversity of governments, citizens, private companies, and non-profits and further explore how the information sharing flows may differ among them.

Second, the specific phase in the emergency management cycle is another factor affecting cross-boundary information sharing. Nevertheless, little has been known about the differences in participants, their roles, and the communication methods they prefer across the three stages. As we highlighted in the former discussion, different citizens and government agencies may possess different levels of willingness and capability to participate in information exchange in emergencies. We believe that these differences could also be present under various stages of emergency management. Therefore, it would be useful to identify which channel a specific actor prefers to communicate in each of the different stages. In particular, most research on emergency management has focused on the preparedness and response stages, and little has been said about information sharing during the recovery stage. However, as one of the main goals during the recovery phase is to better prepare for the next emergency, information sharing still matters during this stage for government agencies, first responders, residents, and other actors to work together in improving community resilience.

Third, we show that communication channels also shape information sharing in emergencies. It is shown that the use of communication channels could vary depending on user characteristics, such as geographical area, age, gender, and their expectation of the channel's value. As such, there is not a one-fit-all communication method for every involved actor. Future studies should consider subpopulation's communication channel preferences to better assess how they may create barriers for different types of citizens and other actors to obtain critical information.

Finally, the framework identified some results of information sharing and the mechanisms underlying information sharing and its results. We find that, in general, little attention has been paid to assessing information quality and results. Most studies on information quality are conceptual, and studies do not elaborate on results. In addition, there is a lack of long-term evaluations of the effects of information sharing in emergency management. Future research could contribute to these gaps by probing how government agencies, first responders, and citizens evaluate the effectiveness, efficiency, and satisfaction of information sharing and how perceptions and interpretations of achieved results reshape different information-sharing flows.

5 CONCLUDING REMARKS

This study provides a comprehensive view of the critical components affecting information sharing flows in emergency management. To this end, we analyzed the literature on information sharing in emergency management and proposed a framework that includes some of the most critical variables and their interrelationships. As scholars acknowledged that emergency management is dynamic, complex, and requires a network approach to realize the expected benefits [14], our work helps characterize the complexities into a simplified framework that helps make sense of various types of information sharing flows. Several gaps identified in this study can help the academic community further investigate the nuances of

information sharing in emergency preparedness, response, and recovery. Some of the insights could also assist involved parties with building up and improving information-sharing flows for emergency management in real-world situations.

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Forming Smart Governance under a City Digital Transformation Strategy - findings from Greece and ICC

Christos Ziozias
University of Thessaly, Greece
cziozias@uth.gr

Leonidas Anthopoulos
University of Thessaly, Greece
lanthopo@uth.gr

ABSTRACT

Digital transformation (DT) is a complex process for cities, which demands both the dedicated role of the local government and the engagement, but also the commitment of the local ecosystem to a commonly agreed strategy. Digital Transformation affects both the city ecosystem and digitally transforms local government into a smart government (SG). European Commission launched its Digital (DCC) and Intelligent Cities Challenge (ICC) initiatives to provide cities with guidance and support to design and implement corresponding digital transformation strategies. This work-in-progress paper aims to present the updates from the strategic planning process for the city's digital transformation that was followed by a famous smart city – the city of Trikala in central Greece. Useful evidence is depicted about the different stakeholders' perspectives and priorities within the city's digital transformation process. Moreover, findings show how local government is digitally transformed into a Smart Government via prioritizing data openness and community engagement.

KEYWORDS

Digital Transformation, Smart City, Smart Government

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1 INTRODUCTION

The use of new digital services continuously improves everyday life. Thus, local governments wish to provide updated services to their citizens, through internal the use of digital technologies, labeled "*digital transformation*" [1].

This approach appeared in 1997 [2], but it was only focused on businesses and enterprises that evolved through applying innovative information and telecommunications technologies (ICT) [3–5]. Research shows that the organizations that are digitally transformed perform better in productivity and efficiency terms [1]. The same steps are followed by large businesses and organizations, as well as communities. Today, even larger organizations and smart cities (SC) are being digitally transformed, with cutting-edge technologies (i.e., artificial intelligence (AI) and robotics) [2].

Although academic literature on this topic doesn't cover all its aspects, Digital Transformation (DT) is an emerging trend [6]. ScienceDirect alone returned approximately 3,000 articles with the keywords "*digital transformation*" [2]. This growing need for DT led various cities, especially SC, to reconsider their vision for their future growth. DT requires new strategic planning, accompanied by actions that will help cities be digitally transformed [2, 7]. European Commission (EC) launched 2 initiatives to guide the DT of European cities, and to help them build sustainable and resilient ecosystems that will foster innovation and improve the quality of life for their communities: the "*Digital Cities Challenge*" (DCC) in 2017 [8] and "*Intelligent Cities Challenge*" in 2020 [9]. While the first one was completed in 2019, the second is under implementation.

This work in progress comes to an extent [2], where the case study methodology was used in the city of Trikala, Greece – a city that already had participated in the DCC initiative as a fellow city and now is a core city of the ICC project. Evidence provides useful insights regarding the DT strategic planning process in Europe, while it highlights how smart government (SG) is being approached in the examined case with openness and community engagement requirements. Regarding the research questions, the major concern is if there has been a change in effort and commitment, during these 2 European projects, to transforming the city into an intelligent one and how this will continue even after the end of the projects. Another significant goal is to examine how the city's DT planning is aligned with the planning for city resilience and realize whether a correlation between objectives, factors, and activities exists. By now, there is not sufficient literature or an accepted pattern on how resilience and intelligence, or the smartness of a city affect one another [10, 11]. Of course, relevant data from the rest of the participant cities must also be analyzed, to generalize the findings of one city and this is the purpose of an ongoing research topic, like this one.

The rest of this paper is organized as follows: the next section presents a brief background of SG and DT. Then, section 3 demonstrates the DT strategic planning of the case of Trikala, Greece, with useful findings on the municipal focus on SG. The final section contains some conclusions and future thoughts.

2 BACKGROUND

Defining smart government (SG) was complex and quite ambiguous and only recently, a study concluded the following: "SG concerns the transformation of government to an open, more effective, efficient, and transparent one, with the mix of emerging technologies and innovation, which goes beyond typical digital and open government approaches. Moreover, SG is seen under the lens of local

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government, where SC government is performed at a specific geographic location and community" [12].

On the other hand, the concept of DT is quite broad, and often confusing, while a commonly accepted definition is missing [3]. Initially, the concept of DT was synonymous with digitization, which was essentially about converting analog information into digital. The trend toward using digital technologies followed a shift that required change, strategy, and other parameters, such as staff, culture, talent development, leadership, and so on [3, 13].

From 2004 when DT was referring to the effects of digital technology on every aspect of human life, to 2019 where DT discussed the adoption of technologies and the ability to digitize organizational resources; or the increasing interaction between digital technologies, business, and society, which has transformative effects and increases the speed, scope and impact of the change process, many researchers tried to conclude to a commonly agreed definition. Until then there were various approaches to the DT concept but there were objections such as conceptual ambiguities, orientation to concrete results, and conflicts between the original concept and the expected results. In 2020 the DT referred to the completion of digitized processes to achieve automation and modernization across an enterprise [3]. Finally, Gong and Ribiere, the same year, came to a unified definition of DT: "*A fundamental change process enabled by digital technologies that aim to bring radical improvement and innovation to an entity [e.g., an organization, a business network, an industry, or society] to create value for its stakeholders by strategically leveraging its key resources and capabilities*" [2].

It is easily understood that DT differs from digitization as it represents a fundamental change, which is something that is not happening in the second case. DT is not only a technology affair but rather a strategic renewal to gain value in various entities, with human resources and leadership as key players in this effort. In general, DT involves a substantial change in the form, function, and structure of an organization, using new value-generating digital technologies [3].

The same strategy is followed by organizations, industries, and governments. Their common goal is not only to provide some digital services to their customers/citizens but to transform them into digital ecosystems, enhancing their performance and efficiency. At the same time, actions are taken toward a more friendly and open city administration [1, 14, 15].

There is still significant progress for the city's DT, due to the complex city ecosystem and the lack of knowledge by city managers to utilize advanced technology. This knowledge is important for the city's DT, since it involves decisions at the highest management levels, with a great impact on the city stakeholders. Moreover, organizational processes must be transformed for DT, new technologies must be used, new skills are required, and new working methods must be undertaken. Thus, the DT process is complex and requires the city stakeholders to be engaged [1].

More specifically, changes are required for DT to be performed in 4 major areas: "*organizational strategy, IT strategy, organizational structure, and IT structure*". The faster these changes are made, the easiest the DT will be performed. To achieve this rapid change, city managers must recognize the forthcoming political changes; have a vision of a new type of leadership; be aware of citizens' needs and expectations; be informed of the advanced technology's potential; and crises [1]. To succeed in this process, city managers must initially ensure a well-organized administration, which will control change and harmonize the competitive stakeholders' interests.

The DT benefits not only the city administration but also the local communities: new business development, local growth, community welfare, etc., are only some of the DT expected outcomes via [2]:

- "High quality infrastructures (digital and physical)
- A data rich environment
- Digital talents and skilled workforce able to harness digital opportunities
- Hands-on support for companies to engage and succeed in their DT"

Under these lenses, and the impact of a low rate of implementation of the D.T. strategy. by cities, European Commission (EC) designed and delivered two initiatives that could help the European cities successfully enter the Digital Era [16, 17]. The first one was the Digital Cities Challenge (DCC) in 2017 and the second one was the Intelligent Cities Challenge in 2020.

DCC was "*a tailored programme of coaching and facilitation launched by the EC to help 15 European cities develop and implement digital policies that can transform day to day life for residents, businesses, workers, and entrepreneurs*" [8]. Along with these 15 cities, 20 fellow cities were supported during a total period of 18 months to design and implement new strategies for policies like [2]:

- "Help European cities to improve the quality of life of their citizens
- Put advanced technologies at the service of the citizens
- Transform production and services to boost productivity and create growth
- Create and attract talents and entrepreneurs
- Investments in critical infrastructures, technologies, open data".

The importance of a dedicated project team to manage the transformation process was found in the literature and mentioned above. The same happened in this case since all the participant cities had to present political commitment towards this goal along with a dedicated project manager assigned by the city to guide and manage all the local stakeholders that were involved in the project [2].

The second initiative, labeled the ICC, was launched in 2020 to help 136 European cities overcome the difficulties that climate change and pandemic has brought, through the transition to a greener and more digital era. ICC targeted solving common problems and challenges for European cities by forming 5 thematic tracks (horizontal activities). These are [9]:

- Citizens' participation and digitization of public administration
- Green economy and Local Green Deals
- Upskilling and reskilling
- Green and digital transition in tourism, and
- Supply chains, logistics and the economics of mobility.

Participation in such a project will benefit the cities in different domains, such as urban management, smart and green transport and mobility, e-government and digitization of public services, strengthening citizens' security, education, etc. The cities will have the

opportunity to co-operate with others cities, since all of them are core cities, with almost the same needs and characteristics, and apply innovative solutions that have been successfully implemented. Like in the DCC, the city government is obliged to define a project team that will be responsible for the implementation of the strategy and the coordination of the stakeholders. The commitment of all involved parties must be at a higher level to complete the project without any delays or differentiation from the original goal [2].

3 RESULTS

To examine the research questions and highlight the results, the case-study approach of the qualitative research method was selected [18] and certain tools like interviews and observations were applied, providing relevant data. This study so far is the first part of continuous research. More methodological approaches will be needed in the future steps, like quantitative analysis of the results, from the study of cities that participate in the ICC project and how they evolve through Digital Transformation. So, it is expected, among others, a turn from an "*intrinsic*" to a "*collective*" case study [19]. Findings, like these, will help present the implementation of an overall D.T. strategy at a European level, and a city's benefit from participating in such endeavors, like the particular project.

Of the total of 136 core cities that participate in the ICC initiative, 11 of them are located in Greece. This ratio (almost 8%) is far more than the ratio of Greeks among European citizens. It is a clue, among others, that cities in Greece want to offer innovative solutions to their citizens and to continuously evolve. The case study methodology is applied, with the demonstration of the case of one of these 11 cities – the City of Trikala.

Trikala is a medium-sized city with 61.000 citizens, located in the center of Greece. It is a green and flat landscape, surrounded by beautiful hills and mountains. Trikala's history goes back to 1,000 years BC when the ancient city "*Trikki*" was located in the same place. In 2003, the first projects based on ICT appeared along with some smart services the city was offering to its citizens [20]. This made the City of Trikala one of the first in Greece that applies such technologies to become one of the Smart Cities across Europe.

Since then, numerous projects were implemented, all under the local government's vision to become a Smart City, until 2017 when Trikala participated in the DCC initiative and its project activities, to enter the Digital Era. For that, a strategic vision should be defined and this came out to be "*To simplify, standardize and digitally transform internal processes and offer useful data and smart services, which can improve well-being in Trikala, support local growth and enhance local sustainability*" [2]. To best serve it, 4 ambition statement was commonly agreed upon across the city's stakeholders (Figure 1) and 7 objectives in ICT upskilling, innovation hub's foundation openness, and citizen-oriented service delivery. The actions that were selected served the goal to improve local growth by applying ICT and strengthening community coherence for the period late 2019 – to early 2021 [2].

Having the experience from the DCC initiative, the city's administration was ready to participate in the next one – the Intelligent Cities Challenge in 2020. From all the domains, 4 of them are considered to be the most important for an application to the ICC [2]:

- eGovernment and digitizing public services
- Innovative education and training for up- and re-skilling
- Smart and green mobility and transport
- Enhancing citizen participation, connectivity and community

Trikala jointed the ICC initiative in July 2020. Like in the DCC, the city government formed a project team that will be responsible for the implementation of the strategy and the coordination of the stakeholders. The project team includes the City Project Manager for the ICC, along with Project Team Members while a City Lead Ex-pert, that was set by the ICC management, was the official city's assistant in this effort. One of the first and more important steps was to identify and involve the relevant local stakeholders.

11 of them participated in various project meetings and helped re-defining the new priorities that would best serve Trikala's DT during the ICC initiative. These eleven stakeholders were selected not only because they come from different areas (education, business, commercial sector, governance, and utilities) and their decisions and actions have a huge impact on the community, but also because they appeared highly interested in the project's mission.

The diversity of different sectors in the city's ecosystem is considered to be an advantage because the synthesis of different perspectives can become an important asset for this project. The local stakeholders that participate, based on their profile, are [2]:

- Governance (the municipality of Trikala, the Prefecture of Thessaly)
- Education (the University of Thessaly – department of sports, and department of nutrition)
- Business and Commercial Sector (the Municipal Company responsible for ICT and Tourism, the Municipal Company responsible for Transportation, Parking, and Sports, the Commercial Chamber, the Commercial Union of Trikala, and the Joined Public Tourism Agency)
- Utilities Sector (the Regional Waste Management Provider, and Urban Public Bus Provider)

After many interviews and 2 daily workshops, the project team guided the coalition of stakeholders to finalize what they thought as most important aspects of a successful DT The results emerged 3 different topics [2]:

- Openness and community engagement: with the use of open data and open consultations
- Sustainable mobility: with an emphasis on parking management and traffic control
- Smart tourism: as a local growth enabler

These new data formed a new vision for the city that could be summarized in "*The development of an innovative ecosystem that attracts citizens, visitors and businesses, accompanied by a digitally transformed and interconnected local environment and by a strong stakeholder partnership and encourages new idea growth, towards an intelligent and resilient city*" (Figure 2). Like before, ambition statements were defined, that could cover all the necessary actions towards implementation of the new vision [2]:

- Create an interconnected ecosystem with a commonly agreed data policy and via a common open data and public consultation portal.

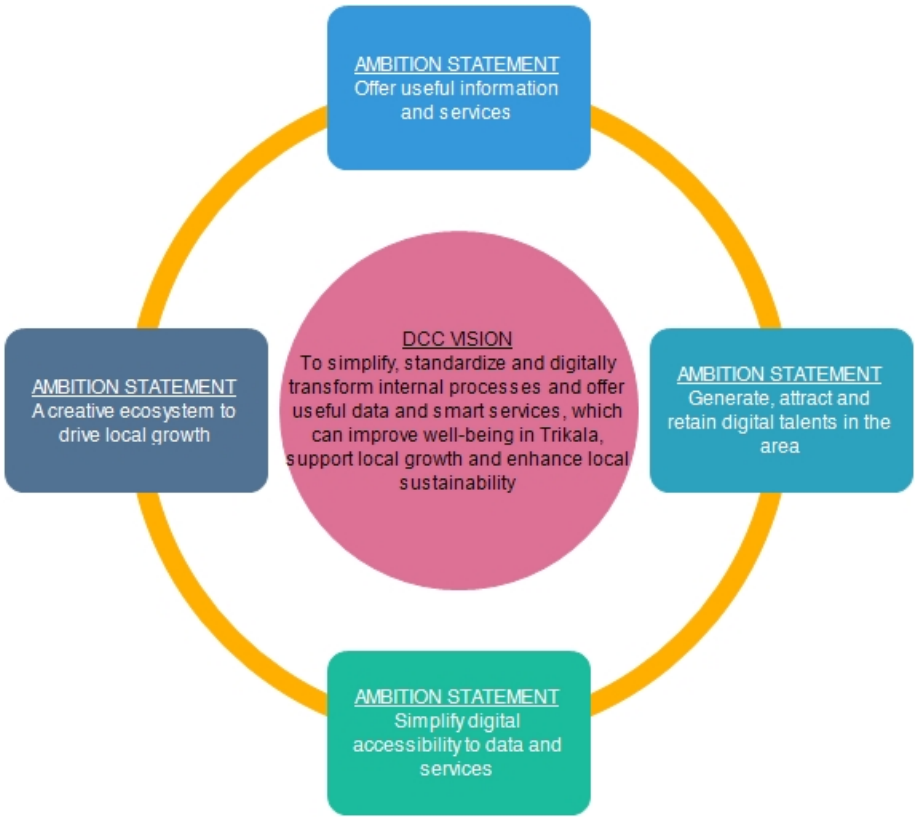


Figure 1: Trikala strategy map during the DCC

- Enable a common digital platform for sustainable mobility activities.
- Utilize common tourism organization and digital tools to highlight local assets and safety, and attract digital nomads and virtual tourists.

Comparing the vision in these 2 EC initiatives, the city made "*a shift from useful-ness to inclusiveness, and from sustainable growth to resilience. Both changes are reasonable since the COVID-19 outbreak questioned both coherence and community resilience*" [2].

Although the statements were concise and clear to the coalition, certain barriers or uncertainties threaten these efforts. First, in data opening and data policymaking the change must be made at a national or regional level, to have chances of success. Other obstacles are low open service usability, the absence of local ICT industry to utilize open data, and citizens that are not aware or interested in open data, although they needed remote access to data and services. Regarding mobility, the flat landscape of the city and its short distances make citizens prefer walking or cycling to using their car or public transportation. The latter is mostly used by nearby villagers who want to visit the city and is not oriented toward serving the majority of citizens within the city's limits. Also, a lack of ICT-based notification services was recorded.

Except for the above obstacles and threats, the COVID-19 pandemic had a very serious impact on the mobility and tourism sectors. The fear of the virus spreading made people avoid the use of public vehicles, even though these are not used but the majority of citizens. Health restrictions significantly constrain any car-sharing services. Finally, like all over the world, the tourism sector was under a shock since both the public and private sectors of the city invested in tourism activities but they were no visitors or an easy way to attract them.

The meetings with the involved stakeholders brought some ideas about the direction for solutions that would minimize the above negative effects. For open data and citizens engagement actions to motivate citizens to participate in the city's government could enhance the public value and improve social interest in citizen engagement while securing long-term project sustainability. Greek government's plan for data opening is expected to support this effort by adopting a common data platform and policy and openness for data can be achieved with the cooperation of all the relevant bodies [21]. On mobility, a combination of relevant services along with reciprocally benefits (i.e., use the bus and get a discount at the local market) could be helpful along with innovative ICT solutions for mobile data collection, and analysis and traffic management systems. Regarding tourism, a new service provision on smart tourism is considered to be of high importance. Not only innovative ideas and solutions should be applied but also a corresponding digital upskilling must be undertaken by the tourism sector in the city. On the other hand, for the stakeholders, it is not easy to realize which

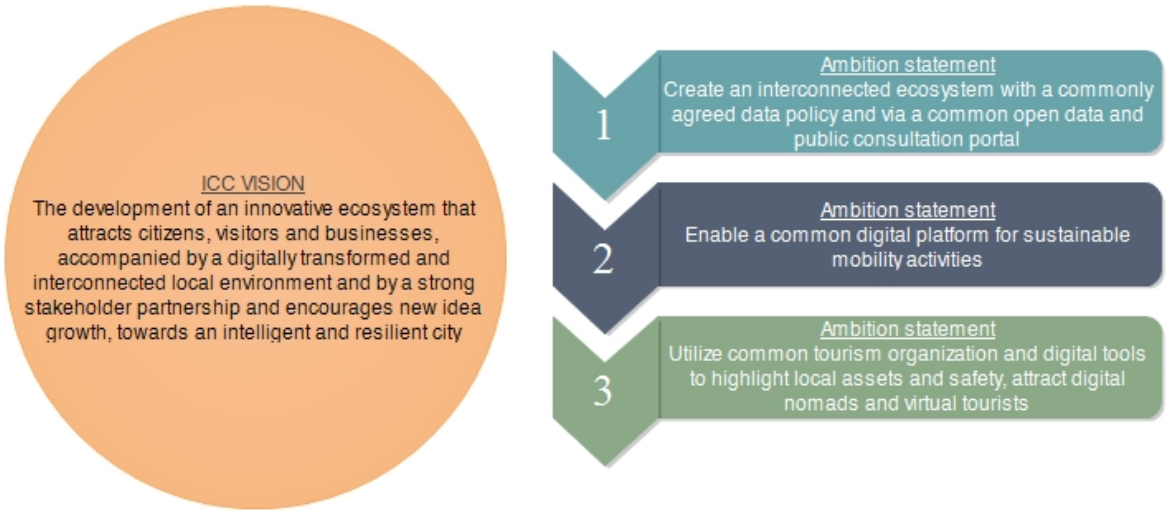


Figure 2: Trikala strategy map during the ICC

comparative advantages must be approached and how to highlight them.

After the confirmation of the 3 new priorities that serve the ICC city vision, specific solutions that fit every one of these priorities should be identified. For that, the consortium of city's stakeholders had the support of thematic experts, that were involved in the ICC project. These experts helped focus on applicable solutions that best fit the city's needs. The meetings with thematic experts took place in February 2021 [2]. The thematic experts, each in his area, presented the current situation, in similar size cities, as a first approach. Stakeholders were informed about possible solutions to the same problems, that other cities had already overcome. After a brainstorming and internal meeting, a list of possible solutions for each priority came up. To specify the best possible solutions that would easily be implemented, 4 major aspects for each of them should be under consideration and commonly agreed upon - solution's impact, main features, business model, and risk management. These aspects were a kind of qualitative criteria that could promote the most important solutions.

The first and more important step to accepting a possible solution was its impact on the city's ecosystem. To be more specific on that, the nature and characteristics of the problem the solution had to solve, should be identified. Furthermore, the link between the solution's actions and the city's vision should be clear and direct. These two data helped avoid including solutions that would not benefit the city or serve its vision.

Regarding the main features of each solution, answers to the question "what must happen, where, and when" could form the scope of the actions that compose the solution. After that, it would be easy to point to the main stages to get the solution at full impact and form the life cycle of the solution. An image of what a solution might look like would be helpful since it would point to solutions that would be acceptable to the city's stakeholders according to their criteria and point of view.

None of the proposed solutions will be successful unless a business model for its implementation is defined. First of all, the project participants should seek out possible ways of financing - private or public funds, or other kinds of funding sources. Then, they should set the sustainability model of the solution to ensure its continuity and impact for at least the next 5 years.

The management of the activities that compose each solution was very important. To create the management structure of the solution implementation process, the departments, agencies, or the persons who could make it happen should be emerged and be accepted along with the form of this structure. Furthermore, conflicts of interest between parties could be avoided if the management administration know the way that these different parties interact during implementation what are the possible "benefits" for them, and what is their role.

Since the vast majority of projects or actions face risks and obstacles, a kind of risk management should be undertaken, at least in an early stage. First of all, the main blockers and risks for every solution should be identified and logged, along with the possible assumptions that the solution is rest on and are factors of uncertainty. The thematic experts could help the city realize why every proposed solution hasn't happened already in this city and what are the differences with other cities that manage to implement similar solutions. When the identification of all possible risks and blockers would be completed, then the consortium should find ways to overcome them. Any major uncertainties that still needed to be investigated should always be in the minds of the management team to foresee them in an early stage.

Of course, the selection of various independent solutions doesn't always bring the best possible result. That is why a study of the interaction between solutions, in the 3 priorities, should be completed after the selection of them. If the solutions "co-operate" positively they will help each other and boost the impact of the whole DT process. If not, they probably will undermine the whole effort and this is a reason to be managed more carefully. Finally, common important factors that ensure the success of all the solutions, should be identified and managed in the best possible way through the project life cycle.

During the same month, thematic workshops and action groups took place under the ICC initiative, for cities to get more familiarized with smart and digital solutions in various areas. Form a large group of thematic workshops, Citizen participation and public administration, Supply chains and logistics, and Green and digital transition in tourism were the ones that the City of Trikala was more interesting in. At the same time, the project consortium participated in many thematic action groups, like Smart & green sustainable tourism, Smart tourism destinations, Sustainable mobility in urban centers, Digitization of government services, and Citizen participation processes through digital technologies. In these action groups cities involved had the opportunity to get to know innovative solutions and technologies in each one of these domains. In the end, there were transversal sessions about Access to Finance, Public Procurement, and Open Data, information, and guides very useful for a city to implement digital projects.

In the next two months (March and April 2021), two more rounds of meetings with experts, in each one of the 3 priority areas, took place, for the city stakeholders to finalize the proposal of digital projects for every priority.

Regarding open data policy and relevant solutions by thematic experts, one of the most important factors for a successful transition to openness is the data portability to achieve open data, since it will remove the data sealing and the use of a closed platform logic, so everyone will be able to have access to them. Of course, interoperability and common standards are the key elements for data portability on platforms and applications that use these data. Many of the existing interaction problems – especially those of the city services – will cease to exist, like the different interpretations of data by each user. Open data will not be sufficient enough for the city administration to provide innovative services to citizens unless a way for standardization of open data will be implemented. Many cities around the world have successfully achieved that. To achieve interoperability through this standardization, problems of interoperability of a technological, semantic and structural, organizational, and legal nature must be overcome. The interoperability of data provides improved provision of services to citizens at a reduced cost, facilitates semantic agreements and is accepted by all stakeholders, achieves a greater range of control and any changes are readily understood. A basic prerequisite for the identical interpretation of the data is the use of predefined common concepts and dictionaries by those using them, whether they be individuals or software and hardware. Such open data can easily be used to provide updated and in-time information about e-governance issues. Although it is a very interesting solution, medium-size cities like Trikala, where is no ICT local industry, with limited demand for open data by businesses and a lack of attraction for data-based investments, will have serious obstacles in mobilizing their citizens, officials, and services.

A key precondition for keeping citizens' participation and engagement in digital government alive is to be continuous, to generate real interest, and for participants to reserve time for participation. The latter consider being as the most important of the other two criteria. In all actions, to be successful, there must be a form of "*ownership of action*", both by officials in the municipality and by citizens, so that there are specific forces/persons responsible for driving the action forward. This, along with the commitment of personal time by the citizens concerned is a key to success.

The coalition mentioned the difficulty in attracting youth and other parties to engage in the city's governance. For that, a more intense effort must be made along with some kind of reward for the most active citizens. Of course, the keystone in these actions is to notify them in the best possible way. At the same time, the reasons why similar actions failed in the past must be analyzed, to avoid the same mistakes. In general, all the stakeholders were very interesting and positive about the transition to open data, since it can be a basis for local entrepreneurship. Towards this goal, the local university departments will be very helpful since they are connected to the younger part of the city's population.

During the meetings with mobility experts, a scan of the strengths and weaknesses of the city was made, with the participation of local stakeholders. Through that many interesting points emerged on different mobility areas like pedestrians, bikes and micromobility, public transport, road mobility, logistics, green & innovative mobility, multimodality, and culture. In each area city's performance emerged based on certain criteria. In general, there were no surprises in comparing stakeholders' opinions on these matters. Maybe the most important issue that has to be solved is the coexistence of pedestrians and cars because Trikala is a city where most citizens choose to walk or use their bicycles but on the other hand, too many of them use their cars for small distances in the center of the city.

The coalition recognized the priority the municipality gave in this area since a Sustainable Mobility Plan has already been defined, to implement the relevant actions over the next five years. Unfortunately, other smart solutions that are implemented in other cities may not be easily applicable due to the smaller size of the city and the mobility habits of citizens. That is why the consortium suggested that solutions in mobility will be one of the projects of the SMP since many of these are still pending and have a higher level of maturity. Of course, all the possible solutions must-have elements of ICT and provide smart characteristics to the city. One of the proposed solutions was the implementation of a unified digital platform that includes all the relevant information on various aspects of mobility, although it seems to have serious implementation difficulties. Maybe short-term and lower-cost projects must be selected, as they are easier to mature and secure funding.

Regarding tourism very interesting ideas and solutions were presented by thematic experts, like the use of blockchain technology in a public digital platform that will inform and attract citizens and visitors about points of interest, website management, commercial offers, places to stay, etc. Cities around Europe already use such technologies with very positive outcomes. Solutions must also target Digital Nomads, this new trend that the COVID-19 pandemic enhanced so much. Digital Nomads are, usually, free-lancers that can complete their job obligations from a distant place, using digital technology. They prefer to stay in many different places and cities, combining work with pleasure, as long as the cities offer easy interface and accessibility. This is why they usually prefer smart and resilient cities. As another solution was proposed the utilization of digital museums. Since the traveling restrictions prevent people from other places to visit cities with museums or points of interest, a digital museum could cover up to a point that needs, and attract

even more someone to live the real experience when he will be able to travel. The city of Trikala has a great local history with many museums and this is a great opportunity to be taken advantage of. Finally, the use of real places as background themes in video games is a way to advertise the city and its unique characteristics.

On the other hand, the stakeholder consortium was concerned about the large competition that already exists in attacking digital nomads, mostly because of the unknown future of this trend and the use of video games to attract tourists, based on the extreme expenses of such a solution while it will be very difficult to attract gamers from other, already famous, video-games. The use of a digital platform that will use blockchain technology was found to be very interesting since already a digital platform exists, although it is at a very basic level and a new one will be fully operating in the next months. Through that technology, beneficiaries will not be only from the tourism parties but also from the commercial and entrepreneurial segments of the city. Other solutions that were presented were about thematic festivals based on the ancient history of the city, the music culture, or the local tastes.

After some internal meetings and the information of thematic experts, the coalition of stakeholders finalized the actions for each ambition statement that would be implemented as a project. Openness in data is aimed to be established with the implementation of a data portal, accompanied by a commonly agreed data policy, and with a public consultation portal. Smart mobility prioritized harmonized people and vehicle flows downtown and addressed an issue that causes traffic bottlenecks due to specific pedestrian crosses/passages, which need to be automated and controlled according to the traffic. Finally, smart tourism prioritized two innovative activities: a blockchain network that interconnects all the corresponding stakeholders (tourism unit; tourism agencies; hotels, etc.) and virtual tours to specified sights. The project portfolio aligns with the strategic vision and is organized appropriately for its successful implementation.

The Municipality of Trikala launched its public consultation portal (*dialogos.trikalacity.gr*) in 2018, its data portal in 2019 (*data.trikalacity.gr*), and drafted its first data policy the same year. Similarly, data portal performance needs to be enhanced with the development of a commonly agreed data policy for all the city stakeholders, as well as with the improvement of data streams that will be available via the portal. Data policy will extend the municipal one according to the ICC stakeholders' capacity and provide them with specifications for data dissemination via the data portal. Moreover, the following data sources will be connected to the portal and data collection will be based on:

- The Network of meteorological stations with the integration of Precision Agriculture application
- The water measuring stations of the rivers, with Feed from meteorological stations and real-time alerts
- IoT system for management and supervision of street lighting
- Parking management.

The Municipality will continue to enrich the data portal with data sources, to enhance transparency, bring citizens closer and support local development. The ultimate goal of the initiative is three-fold:

- To engage stakeholders in public consultations, which is expected to engage citizens too
- To draft a commonly agreed data policy for all the city stakeholders, which will extend the municipal data policy
- To enrich the data portal with valuable data streams, collected dynamically from sensors, IoT devices, and Civil Protection system Raw Data to attract research centers, universities, private companies, etc. that will process them and give back solutions or policies about existing city problems.

The solution that was selected in the Smart Mobility statement refers to actions to resolve the traffic and parking problems in the city by applying smart traffic lights on both sides of the central bridge connected to a digital platform. This smart technology will be able to monitor, learn, predict and respond to continuously changing traffic conditions via specific optical signals. The best-fit use is connected to pedestrians and cyclists as a target group and this will be delivered with innovative ICT solutions. The raw data will be also available to a traffic control platform, so the traffic engineers can have a higher-level view of traffic conditions. The use of such technology for many more pedestrian crosses will improve the mobility flows in the center of the city, especially during the busiest hours and days. The implementation of this project aims to significantly increase citizens' and visitors' satisfaction.

In the tourism sector, two solutions were promoted, that encourage a new idea of local growth, by attracting more visitors. Both of them have to do with the utilization of online platforms. For the first one, the online platform will be applied for digital tours on specific routes. These routes can cover different areas such as local history in health, water flows and rivers, and local history in music. The second one will be used to inform citizens and visitors about everything they need and create a smart tourist community that involves all the local tourism stakeholders. This latter digital platform will be using blockchain technology.

The two goals are for the visitors to be able to "travel" digitally to the city, from various places and countries and be familiar and a part of this destination and help provide higher-value services to the visitors, and upscale the businesses that are affected by the tourism wave. These initiatives will bring together the tourism stakeholders and generate a digital tourism ecosystem in the city. Additionally, virtual tours will extend the touristic period of the city and expand the Trikala's fame beyond the national boundaries.

The consortium also finalized the first draft of the timeline and scope for each project. As presented in Table 1, 2 of the 4 projects are planned to finish after 18 months, and the other two have a similar duration (9 and 10 months). The utilization of the Trikala Open Platforms project consists of the delivery of 3 different and continuous activities that have a total duration of 10 months. In more detail, in the first 6 months activities like portals upgrade, the establishment of a common data policy, and stakeholders' training on platforms will take place. For the next month planned to be completed the selection of the data sources and data sets that will be available, along with the consultation testing. Finally, in the last 3 months, the collection and dissemination of data (JSON, XML) and the consultation launch are planned to start and finish. The Smart Traffic Lights project is scheduled to be completed in a time frame of 9 months since it seems to be easier in its implementation

Table 1: Time scheduling of each project

Project Name	Project steps		
Trikala Open Platforms	Portal's upgrades Common Data policy; Stakeholders training on platforms (6 months)	Selection of the Data Sources and Data Sets that will be available; Consultation testing (1 month)	Collection and dissemination of data (JSON, XML); Consultation launch (3 months)
Smart Traffic Lights	Selection of possible locations for the lights (3 months)	Implementation of smart traffic lights (2 months)	Interconnection with the platforms (4 months)
Virtual Routes	Virtual Trip Development (8 months)	Virtual Trip Dissemination (10 months)	
Blockchain Digital Platform	Blockchain Prototype Installation (8 months)	Stakeholders' training in blockchain use (10 months)	

procedures. Three distinct activities will be the scope of it, each one with a planned duration of 3,2 and months respectively. The first is the selection of possible locations for the lights (although some of them are already known), the second is the implementation of smart traffic lights, and the last is the interconnection of sensors and cameras with digital platforms.

Finally, the two solutions that will enhance the tourism sector, are both of equal duration (18 months), and each one of them is composed of two activities – the virtual trip development and the virtual trip dissemination for the Virtual Routes Platform, and the blockchain prototype installation and stakeholders' training in blockchain use for the Blockchain Digital Platform. For every one of these two projects, the first activity has a planned duration of 8 months and the second 10 months after one and half years both to be completed. The above solutions were adopted by the stakeholders and now the next step in the implementation of them is beginning. The expected results will highlight how certain actions like the above will help the DT of a smart city, like Trikala, and to what level they will enhance the city's overall resilience.

4 CONCLUSIONS

This study highlighted a Greek city's DT process, under the guidance of EC initiatives, like the DCC and especially the ICC. The evidence shows that Trikala followed the same strategic planning approach for its DT in both the DCC and ICC initiatives, which was obliged by its enrollment. The project coalition consists of major city stakeholders, which defined the main strategic priorities: openness and citizen engagement (regarding SG), sustainable mobility, and smart tourism. Comparing the two strategies in DCC and ICC, the city made "*a shift from usefulness to inclusive-ness, and from sustainable growth to resilience*".

The new strategy for DT is served by 3 ambition statements the creation of an interconnected ecosystem with a commonly agreed data policy and via a common open data and public consultation portal, the utilization of a common digital platform for sustainable mobility activities, and the usage of digital tools to highlight local assets, attract digital nomads and virtual tourists.

Certain blockers and uncertainties reduced the possible projects that could serve this strategy and apply it in each priority area. Regarding open data and citizens' participation in e-government, some of them appeared to be the low open service usability, the absence of local ICT industry to utilize open data, and low interest of citizens. Regarding mobility, the citizen's culture of walking and cycling reduces the use of private vehicles since Trikala is a flat landscape with short distances while the use of public transportation is targeted for areas outside the city's center. As was expected, the COVID-19 pandemic had a serious impact on the mobility and tourism sector. The fear of the virus spread made people avoid any use of public vehicles, and tourism activities and trips almost eliminated any thoughts of visiting the area.

All the above risks pointed to corresponding ICT-based solutions to overcome them. Solutions that interact with the others were preferable, since "*cooperation*" would positively affect and boost the impact of the whole DT process. Openness in data is aimed to be established with the implementation of a data portal, accompanied by a commonly agreed data policy, and with a public consultation portal. Smart mobility prioritized harmonized people and vehicle flows downtown. Finally, smart tourism prioritized two innovative activities: a blockchain network that interconnects all the corresponding stakeholders (tourism unit; tourism agencies; hotels, etc.) and virtual tours to specified sights.

With support from thematic experts in each domain, the stakeholder coalition finalized 4 specific actions to support Trikala's DT. Trikala Open Platform will connect and select data from many sources of the city's administration to provide better services and attract citizens to participate in e-government and from various sensors in the environmental sector, that will add value to local growth. Furthermore, Smart Traffic Lights with sensors, that will be connected to a digital platform, will be placed at certain crossroads within the city's center to support mobility management and record traffic conditions. The other two solutions are about tourism, and aim to enhance local growth and attract more visitors – two online platforms will be applied; one for digital tours on specific routes and the other to inform citizens and visitors about everything they need and create a smart tourist community.

The importance of open data in all 3 priorities (open data and citizen participation, smart mobility, and smart tourism) was of high value. None of the 4 proposed projects that will be implemented during the ICC can be completed without the use of data and especially with some form of open digital platform. Of equal importance is also the staffing of a coherent and determined project management team to reach, manage, and guide all the relevant stakeholders. Sufficient time and scope management of activities both in DCC and in ICC along with stakeholder management kept the previous initiative and the ongoing one on track.

The examined case is still in progress and it remains to see whether the defined roadmap will be implemented by the city coalition until the project completion. Some future thoughts concern the completion of the project and the continuous update of the city DT strategic planning and implementation, as well as a comparison with other European cities' DT performance. Moreover, the authors aim to approach the relation of city DT planning with planning for city resilience and realize whether a correlation between objectives, factors, and activities exists. Both DT and resilience are of high interest to scholars, cities, and vendors, and updated outcomes are expected to appear.

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Intergovernmental Relations in the Implementation of the Public Service User Defense Code in Brazil: State capabilities and institutional arrangements

Thiago José Tavares Ávila
Fundação Getúlio Vargas - Escola de Administração de Empresas, Brazil
thiago.avila@fgv.edu.br

Danilo Gonçalves dos Santos
Fundação Getúlio Vargas - Escola de Administração de Empresas, Brazil
danilogoncalves92@gmail.com

Ronise Suzuki de Oliveira
Doutorado em Administração Pública e Governo, Fundação Getúlio Vargas - Escola de Administração de Empresas, Brazil and Instituto Federal de São Paulo, Brazil
ronisesuzuki@gmail.com

ABSTRACT

Among the stages of maturity in Digital Government proposed by [33], Brazil evolved nationally and federatively towards the first stages with the publication of Federal Law 13,460/2017, which instituted the Public Services User Defense Code (PSUDC). First, however, it is necessary to investigate whether this code created a National Public Service User Defense System in Brazil. The PSDUC has mandatory commands for all federal entities, giving ombudspersons a prominent role in defending the user's rights to public services, representing an advance in protecting fundamental rights. Since the law impacts various levels of government, this work aims to identify characteristics in the institutional arrangement around the PSUDC that indicate whether there is an outline of a Federative System of Public Policies. Furthermore, they determine which institutions in the different entities act for the user's defense and which state capabilities are present. For this theoretical-empirical study, its central methodology is the documentary analysis and descriptive and geospatial analysis of data on the National Network of Ombudsman Offices (Rede Nacional de Ouvidorias Públicas – ReNOuv). The results indicate, within the ReNOuv, the existence of four characteristics regarding the institutional arrangement; the identification of administrative, political, relational, and legal state capabilities and features information of a system of public policies for the defense of the public service user. Finally, the article elaborates a future research agenda, indicating the necessary improvements for the consolidation of the public policy system investigated in the federative context of Brazil.

KEYWORDS

Public Service User Defense Code, Federative System of Public Policies, State Capabilities

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1 INTRODUCTION

In recent decades, national, state, and local governments have become interdependent as they work together to manage complex policy problems, with sophisticated new forms of governance emerging that challenge the conventional hierarchies of the federal system [20, 36].

Public policy systems are advanced forms of governance, representing a strategy to promote cooperation between governments in federal countries. They establish national parameters that organize the distribution of competencies, instituting spaces for federative negotiation. [28]

Some essential elements for achieving a balance between cooperation and competition between federative entities. The federative entities approve the partnership mechanisms, such as legal rules that oblige actors to share decisions and tasks, mutual respect, and negotiation at the intergovernmental level [28].

Through the institutional design, it is possible to reconcile the autonomy and interdependence of federative entities. This design, however, is not only constituted by constitutional provisions but includes a more extensive set of rules and instruments that shape the relations between the spheres of government in each particular policy [4].

Thus, we need to consider that, in addition to the complexity of intergovernmental relations and arrangements, constant economic, political, social, and technological changes, combined with restricted budgets and growing citizens' expectations, make the digital transformation in the public sector imperative [19].

The digital transformation in the public sector, also known as electronic government (e-gov) or digital government, has been studied since the early 2000s. [33] present the four-stage model of the evolution of the e-gov. In Brazil, with the Federal Laws 12,527/2011 - Access to Information - and 13,460/2017 - Public Service User Defense Code, the country evolved nationally and federatively towards the first stages of Digital Government [33].

All public institutions were required to produce information about public services through the User Service Charters and develop structures to promote the participation and engagement of citizens in the context of public policies.

Within this context, the central discussion of this article concerns the intergovernmental cooperation arrangements in the context of Law 13,460 of June 26, 2017, known as the "Public Service User Defense Code - PSDUC." this law provides for participation, protection, and defense of the rights of users of public services in public administration. As such legal commands are recent and mandatory for the Union, States, and Municipalities, it is justified to identify the characteristics and components of this arrangement. Therefore, the aim is to contribute to greater effectiveness in complying with legislation and improving the supply of public services by the Brazilian State.

In this sense, PSDUC is a step forward in protecting the fundamental rights of recipients of public services, essential to guaranteeing participation, defending the rights of those who interact with the State and seeking an adequate provision of services, in harmony with the principle of efficiency in Public Administration established in the Brazilian Constitution.

Thus, this work aims to answer the following investigative puzzle: Does the PSUDC institute a National Public Service User Defense System? Which State capacities can be identified under Law 13,460/2017?

This article intends to understand the factors contributing to intergovernmental relations to establish a National System for the Defense of Public Service Users. Furthermore, the aim is to identify the actors in the federative entities and the mechanisms for inducing new state capacities to subnational and local governments that should be necessary for the successful implementation of the public policy to protect the public service user, which may lead to improvements in the implementation process ensuring the quality of service to the public service user.

To contribute to answering these questions, this article has four sections and an introduction. The following section discusses the concepts of federalism, institutional arrangements, public policy systems, and state capacities, offering theoretical-conceptual support for the analysis of public policy institutional arrangements in the National System for the Defense of Public Service Users. Section 3 presents and justifies the case selected for study and describes the applied analytical strategy. Section 4, in turn, raises the main findings of the analysis carried out, highlighting the main actors of the National Public Service User Defense System in federal entities and the central state capacities induced by Law 13.460/2017. Finally, the last section concludes the text, returning to the questions that motivated the analysis, the findings, contributions, limitations, and a future research agenda.

2 BACKGROUND

2.1 Intergovernmental relations and institutional arrangements in federalism

Federalism is a pact [31], "a political construction to deal with relations between all levels of government around common agendas." Cooperation between federated entities is a central element in generating consensus through negotiated arrangements, distributing power and autonomy to achieve common goals. Federalism can also lead to competition between federative entities to attract new businesses, discourage the residence of citizens who are large consumers of public services, and orchestrate intergovernmental relations that organize these relations in federative contexts and heterogeneity.

We define Intergovernmental Relationships (IGR) as formal or informal relationships between elected officials or public servants at different levels of government. IGRs evolve to meet the needs for cooperation and coordination [33]. In Brazil, the decentralization of policies is the main form that organizes the IGRs, in contexts of federative heterogeneity. Therefore, to assess whether national policy systems are the best format to coordinate the modernization of autonomous but unequal governments, it is necessary to overcome certain conditions that, if absent, can generate problems of intergovernmental cooperation [31].

In this regard, coordination can be used within the IGRs to ensure synergy between the respective jurisdictions' unique but related policy areas [42] and establish roles and responsibilities in shared policy areas to reduce duplication [30].

Analyzing joint efforts and actions is essential for working public policies [28]. This process involves modalities of participation and protection of subnational governments from federal decisions, primarily through intergovernmental forums that minimize unilateral actions, effectively functioning as federal safeguards [47].

For the federative pact to be successful, cooperation between the actors is necessary to overcome the challenges of coordinating actions between federative entities [44]. Moreover, according to [34], it is relevant to identify how political, institutional, and administrative arrangements can coexist with more controversial or cooperative relationships between central and subnational governments.

The models of arrangements support and impact the ability to implement public policies through collaboration between different actors that optimize the results of the implementation process [26; 3].

The degree of success of a public policy depends directly on the degree of success in achieving cooperative action among governmental and non-governmental, depending on the design of the policy. In this sense, [37] argues that public policy is a complex and continuous process involving multiple decisions, which also occur in the implementation process. Hence, understanding the actors involved and their contexts becomes necessary for more assertive decision-making.

For each policy, organizations are arranged (with their mandates, resources, competencies, and legal instruments), coordination mechanisms, spaces for negotiation, and decisions among actors (from the government, the political system, and society) [26]. Therefore, understanding the process of public policies requires a deeper look at the institutional arrangements that support the implementation of these policies. [43] argues that institutional arrangements improve federative relations between federative entities, seeking intersectionality focusing on addressing specific problems and including new actors in decision-making.

National policy systems are the most appropriate institutional political design considering the characteristics of federalism in

Table 1: Synthesis of federal public policy systems in Brazil

Characteristic	Definition	Example	Related capabilities
Interfederative coordination	Distribution of competencies in the public policy cycle through the municipalization of service provision	Elementary school enrollment	Municipalization ends up expanding administrative capacities [28, 31]
Inducing the role of the Central government	With policy-decision-making centered on the federal government, one way to ensure adherence without compromising autonomy comes from the national government's ability to incentivize local government participation in programs.	Transfer of funds from the SUS	The inducing power of the central government in itself is a political capacity as it seeks to influence the agenda; The transfer of funds is a mechanism to make up for the lack of collection capacity [1]. It serves to make up for inequalities in fiscal capacity.
Arenas of agreement	Intergovernmental safeguards guarantee some decision-making power at all federal levels to preserve autonomy and avoid harmful federative behavior such as opportunism and unilateral decisions.	Interagency Committees of SUS	The negotiation arenas constitute spaces where it is possible to mobilize and expand political capital [36].

Source: Elaborated by the authors

Brazil [31]. Therefore, it is essential to analyze the institutional arrangements and results to act in a coordinated and cooperative way among federative entities, so that decentralization represents a way to strengthen the capacities of federal entities to implement public policies, because often local entities do not always have compatible management capabilities and resources to implement them [5, 6].

2.2 Federative Public Policy Systems: decentralization and state capacities

The structure of public policy systems is a strategy to promote cooperation between federative entities and establish national parameters that organize the distribution of competencies and establish spaces for *Federative Public Policy Systems* [28]. Characterized as a cooperative arrangement between federation entities to implement a specific public policy, that kind of system is a way to organize roles, distribute competencies, and institute negotiation spaces to promote policy in a decentralized manner [24, 25].

Table 1 summarizes the characteristics of *Federative Public Policy Systems* based on the literature review used for this article. A debate started on the Unified Health System (*Sistema ùnico de Saúde*) in Brazil, and it is based on its characteristics that one can indicate how to classify an organization as a federative system. First, the municipalities gain a prominent role in implementing public policies. In the distribution of competencies, local governments gain the role of the main implementer, that is, there is municipalization of management and provision of services [25, 35]. Clear cases are primary health care and elementary school enrollments.

Municipalization is intended to combat territorial inequalities in the supply of social services and to ensure that within the system, policies can be adapted to local needs. Local governments are left with the so-called policy-making, the execution, while the decision-making (policy-decision-making) remains in the hands of the central government. Local government spending on sectoral policies is mainly decided by federal regulation [06].

Another key feature of federal public policy systems is the role played by central governments. In this organization of state action, the Union is the leading decision maker [24] and the primary holder of resources. In addition, the federal government has induction mechanisms, mainly based on cash transfers [35], to ensure that municipalities adhere to the programs [25]. In other words, it is up to the Union to have as a management tool for these public policies mechanisms to encourage and sometimes even punish states and municipalities in their participation [20].

Finally, these systems are also characterized by the existence of arenas for federative pacts [24, 25, 35]. These are the so-called intergovernmental safeguards, spaces that guarantee equal decision-making power to the different levels of the federation to prevent harmful behaviors in intergovernmental relations. Its main objective is to guarantee that decision-making power on some scale to all members of the federation, preserving autonomy and ensuring greater coordination of conflicts [9, 10].

In health and social assistance, these spaces take the form of the Tripartite Interagency Commissions (CITs) and the Bripartite Interagency Commissions (CIBs), analyzing the work of these commissions serves as evidence that arenas of federative pacts impact the results obtained in systems of federalist cooperation, with the CITs being an example of how federalism preserve the action of subnational and reduce the effects of unilateral initiatives of the central sphere in Brazil [27].

It is important to point out that the non-existence of one of these characteristics shown in Table 1 does not mean that a system does not exist but that it is incomplete. Education is the most classic case of these, where even without arenas of pacts there is a process of municipalization of services (even if weak) and induction by the Union with funds for transferring resources [20, 45]. It is something that differs, for example, from social security, a public policy managed exclusively by the federal government that has none of the characteristics presented so far [20].

Table 2: Dimensions of state capabilities

Capabilities	Characteristic
Coercive	The ability of the State to monopolize the administration of coercive power.
Fiscal	The ability to extract resources from society, mainly in taxes, may also refer to efficiency in government spending.
Administrative	Based on the existence of a professional and insulated bureaucracy. This dimension of state capacity is perhaps the most mentioned in the literature, related to good governance.
Transformative	Ability to intervene in the production system and shape the economy
Relational	Territorial coverage seeks to capture the extent to which the state permeates society and can internalize social interactions within its actions.
Legal	Role of the State in guaranteeing signed commitments and the execution of contracts.
Politics	It refers to the level of power accumulated by elected leaders to drive political priorities among different institutional actors (parties, Congresses, Chambers, etc.) It is equated with political leverage or policy-making capacity.

Source: [47] adapted from [18].

According to [27], the "quality of federalism" would be measured by its ability to reproduce in each political unit "miniature reflections" of relevant aspects of the system. In the literature, there are examples of how in combating territorial inequalities, mainly in terms of state capacity, the role of the Federal Public Policy Systems stands out [25; 31]. The regionalization of the SUS (Unified Health System) expanded capacities mainly in the Northeast Region [34]. Something that also happened with the municipalization of education in Ceará [45]. Both examples highlight the inductive role of the mid-level (respectively, Union for SUS and State Government in the case of Ceará) in the expansion of local capacities. The extent to which more state capacities in subnational governments enable the combination of political autonomy with interdependence in federal public policies must be assessed" [50].

In this case, it is essential to know what is the possibility of reconciling the "intergovernmental partnership" focused on "jurisdictions" (territories) with those anchored on "functions" (policies). This issue is more critical when the links between the federal government and subnational entities are based on the growing expansion of the latter's attributions. One of the requirements placed on IGRs, when constituted on policy decentralization processes, concerns the state capacities of subnational entities [29]

[46] states that "it is a consensus that the state capacity is relevant to explain public policies." According to [21], one way of investigating state capabilities is to identify organizational structures whose absence or presence seem critical for authorities to carry out specific tasks. As building these capacities is a "key policy element" in intergovernmental relations, it is essential to clarify the status and demands of federal technical assistance to achieve this result in local governments.

According to Cingolani [18], state power is determined by a combination of state capacities to carry out public policy. The author than through a literature review presented several types of state capability, based on her article [18], Table 2 summarizes these different capabilities. We use her debate and definitions to help us to clarify what a *Federative Public Policy Systems,* or a policy like the PSUDC, can impact In terms of capacities, in other words, what look for when to assess state capacities under a federal system of government.

2.3 Public Policies for Digital Government

Aiming at management models that make governments more efficient, effective, and coordinated, information and communication technologies (ICT) has become an essential component (adapted from [5]). We understand Digital Transformation as "an evolutionary process that leverages digital resources and technologies to enable business models, operational processes and customer experiences to create value" [38] and that its application in the public sector, "Digital Government" can be understood by public entities that adopt digital technologies as an integrated part of their governments' modernization strategies to create public value [41].

The evolution of Digital Government has been studied in the literature since the early 2000s. The first stage, (1) digitization, does not present significant government changes and intergovernmental relations. Focuses only on adopting digital resources for the execution of processes and services. The second stage, (2) transformation, presents some relevant digital changes within the government but does not act on external relationships and is independent of the application context. Finally, stage (3) of "engagement" presents the transformation of the internal government of external relations. The changes are more general in these three levels without depending on the application context.

Within this context, Digital Government has been gaining prominence in the public policy agenda of Brazilian federated entities since the 2000s. As a result, normative acts related to Digital Government and the simplification of the State-society relationship were sanctioned, such as Federal Laws 12,527/2011, 13,460 /2017, and 14.129/2021, known respectively as the "Access to Information Law - LAI," "Public Service User Defense Code - PSUDC" and "Digital Government and Public Efficiency Law - LGD" [13, 14, 21].

In this direction, after LAI and PSUDC, Brazil evolved nationally and federatively towards the first stages of Digital Government brought by [32, 33], especially with the obligation that all institutions Brazilian public authorities should produce information on public services through User Service Charters, as well as develop

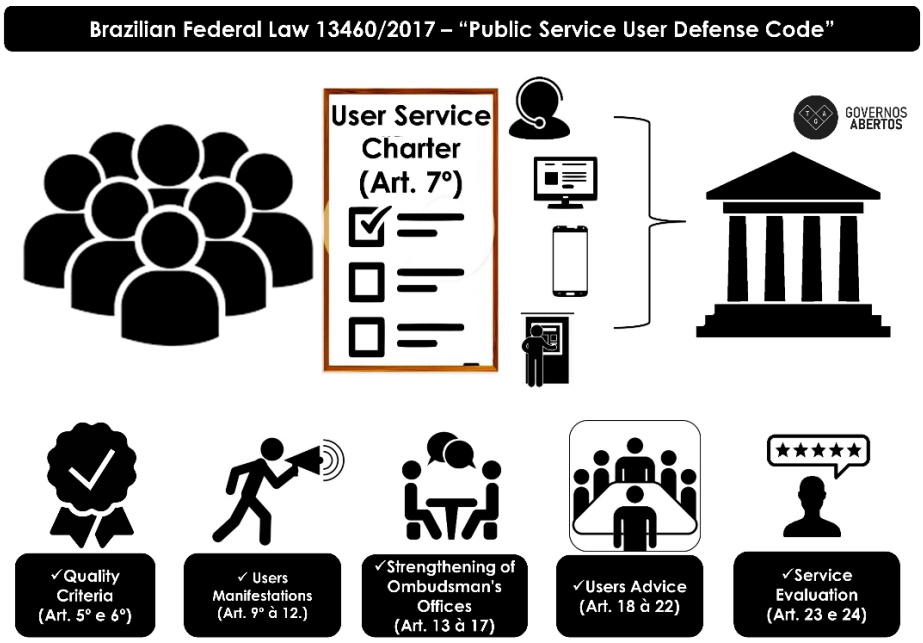


Figure 1: Innovations in the Public Service User Defense Code [7]

structures to promote the participation and engagement of citizens in the context of public policies.

2.3.1 Code of Defense of Public Service Users: components and attributions. Constitutional Amendment 19/1998 brought several innovations to the functioning of the Brazilian Public Administration. Among such innovations, it is expected that the legislation will discipline the forms of user participation in public administration, regulating complaints related to the provision of public services. In this sense, [48] points out that the PSUDC represented a remarkable advance in the protection of the fundamental rights of recipients of public services, bringing essential innovations to guarantee participation, defend the rights of those who interact with the state, and the search for a provision of adequate services. According to the Figure 1 [7], the six main innovations brought by the PSDUC are: (i) User Service Charters; (ii) Quality criteria for public services; (iii) User Manifestations; (iv) Strengthening of the Ombudsman; (v) User Councils of Public Services and (vi) Evaluation of Public Services.

According to [7], the User Service Charters, as they were instituted by legal command and because they present the procedures for the provision of each public service offered, constitute a relevant innovation in the context of relations between the state and the Service User Public. The Charters act as a "public services menu" for each institution and establish clear and precise information about each service provided.

The PSUDC brings the quality criteria to be considered by public services, bringing guidelines for providing services and users' fundamental rights. Among such controls stand out the presumption of good faith of the user, as well as the importance of service in order of arrival; and the authentication of documents by the public agent itself, given the originals presented by the user, with the requirement of notarization being prohibited, except in case of doubt of authenticity [31].

The PSUDC presents new innovations to strengthen user participation in monitoring the provision and evaluation of public services. First, user councils will monitor the provision of services, participate in the assessment of benefits and propose improvements in the provision of services, as well as monitoring and evaluate the performance of the ombudsman; Another essential contribution of the law is the guidance on the continued evaluation of public services [14, 31].

Table 3 presents the description of the component of the arrangement linked to the PSUDC, the description and main attributions, and where it is located among the federative ones.

To guarantee their rights, the User may present statements to the public administration about public services, which will be addressed to the ombudsman of the responsible body or entity [14]. Under the terms of the PSUDC, the citizen has the right to express his views on public services and the guarantee of analysis and conclusive response to his statement sent to the public ombudsman.

3 METHODOLOGY

Given the characteristics of the PSUDC, it is possible to infer that its proper implementation will change the current institutional arrangement of the processes related to Digital Government in Brazil. Taking into consideration that it applies to all federal entities and that public policy systems are a viable option to manage intergovernmental relations and modify state capacity, this case

Table 3: PSUDC components and their main attributions

Component	Description	Attribution	Federative entity
Service Charter	Clear and precise information about the relationship and characteristics of public services.	The obligation of all organizations covered by the PSUDC	Municipal, state, and federal governments
National Public Services Base	It is incumbent upon each federated entity to make available the information on the services provided, as provided for in their User Service Charters, in the National Public Services Database, maintained by the federal Executive Branch, in an open and interoperable format, under the regulations of the Federal Executive Branch.	The obligation of all organizations covered by the PSUDC	Municipal, state, and federal governments, under the coordination of the Federal Government
Ombudsmen	The elaboration of the annual management report consolidates information about users' manifestations and the respective solutions offered.	Ensure user participation in public administration, their rights and point out possibilities for improvements and failures in the provision of public service	Municipal, state, and federal governments
Ombudsman Manifestations	Receipt, analysis and responses, through proactive and reactive mechanisms, to manifestations sent by users of public services.	Promote user participation in public administration, monitor the provision of services, receive and analyze complaints, and adopt monitoring, mediation and conciliation measures between the User and the public entity.	Municipal, state, and federal governments
User Advice	Consultative body with the participation of users for the monitoring and provision and evaluation of public services	Monitor the provision of services; participate in the evaluation of services; propose improvements in the provision of services; contribute to the definition of guidelines for the adequate service to the User; and monitor and evaluate the ombudsman's performance.	Municipal, state, and federal governments
Assessment of public services	Instruments for citizen participation and promotion of the quality of public services	Public organizations covered by the PSUDC must evaluate the services provided in the following aspects: I - user satisfaction with the service provided; II - the quality of service offered to the User; III - compliance with the commitments and deadlines defined for the provision of services; IV - number of user manifestations; and V - measures adopted by the public administration to improve and improve service provision.	Municipal, state, and federal governments
National Ombudsman Network - ReNOuv	National forum for public ombudsmen	Integrate the simplification actions developed by the ombudsman units of the Powers of the Union, States, Federal District and Municipalities, being an instrument for the exchange of information and procedures for the defense of the User of public services, dissemination of knowledge and good practices related to ombudsman actions and improving management by promoting participation and social control" [13].	Federal Government, with voluntary adhesion of state and municipal governments

Table 4: Ombudsmen that are part of ReNOuv by performance and administrative level

Component	State	Federal	Intermunicipal	Municipal	Total
Associations, Consortia, Councils and Civil Society Organizations and others	2	4	11	1	18
Public Defense	2	-	-		2
Executive Power	112	120	2	1360	1594
Judiciary Power	2	24	-	-	26
Legislative Power	14	2	-	541	557
Prosecutorial	11	3	-		14
Total	143	153	13	1902	2211

raises interest and because of this was selected for investigation. As a single case study, the implementation of the National System for the Protection of Public Service Users was analyzed in the light of the theory of federalism to understand intergovernmental relations and the induction of state capacities.

This theoretical-empirical study has an exploratory view, seeking practical application from theoretical data and information [32], developing a straw-in-the-wind test able to generate pointers toward and answer the research question. It aims to present the federative institutional arrangement surrounding the implementation of the PSDUC and the characterization of the public ombudsmen belonging to this arrangement, considering their central role as an implementing element of public policy.

It adopts a qualitative-quantitative approach, with analysis and a combination of secondary sources (texts of laws, ReNOuv's databases and documents) in a cross-section. It seeks to understand who and how many actors are and how they are distributed among federative entities, identifying evidence of induction of state capacities in federative entities.

The sample comprises 2,211 public ombudsman offices registered in the ReNOuv [51], having as a source the database made available by the Federal Comptroller General on the institutions participating in the Network, collected in December 2021. In addition, specific variables were investigated, such as: Geographic location of the ombudsman, administrative sphere, role in which power of the Republic, thematic role and classification of the ombudsman in ReNOuv.

Data analysis was performed using content analysis techniques. The data were consolidated with Microsoft Excel software to generate descriptive statistics and chloropletic maps, and Google Maps was used to create the map of points with the special distribution of public ombudsmen registered at ReNOuv. The analysis of this database is justified since ReNOuv is the "national forum for public ombudsmen, to integrate the simplification actions developed by the ombudsman units of the Powers of the Union, States, Federal District and Municipalities, be an instrument for the exchange of information..." [15, 16].

4 ANALYSIS AND RESULTS

4.1 Identification of institutions involved in the implementation of the PSUDC among federal entities in Brazil

Table 4 and Figure 2 summarise the Ombudsmen that are part of ReNOuv by administrative level and area of policy. Health (12.76%) has the most significant ombudsmen registered in ReNOuv. In addition, Federal Council Ombudsman and Education with an expressive difference from other areas.

As for the role of public ombudsmen in the federative arrangement, the database classifies as ombudsmen between full members and employees of ReNOuv. Regarding full members, 1902 (88.22%) are from the municipal sphere, 141 (6.54%) from the state sphere, 102 (4.73%) from the federal sphere, and 11 (0.51%) are from the nature intercity. As for collaborating members, 51 (93%) are federal, 2 (3.64%) states and 2 (3.64%) are inter-municipal.

As for the spatial distribution of ReNOuv ombudsman offices in the Brazilian states, we observe that the State of Santa Catarina concentrates 475 ombudsman offices (21.48%) of the total, followed by the Rio Grande do Sul, with 379 (17.14%), São Paulo with 148 (6.69%), Minas Gerais with 129 (4.16%) and Rio Grande do Norte with 92 ombudsmen (4.16%), according to Figure 3.

The research also identified the adhesion related to Organs central ombudsman bodies of the state Executive Power, generally linked to the Secretariats of Transparency, General Comptroller's Office, or General Ombudsman of the States/Federal District. At the state level, 25 of the 27 FUs had their adhesion to ReNOuv identified in the database, 13 in 2016, 3 in 2017, and 4 in 2019. central ombudsman of the state governments of Rio de Janeiro and Santa Catarina.

As for the state distribution, it is observed that all state governments have ombudsmen integrated into ReNOuv. The Rio Grande do Norte (47) and Ceará (10). As for the municipal distribution of public ombudsmen, 1,441 municipalities in Brazil (25.84%) have at least one ombudsman integrated into ReNOuv. The municipalities of Florianópolis/SC (25) and Juiz de Fora/MG (22) draw attention due to the large number of municipal ombudsmen members of ReNOuv. Furthermore, it was observed that in both municipalities, agencies and entities of the municipal administration joined the network, differing from other cities.

Among the 1,441 municipalities with ombudsmen in ReNOuv, 900 towns have an ombudsman only in the Executive Branch, while

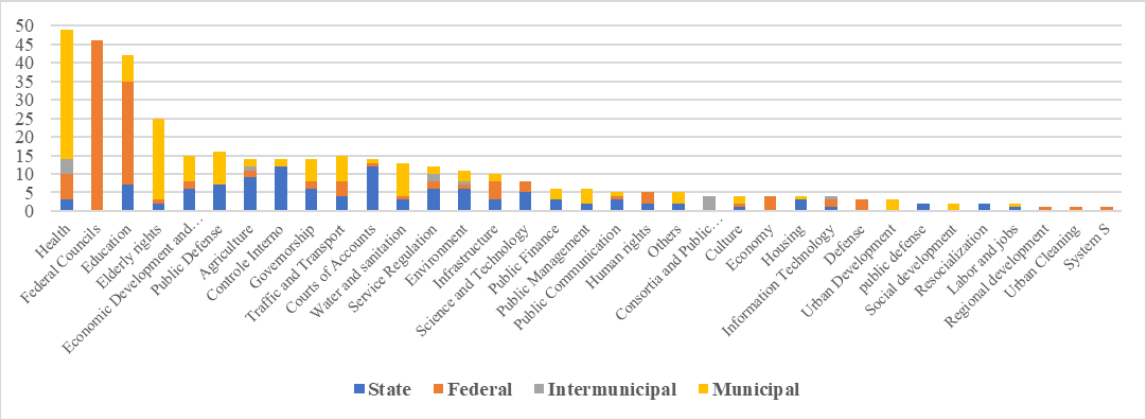


Figure 2: Distribution of ReNOuv ombudsmen regarding federative action and thematic.



Figure 3: Spatial distribution of ombudsmen who joined ReNOuv.

210 cities have an ombudsman only in the Legislative Branch. Therefore, only 330 municipalities were simultaneously identified with the executive and legislative powers ombudsman as highlighted in Figure 4.

Figure 4 deserves further investigation into which institutional arrangements are being developed: within the state executive branch, as well as in the municipal executive and legislative branches for adherence to ReNOuv and, consequently, for the implementation of the User Defense Code of the Public Service.

4.2 State capacities and institutional arrangements in PSUDC

Analyzing the period of adhesion of the Ombudsmen to ReNOuv, among the 1464 ombudsmen, we observe that after the enactment of Law 13,460/2017, the growth of Ombudsmen that are part of the Network was significant. It is essential to highlight, as the Figure 5, that in 2019 when the law entered into force at the municipal level, 501 adhesions (400 from municipal ombudsmen) were the highest result of the historical series.

Back to Figure 2, we can identify the thematic participation of the ombudsmen who are members of ReNOuv. Despite the thematic segmentation being a little different by administrative sphere, for simplifying the visualization, the performance by themes of all ReNOuv's ombudsmen was consolidated. Therefore, for this analysis, only the 368 thematic ombudsman offices were considered among the 2,211 existing in ReNOuv. We identify another relevant feature of the arrangement: some thematic areas show greater maturity in incorporating this public policy into their operation routine.

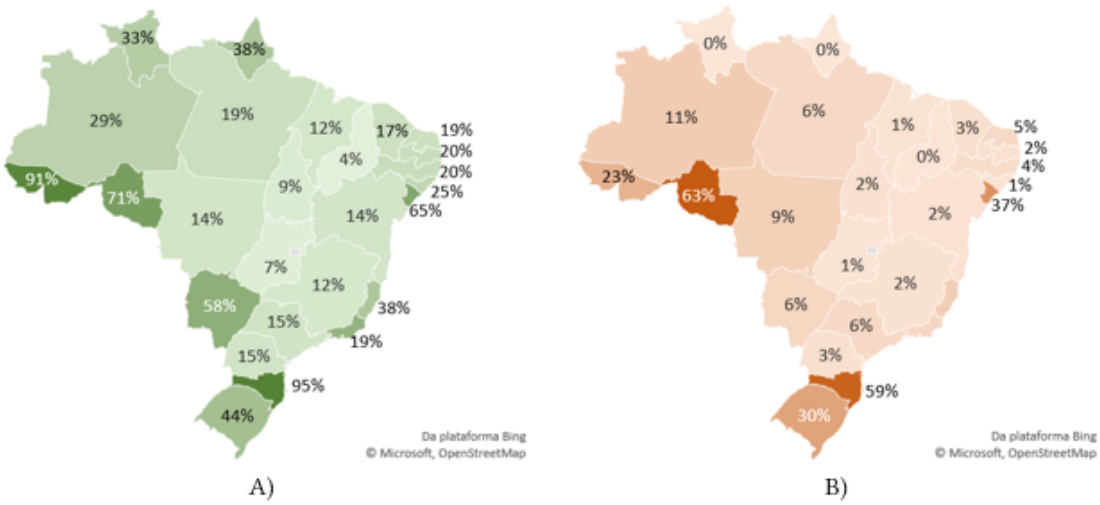


Figure 4: % of municipalities by UF with ombudsmen in the Executive and Legislative branches that adhered to ReNOuv, respectively.



Figure 5: Number of ombudsmen who joined ReNOuv.

Furthermore, we understand that the institutional arrangement of ReNOuv is organized: (1) covering all spheres of Brazilian public administration (federal, state, and municipal governments and Intermunicipal action); (2) all the Powers of the Republic (Executive, Legislative, Judiciary, in addition to the Public Ministry, Public Defender's Office and Courts of Accounts); (3) having distribution in the Brazilian territory, with greater intensity in the states of Rio Grande do Sul and Santa Catarina; (4) and with thematic deepening in some areas of public policies.

In addition to the characterization of the institutional arrangement, the research sought to identify the main state capacities existing around the PSUDC. According to the dimensions proposed by [16], Table 5 summarizes the evidence in the PSUDC that induces state capacities by Law 13460/ 2017. It is observed that a precise institutional arrangement was established based on new types of organizations for the management of shared use of water, such as the Users' Council, of an advisory nature and the Forum of ombudsmen.

Of the seven dimensions of state capacities proposed by [16], it is observed that Law 13460/2017 points out five factors that relate the implementation of the PSUDC with the participation and articulation of other actors. And that there are some gaps and dissonances between federative entities because of the differences in the number of ombudspersons installed, highlighting Santa Catarina than the State. Concerning administrative capacity, the existence of the PROFORT and PROFOCO programs is highlighted, contributing to public servants' professionalization.

Table 5: State capacities identified for the defense of users of public services institutional arrangement

Dimension	Characteristic
Fiscal	It has no created fund or pre-established funding sources.
Administrative	The law provides for the functioning of the PSUDC, with several actors to induce good governance and with the obligation of new administrative procedures for all agencies and entities of the federal, state, and municipal public administration.
Relational	The PSUDC created conditions for a territorial arrangement established at ReNOuv. In addition, with the innovations brought to the PSUDC by Law 14.129/2021, the National Public Services Base will be another federative arena for the sharing and effective use of information from the User Service Charters to improve the delivery of services to society, as they constitute a mechanism for participation and communication with civil society that enhances the capacity to process demands.
Legal	With data from Service Charters, service evaluations, ombudsman manifestations, and annual management reports, federated entities have inputs for improving current legislation, standardizing PSUDC commands in specific contexts and thematic areas.
Politics	Creating arenas for negotiation and exchanging information makes a new institutional arrangement that favors political capacities to influence the agenda.

4.3 Current characterization of the Public Policy System for the defense of the User of public services

Considering the main characteristics of federative public policy systems present in Table 1, we identified that, despite the PSUDC being recent legislation, there was a rapid expansion and development of some state capacities and necessary conditions for the future development of a federative system. evertheless, I consider that more institutionalized systems such as education are still regarded as incomplete [44; 22].

It is impossible to categorize what we have here as a complete system such as SUS. Still, it is possible to identify a level of federative coordination, classifying it as a system in an initial stage and still incomplete. Table 6 describes the characteristics identified in the PSUDC regarding its organization as a system.

5 FINAL REMARKS

Therefore, the objective of this work was to answer the following investigative puzzle: Does the PSUDC institute a National System for the Defense of Public Service Users? Empirical research does not indicate that the PSUDC created a national Public Service User Defense system. It is still an incomplete system, and it still generates social inequalities. Nevertheless, it realizes that some cities are ahead in installing active tapping in their cities and regions of the state.

It was possible to identify the leading institutions in this institutional arrangement. It became evident that the contexts and group of actors influence the implementation of the policy in its entirety and the state capacities. For example, it was identified related to Law 13460/2017 that the PSUDC encourages five new state capacities. However, the law is three years old and may have new developments because of new technologies and user requirements.

Another point to be considered in the 2017 Law is recent. It has some inducing mechanisms, and decentralization presents inequalities between subnational governments. However, it is noted that there are still spaces for other innovations in listening to the public service user's dissatisfaction and how to use this information to make improvements. ReNOuv is an excellent platform for networking practices, as well as a spokes Fala.br platform for ombudsman management and access to information. These resources promote cooperation in intergovernmental relations.

During the research development, some questions were raised that could be a new research agenda, considering that Law 13460/2017 is recent, such as the role of states in inducing public policy for the defense of users in municipalities? What is the role of each federal entity? Investigate possible flaws in the mechanisms that cause public policy?

Like all research, this one has limitations. As this is a case study, it is impossible to generalize state capabilities. Still to be investigated. Another point that should be researched is to identify gaps in the institutional arrangement and the federative intergovernmental relations existing around Law 13460/2017 that establishes the Public Service User Defense Code. This limitation does not invalidate the study. But they make room for a research agenda that expands.

It is also important to point out limitations related to the methodology used, this is a work that aims at practical application from data and theoretical information with straw in the wind test, despite being considered weak by some authors [2]. Even here proving to be able to generate indications and answer the research question, its limitations lead to the need for further research and hypothesis testing. However, it still makes contributions to the research agendas of the topics addressed and sets a precedent for the construction of future agendas involving them.

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Table 6: Characteristics of federative systems applied to the PSDUC

Characteristic	Definition
Interfederative coordination	Interfederative coordination takes place within the scope of ReNOuv, mandatory for federal institutions and optional for subnational institutions. ReNOuv is coordinated and secretariat by the General Comptroller of the Union - CGU, through the General Ombudsman of the Union - OGU through the following bodies: (i) General Assembly, composed of all members of the Network; (II) Board of Directors, composed of six full members elected at the Assembly every two years, with only one reappointment allowed and by the General Coordinator of the National Network of Ombudsman; (III) General Coordinator of the National Ombudsman Network, in charge of the head of the Union's General Ombudsman; and (IV) Executive Secretariat, under the responsibility of the General Ombudsman of the Union, under the Internal Regulation of the General Comptroller of the Union, Federal Decree 9,492/2018 of Normative Instruction No. 3/2019 of the OGU (adapted from [12, 14]) .
Inducing the role of the Central government	Mainly developed through the Ombudsman Strengthening Program (PROFORT), which aims to promote (I) the integration of ombudsman activities; (II) improving process management; (III) the use of new technologies and innovative solutions to improve the handling of citizen complaints; (IV) the exchange of information and experiences between the ombudsmen; and (V) training public agents in ombudsman activities. Through PROFORT, OGU makes available to members of the ReNOuv: (I) courses and training on ombudsman activities; (II) technical and guidance material for ombudsman activities; and (III) - National Computerized Ombudsman System - e-Ouv (currently Fala.br), as well as other computerized solutions that may be made available nationally by the Federal General Ombudsman and by the institutional partners of ReNOuv (adapted from [14]).
Arenas of agreement	ReNOuv is the national forum for public ombudsmen [14]. With the enactment of Law 14.129/2021, the National Public Services Base constitutes a second arena for a pact, under the coordination of the Federal Government, aiming at sharing information on public services, arising from the User Service Charters [8, 21]

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Learnings from a Pilot Hybrid Question Answering System: CQAS

Case Study based on a Singapore Government Agency's Customer Service Centre

Alvina Lee Hui Shan, ALHS, and Lee
Singapore Management University
hslee.2020@engd.smu.edu.sg

Venky Shankararamen, VS, and Shankararamen
Singapore Management University
venks@smu.edu.sg

Ouh Eng Lieh, OEL, and Ouh
Singapore Management University
elouh@smu.edu.sg

ABSTRACT

The Singapore Government first released their digital government blueprint in 2018 with the key message for all their agencies to be "digital to the core and served with heart". With this push, agencies are moving towards human-centric digital services, especially for individual citizens. During COVID-19, Singapore government agencies introduced many COVID-19 digital initiatives resulting in more incoming inquiries from citizens to respective agencies. This surge in inquiries created the challenge on the agencies' end to meet service level agreements. One widely adopted solution is the use of chatbot technology that directly interfaces with the customer. However, several organisations have faced backlash from the citizens or customers when such chatbots cannot answer or give inappropriate answers to the questions. Hence this research takes a different approach to address this challenge using a question answering (QA) system that supports the CSOs to help answer the citizen inquiries more efficiently.

This paper shares our learnings from implementing the pilot QA system; the Citizen Question Answering System (CQAS) was built using a hybrid QA approach that combines techniques from Natural Language Process QA, Knowledge-based QA and Information Retrieval QA. We also highlight the essential learnings in implementing QA systems within a government agency. The research will further share how these learnings could inform the adoption of QA systems in a government setting. The subsequent research following this paper will then focus on conducting a user study with the CSOs to validate further the benefits of this pilot QA system, which is not covered in this paper.

CCS CONCEPTS

• **Applied Computing-E-Government**; • **Applied Computing-Document Management and Text Processing**;

KEYWORDS

Question Answering, Service Innovation, Citizen Services, Text Analytics

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1 INTRODUCTION

The Digital Government Blueprint [1] that the Singapore Government has advocated since 2018 strongly emphasised the need to enhance citizen satisfaction rate by leveraging data and technology to respond to citizens' needs promptly and efficiently. To minimise the impact of COVID-19 on the citizens of Singapore, various COVID-19 initiatives were rolled out by the Singapore Government. This resulted in more incoming inquiries from citizens to respective agencies through telephone, in-person, and email. This surge overwhelmed the Customer Service Officers (CSOs). Creating a government chatbot such as AskJamie to leverage Questioning Answering technology is one of the solutions to increase citizen satisfaction rate [3, 10]. However, such chatbot solutions were unsuccessful due to incorrect and inappropriate answers given to citizen inquiries [17].

A more viable solution is to leverage the concept of applied artificial intelligence (AI), which uses AI to enhance and extend software applications. In this research, applied AI comes in the form of a software system that incorporates question answering (QA) systems to help the CSOs respond to citizen inquiries [4, 9, 13, 14, 16]. QA systems involve the analysis of a question phrased in natural human speech and then locating a recommended answer to that question within a database of documents [2]. CSOs using the QA system would likely reply more promptly and appropriately to the citizens.

With such systems in place, there is potential operational effectiveness that can be achieved within a citizen service setting.

This research paper presents our experience building and evaluating a pilot question answering system - Citizen Question Answering System (CQAS), using the existing case records and documents in a knowledge article database from a government agency. The overarching goal of this research is to elicit the learnings during the initial implementation of a hybrid question answering system (CQAS) that combines techniques of Information Retrieval QA, Natural Language Processing QA and Knowledge-Based QA. The research will further share how these learnings could inform the adoption of QA systems in a government setting.

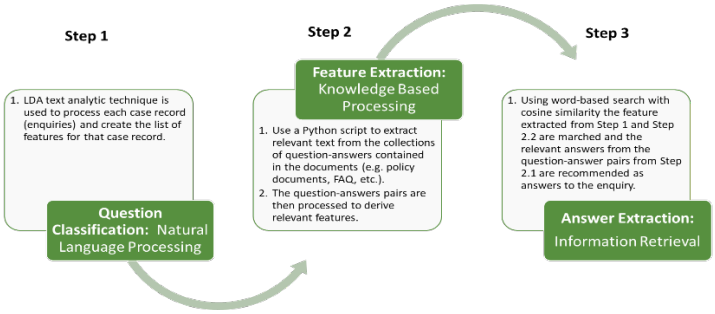


Figure 1: Overview of the Hybrid QA Technique used in CQAS

The contribution of this research is to provide insights into the challenges of the implementation of QA systems within a government agency. The subsequent research following this paper will then focus on conducting a user study with the CSOs to validate further the benefits of this pilot QA system, which is not covered in this paper.

2 METHODOLOGY

2.1 Business Context and Data

The case study was based on a Singapore government agency that uses an external customer service centre that caters mainly to individuals and companies who have inquiries about training-related programmes and initiatives that this agency manages. The citizen sends an enquiry through one of the different mediums such as telephone or email. The CSO inputs the enquiry into CQAS, retrieving a ranked list of relevant answers. The CSO can either select an answer or adapt from the list, which is then sent to the citizen. CQAS uses two types of pre-processed data, namely past inquiries from citizens captured in case records and information from FAQ and other policy documents.

2.2 QA Techniques Used

The CQAS is built using the Hybrid QA technique. Figure 1 depicts the different techniques used.

3 FINDINGS AND DISCUSSION

3.1 Presence of feedback-related statements increased the complexity of CQAS

The pilot QA system had a low accuracy of 33%. It was uncovered that, unlike a chatbot, inquiries submitted by citizens via email or digital feedback portal tend to be lengthy and structured more like feedback than as a question only. Hence if a government agency wants to adopt the QA system, they must investigate ways to enhance the QA system to differentiate feedback-related statements from questions so that the recommended answers can be relevant to what the citizens are looking for[6]. A proposed approach to handling this issue will be through introducing a task for CSOs to manually identify the question being asked or allow the CSOs to read the case and then key in the question instead. This approach might facilitate better accuracy during answer extraction later if the question was elicited correctly [7, 15].

3.2 Review of Typology for Questions that had failed

Additionally, to better understand how the low accuracy of CQAS comes about, we also studied the typology of the questions that had failed to get an accurate recommended answer. Generally, questions can be defined by the type of answers expected. Based on this school of thought, there are four key question types: factoid, list, definition, and complex question [5, 8, 11]. Going by the definition of a complex question about the information in a context and the answer required will likely be a merge of retrieved passages [12]. Many of the case records that had failed to get an accurate answer to fall into this category of complex questions.

4 CONCLUSION

In this paper, using real-world data sets, we presented our experience building and evaluating a pilot QA system, CQAS, for a government agency's customer service centre. CQAS is a hybrid QA system that combines techniques from Natural Language Process QA, Knowledge-based QA and Information Retrieval QA. Due to the low accuracy of CQAS, we did a deep dive into both the case records and the collections of documents. We presented the following key learnings which can be considered for future research work when further enhancing CQAS QA systems:

> *Inclusion of a manual question classification mechanism so that CSOs can indicate within the system which part of the case record is a question and thus improve the question classification capability of the QA system.*
>
> *Establishing a question typology for the failed questions that did not have an accurate answer could be recommended as a reply to citizens. This will help the people developing the QA system further enhance it to cater to the different question types (e.g., ambiguity, poor syntax, etc.) that the CSOs might encounter.*

This research contributes to the body of AI applied research in digital government and, more specifically, to QA systems to support CSOs responding to citizen inquiries. Future work will address the learning points discussed and implement them in the future version of CQAS. A user study will also be conducted to evaluate CQAS further.

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Creating Trust in Citizen Participation through Decentralized Autonomous Citizen Participation Organizations (DACPOs)

Olivier (O.K.) Rikken MSc MBA*
PhD Candidate, Faculty of System Engineering, Policy Analysis and Management, Delft University of Technology
o.k.rikken@tudelft.nl

Prof Dr Marijn (M.F.W.H.A.) Janssen
Professor IT and Governance, Faculty of System Engineering, Policy Analysis and Management, Delft University of Technology, Delft University of Technology
M.F.W.H.A.Janssen@tudelft.nl

Dr Zenlin (Z.) Kwee
Assistant Professor of Strategy, Faculty of System Engineering, Policy Analysis and Management, Delft University of Technology, Delft University of Technology
Z.Roosenboom-Kwee@tudelft.nl

ABSTRACT

Blockchain-based Decentralized Autonomous Organizations (DAOs) are systems for transacting and storing value by automatically executing a function without the need for trusted, centralized authorities. Participative budgeting requires voting about budget allocation by communities and is often confronted with issues in trust and transparency. Yet, DAOs are hardly used for participative budgeting. In this research, we introduce Decentralized Autonomous Citizen Participation Organizations (DACPOs). In a DACPO, data and actions are recorded and autonomously executed in a decentralized way. DACPOs can be used for enabling participative budgeting and thereby provide transparency, decrease the risks of fraud and corruption, and increase citizens' trust. The viability of DACPOs depends on a number of factors, including a minimum number of citizens who participate. In further research, factors influencing the use of DACPOs for participative budgeting can be further analyzed and tested.

KEYWORDS

Blockchain, Decentralized autonomous organization (DAO), Decentralized autonomous citizen participation organization (DACPO), Participative budgeting, Token smart contract

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1 INTRODUCTION

Since the rise of the first blockchain-based application of Bitcoin and smart contracts, numerous new possibilities for decentralized applications have emerged [1]. As shown in the figure below, over the past few years, there has been an exponential growth in Decentralized Autonomous Organization (DAO) applications and projects on various blockchains. DAOs are systems for transacting and storing value using voting or notary functions without the need for central authorities. Data and actions are recorded and autonomously executed in a decentralized way [2].

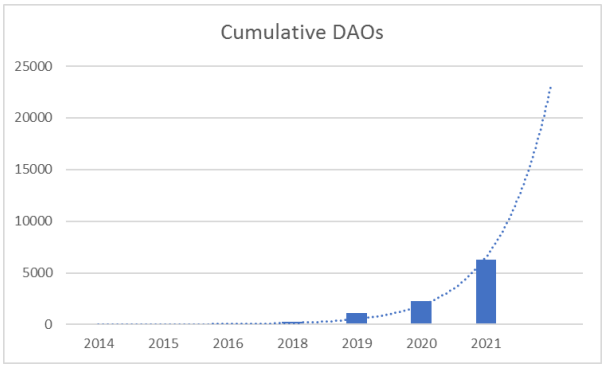


Figure 1: Cumulative amount of DAOs 2014-2021 - Rikken, Janssen, Kwee 2022

Since the end of the 1980s, participative budgeting initiatives have emerged from Latin America to Europe [3]. Challenges faced by these initiatives include challenge of empowerment of participative governance, threat of losing autonomy by institutionalization, information asymmetry and control loss, and lack of personal characteristics [3-5]. These issues can be resolved by using DAO applications to create transparency, decrease information asymmetry, and execute autonomously based on predefined logic. Through code in smart contracts, DAO applications can help to resolve issues of losing autonomy and control loss by citizens. The ideas of DAO using for participative budgeting results in a new organizational form which we label *Decentralized Autonomous Citizen Participation Organization* (DACPO).

DACPO applications can be very suitable for increasing citizen participation and enhancing trust. In DACPOs, there is joint control

over the storage and transaction of value and voting. Voting results are autonomously monitored and executed. In this way, participants have direct control over the budget without any need for government involvement or other parties. Hence, fair decision execution is warranted.

2 INCREASING CITIZEN PARTICIPATION THROUGH DACPOS

Our research aims to increase citizens' participation by designing a DACPO and its governance. A schematic overview of how such a DACPO works is displayed below. At the top, the citizens are shown, whereas the bottom shows the automatic execution of approved budget allocation.

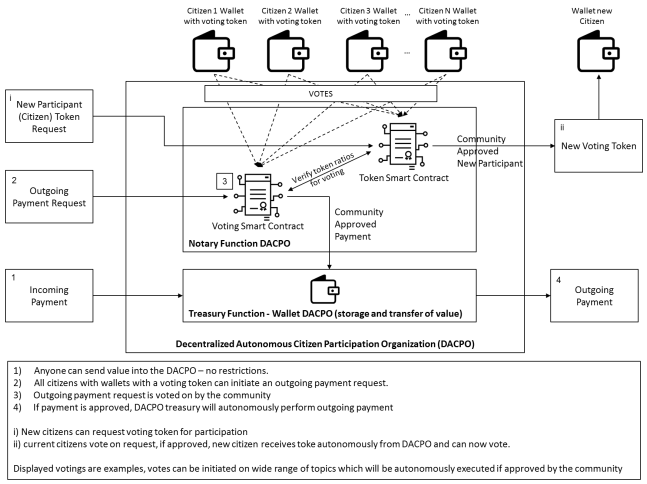


Figure 2: Schematic overview of possible processes DACPO

3 RESULTS, CHALLENGES AND BENEFITS OF DACPOS

Our research shows a correlation between the number of participants and long-term viability of DAOs. Using a survival analysis through ROC curve, we found that DAOs with more than 20 participants seem to have a longer activity level than DAOs with less than 20 participants [2]. Furthermore, our research demonstrates that DAOs without a direct or indirect incentive for participation (e.g., increased value of a token), are more likely to show long-term viability than DAOs with incentives. We expect something similar for DACPOs, that a minimum number of participants is needed to increase the likelihood of long-term viability, and that the participants need to be motivated intrinsically.

The long-term viability of participation seems to be dependent on a combination of the functional characteristics of managing community funds and community voting. Such a combination further enables the democratization of the budgetary participation process, including the execution of the outcome of the voting. Hence, DACPOs fundamentally facilitate participatory communities as they seem to solve some of the challenges, such as trust and transparency, as identified in participatory budgeting research [3-5]. The benefits of DACPOs, derived from benefits in other DAO areas, related to the challenges in participatory communities are displayed below.

Additionally, our current research empirically investigates the relations between the number of participations and long-term viability. One step further is to test this empirically by investigating various forms of governance mechanisms and the DAO goal in relation to the governance mechanisms.

4 CONCLUSION AND FURTHER RESEARCH

DACPOs can create trust in participatory budgeting initiatives to ensure long-term viability. DACPO applications appear to be very suitable for increasing citizen participation. Challenges like control, personal characteristics through true direct participation, and information asymmetry in decision-making can be addressed

Table 1: Potential Benefits DACPOs related to participatory community challenges

Participatory Community Challenge	DACPO Characteristic Solving Challenge	Resulting Benefit of DACPO
Information asymmetry	Transparency and smart contracts	As DACPOs are built on decentralized infrastructure, all information regarding voting is transparent for all participants as specified in the "business rules" for voting and tokens in the smart contract.
Lack of empowerment	Direct voting	Due to direct voting capability of all participants in DACPOs, all participants stay empowered in all decisions, including budget spending.
Losing autonomy and control	Direct voting and autonomous execution through smart contracts	Due to direct voting through blockchain-based smart contracts, the outcome of votings is executed autonomously and not prone to centralized bureaucracy for execution. Also, the immutable characteristic of functions (rules) in smart contracts helps to improve the feeling of control (i.e., no one can single handily alter the rules).
Lack of personal characteristics	Direct voting and transparency	All participants have direct control and equal information, thereby creating a better sense of ownership and thus adding to a more personal characteristic.

by using DACPOs. Although DACPOs can enhance trust, further research is needed on how they can be realized in practice. In further research, factors influencing the use of DACPOs for participative budgeting can be investigated.

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The survey of the factors influencing the use of open government data in Taiwan: The preliminary findings

Tung-Mou Yang
Dept. of Library and Information Science, National Taiwan University, Taiwan
tmyang@ntu.edu.tw

Yi-Jung Wu
Dept. of Public Policy and Management, Shih Hsin University, Taiwan
yijungwu@mail.shu.edu.tw

ABSTRACT

Recent research in open government data has indicated that data providers and data users both play important roles to form a sound open data ecosystem. Nevertheless, researchers find that the use of open government data has not kept with the expectation. Accordingly, this study adopts the constructs of UTAUT and IS Success model to investigate how open data users perceive the impacts of the influential factors, and whether open data users intend to continue their use of open government data. A survey approach through online questionnaire is employed to collect quantitative empirical data from open data users in Taiwan. The preliminary descriptive data analysis is briefly presented and discussed in this paper.

KEYWORDS

Open Data, Open Government Data, Open Data User, Open Data Use

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1 INTRODUCTION

Researchers have suggested that a sound open government data ecosystem needs to have dedicated data providers, and data users are also necessary to engage in using the published datasets [1, 2]. Nevertheless, recent research finds that the use of open government data has not achieved the expectation while government agencies have continually opened their datasets through open data sites [3, 4]. It is indicated that the applications of open government data is still limited, and there is a need to continue promoting the use of open government data. Therefore, this research investigates the factors that can have influences on user's adoption of using governmental open data. The constructs of UTAUT and IS Success model [5, 6] are adopted for the investigation, and the preliminary survey results are presented and discussed.

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2 THE FACTORS INVESTIGATED IN THE SURVEY

As Zuiderwijk, Janssen, and Dwivedi [7] indicate, while open government data can be conceptualized as an innovative e-government service provided through open data sites and related technological infrastructure, four constructs of Venkatesh, Morris, Davis, and Davis' [5] UTAUT model are employed as the influential factors in this study, including performance expectancy, effort expectancy, social influence, and facilitating condition. Performance expectancy represents the perception that using a system will help achieve gains in performance. Effort expectancy refers to the perception of whether a system is easy to use. Social influence means that important others suggest to use a system, and facilitating condition indicates the availability of related infrastructure or resources to support system use. In addition, while open data sites represent the web information systems that open data users utilize to retrieve the published datasets, the three quality constructs of DeLone and McLean's [6] IS Success model are also adopted as the influential factors in the study. Specifically, information quality is to measure semantic success, system quality is to evaluate technical success, and service quality is to measure the related services provided by system professionals. Furthermore, open data users' perceived value of open government data, and their satisfaction and intention to continually use open data are also explored.

3 RESEARCH DESIGN AND METHOD

Because of its long-term commitment to implement open data policies and to promote open data use, the context of Taiwan open government data represents an ideal case for conducting this investigation. A quantitative approach by distributing online questionnaires to open data users was employed. The questionnaire items of the factors were developed according to the existing related literature, and five-point Likert Scale (from strongly disagree/1 to strongly agree/5) was utilized for collecting the respondents' survey answers. While one of the major challenge of this research was to approach open data users, the online survey was conducted from mid-April to early July in 2021 with the help from government officials and social groups, and there were 144 responses received, which were then applied to the preliminary descriptive analysis presented in this paper.

4 THE PRELIMINARY SURVEY DATA ANALYSIS

Among the 144 respondents, 41% have more than four years of open data use experience, 29% have 2 to 4 years of data usage experience, and 30% have less than 2 years of experience in using governmental

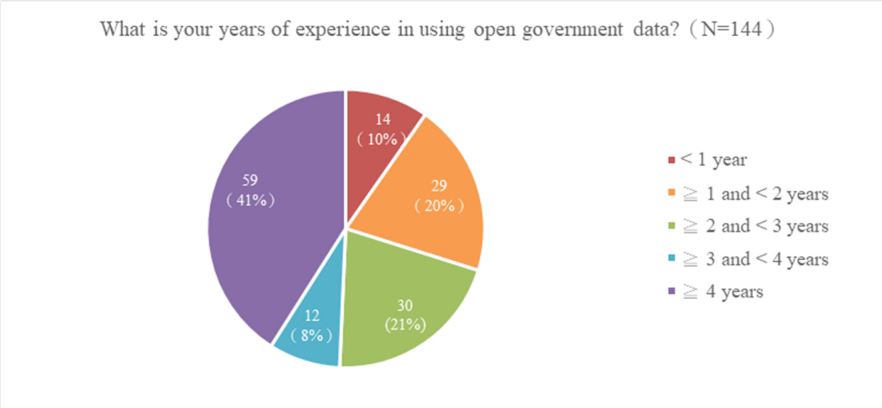


Figure 1: Respondents' years of experience in using open government data.

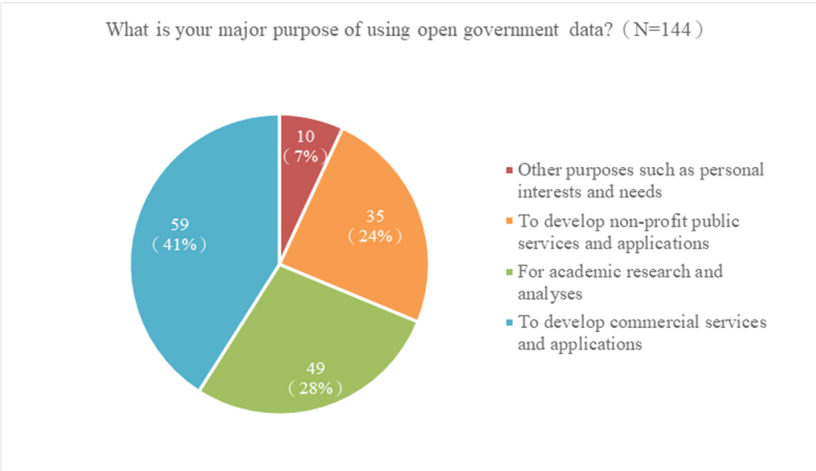


Figure 2: Respondents' major purposes of using open government data.

open data (see Figure 1). Regarding their major purposes of using governmental open data, 41% use open data to develop commercial services and applications, 28% use open data for academic research and analyses, 24% use open data to develop non-profit public services and applications, and 7% use open data for other purposes such as personal internets and personal needs (see Figure 2).

Regarding the respondents' perceived value of open government data, the survey results suggest that most respondents agree that the implementation of open government data can help spur innovative applications (Mean=4.118, SD=0.743), create benefits to the general public (Mean=4.326, SD=0.667), enhance government transparency (Mean=4.118, SD=0.957), and promote potential public-private collaboration (Mean=4.139, SD=0.905). Overall, most of the respondents tend to recognize the perceived value of open government data (see Figure 3).

Nevertheless, when evaluating the perceived usefulness of their open data usage, the respondents' average responses are between neutral and agree. The respondents tend to agree that using open government data can benefit their work (Mean=4.021, SD=0.780); however, in terms of whether open government data can enhance the productivity and increase the efficiency of their works, the average responses tend to be lower and are between neutral and agree respectively (Mean=3.729, SD=0.868; Mean=3.618, SD=0.961). The results show that although the respondents are positive toward the values that open government data can achieve, their perceived usefulness of applying open government data to their own work seems to be more reserved (see Figure 4).

Regarding their perceived effort of using open data, the respondents indicate that they need to spend extra time and resources on using the datasets (Mean=4.063, SD=0.830). They also agree that the processes of using open data, including data access, data cleaning, and data integration, are complex and time consuming (Mean=4.076, SD=0.837), and they need to spend considerable effort on using governmental open data (Mean=4.083, SD=0.815) (see Figure 5).

Most of the respondents also tend to agree that external influences exist in their surrounding environment to urge the public to use open government data. The external influences may come from several aspects. First, government agencies have been encouraging the public to engage in using open government data (Mean=3.896,

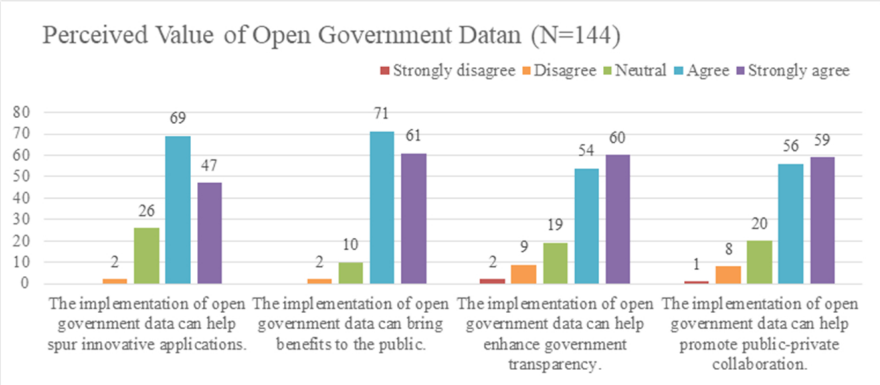


Figure 3: Respondents' perceived value of open government data.

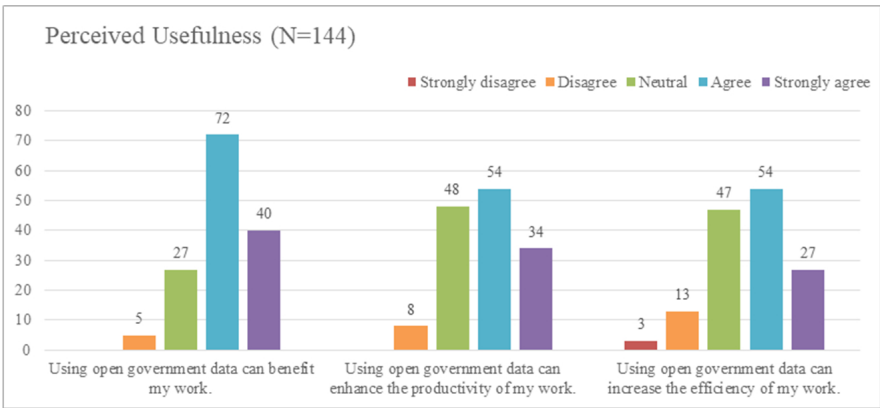


Figure 4: Respondents' perceived usefulness of using open government data.

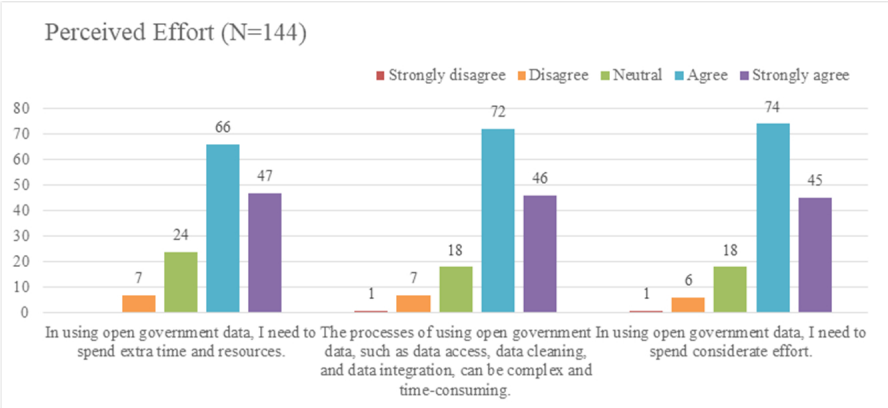


Figure 5: Respondents' perceived effort of using open government data.

SD=0.800), and media and public opinion also suggest the public to participate in using the published datasets (Mean=3.681, SD=0.921). Particularly, the respondents seem to agree more that related social groups have been advocating the public to use open government data (Mean=4.069, SD=0.874) (see Figure 6).

Regarding facilitating condition to use open government data, most of the respondents' responses tend to be between neutral and agree. In terms of whether they can obtain assistance, receive sharing of information and experience, and get related resources

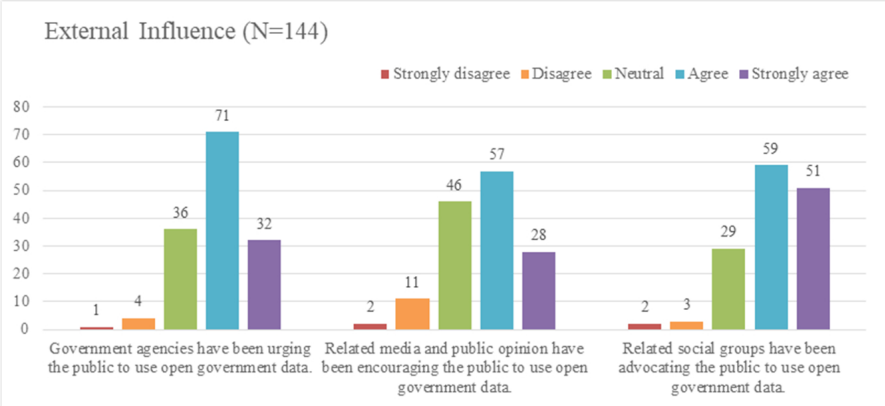


Figure 6: Respondents' external influence on using open government data.

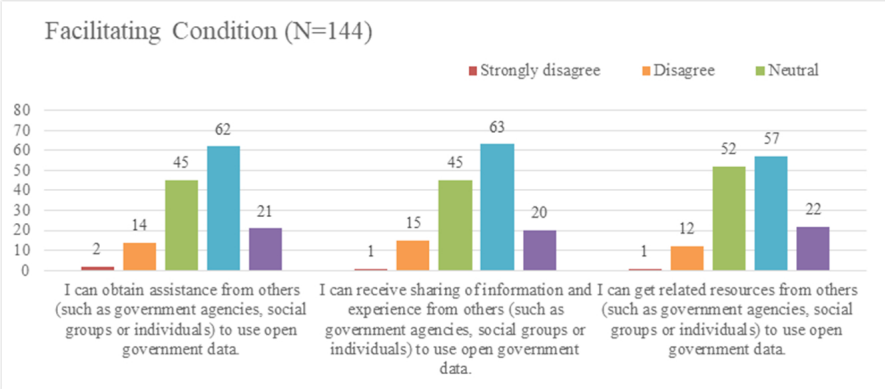


Figure 7: Respondents' facilitating condition for using open government data.

from others, such as government agencies, social groups, and individuals, the respondents' average responses are 3.597 (SD=0.903), 3.597 (SD=0.808), and 3.604 (SD=0.871) respectively (see Figure 7).

In this survey, four measures were adopted for evaluating the data quality of governmental open data according to the respondents' data usage experience. The four measures are accuracy, completeness, timeliness, and format consistency. Regarding accuracy and timeliness, the respondents' average responses are close to neutral (Mean=3.118, SD= 0.889; Mean=3.042, SD=0.974). However, regarding completeness and consistent format, the respondents' responses seem to be lower, which are between disagree and neutral respectively (Mean=2.792, SD=0.938; Mean=2.701, SD=1.091). These results also correspond to the respondents' reserved perceived usefulness and high perceived effort of using open government data (see Figure 8).

Similarly, three measures were adopted for evaluating the respondents' perceived quality of the open data platforms or systems that they use for accessing open government data. The three measures are responsiveness, transmission stability, and operation. According to the data analysis, the respondents' average responses are also close to neutral. First, regarding whether the open data platforms (or systems) can respond quickly, the average score is 3.201 (SD=0.816). Second, the average score of the respondents' response toward transmission stability is 3.243 (SD=0.879). Lastly, with regard to operation, the average score is 3.181 (SD=1.001) (see Figure 9).

Then, the service quality of using open government data and the related infrastructure was evaluated by using three measures, including the existence of appropriate communication channels, the responsiveness of questions regarding open data use, and the assurance of problem solving. The respondents' average responses are also close to neutral or slightly below neutral, and the respective mean scores are 3.153 (SD=0.903), 2.944 (=0.859), and 2.896 (SD=0.883) (see Figure 10).

The respondents' satisfaction with using governmental open data was also explored. Three measure were adopted to evaluate the respondents' satisfaction through measuring their experiences and expectations, and whether the use of open government data can meet their needs and requirements. The average scores of the three measures are 3.361 (SD=0.850), 3.250 (SD=0.832), and 3.271 (SD=0.895), which are also close to neutral (see Figure 11).

Lastly, the study investigated the respondents' intention to continue using governmental open data. The mean values of the three measures are 4.153 (SD=0.713), 4.153(0.751), and 4.000 (SD=0.784) respectively. The results show that most of the respondents tend to

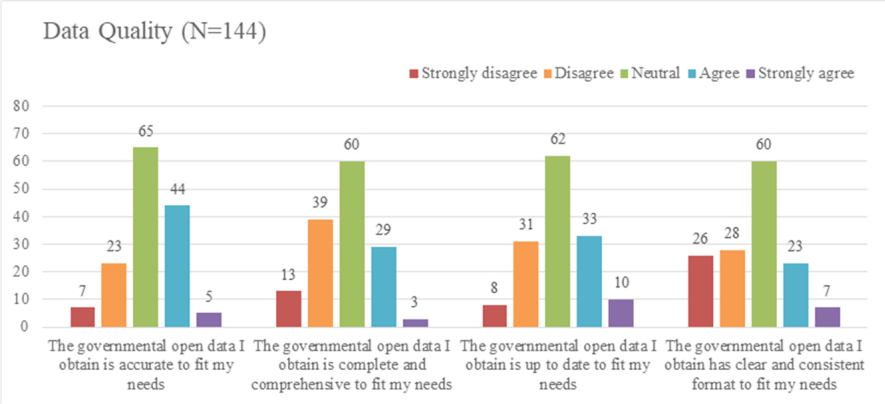


Figure 8: The respondents' perceived data quality of governmental open data.

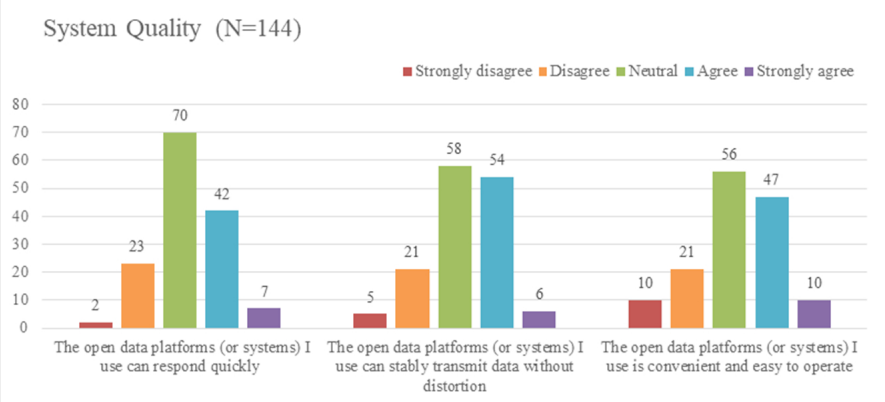


Figure 9: The respondents' perceived system quality of governmental open data.

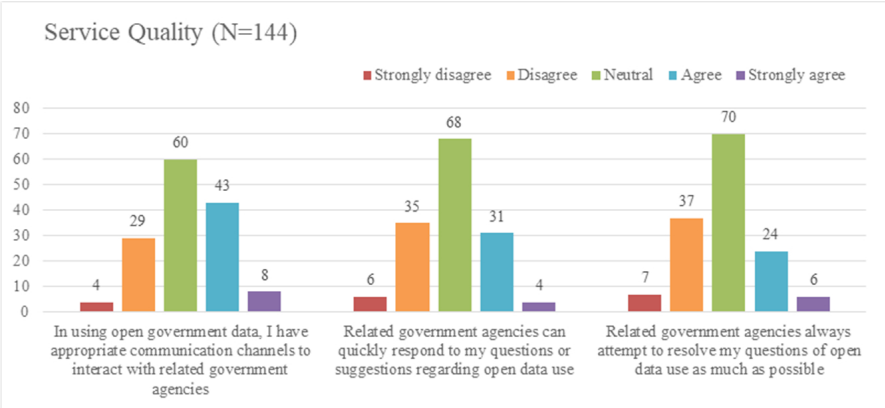


Figure 10: The respondents' perceived service quality of using governmental open data.

agree that they will continue using the published datasets. Compared with the average scores of the respondents' satisfaction, these results indicate the respondents are looking forward to using governmental open data further; however, there is still room for improving the current services in terms of the perceived usefulness and perceived effort of using the datasets, which can be influenced by the aforementioned quality aspects (see Figure 12).

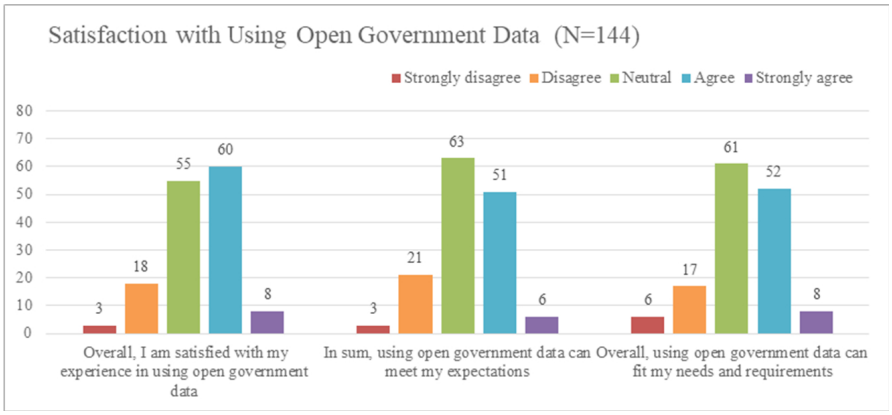


Figure 11: The respondents' satisfaction of using governmental open data.

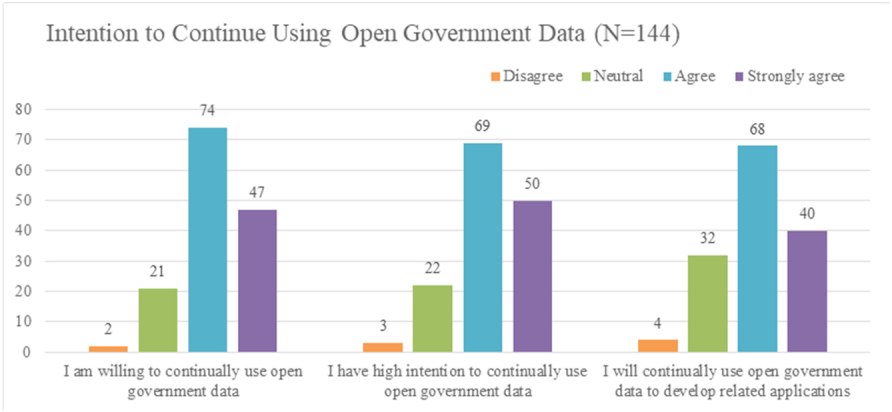


Figure 12: The respondents' intention to continue using governmental open data.

5 DISCUSSION OF THE PRELIMINARY FINDINGS

Regarding the survey results, as indicated in Figure 13, the average scores show that the respondents tend to recognize the perceived values of open government data in terms of the potential of open data to create innovative applications, bring benefits to the public, enhance government transparency and promote public-private collaboration. However, the respondents' average responses of perceived usefulness of using open government data in their own work tend to fall between "Neutral" and "Agree", which indicates that there is still room for improvement while there is a gap between the respondents' perceived value and perceived usefulness of governmental open data. Regarding the required efforts of using open government data, the respondents' average response is "Agree", which also suggests the existence of barriers that can be further reduced for encouraging open data use. Specifically, most of the respondents agree that the process of data access, data cleaning, and data integration can be complex and time-consuming. How to reduce the respondents' perceived effort can be a direction worth exploring further. Regarding the external influence to promote open data use, the respondents also tend to agree that government agencies and media and public have been promoting open data use. Especially, the respondents seem to agree more that open data related social groups are advocating the use of governmental open data. Nevertheless, regarding the facilitating condition from their surrounding environment, the respondents have their average responses fall between "neutral" and "agree", which shows that there is still room for helping open data users to obtain more supports such as resources and experience sharing from government agencies, social groups, and other related organizations and individuals.

In this survey, three constructs, including data quality, system quality, and service quality, were adopted for evaluating the overall quality of open data systems that the respondents use to retrieve the published datasets. As indicated in Figure 14, the respondents' average responses are close to "neutral" or slightly lower than "neutral", which suggests that there is room for enhancing the current open data systems provided to the general public in terms of the three quality aspects. In addition, the analysis results show that the respondents' satisfaction with open data use is just slightly higher than "neutral", which also suggests that there is still a gap between what government agencies have offered and what the respondents have expected in open data initiatives. Nevertheless, most of the respondents point out that they intend to continually use governmental open data. According to the empirical evidence, about 75%

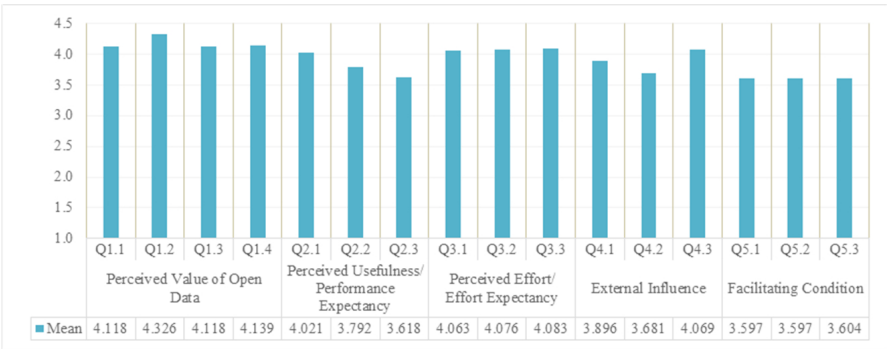


Figure 13: The mean scores of the online survey results.

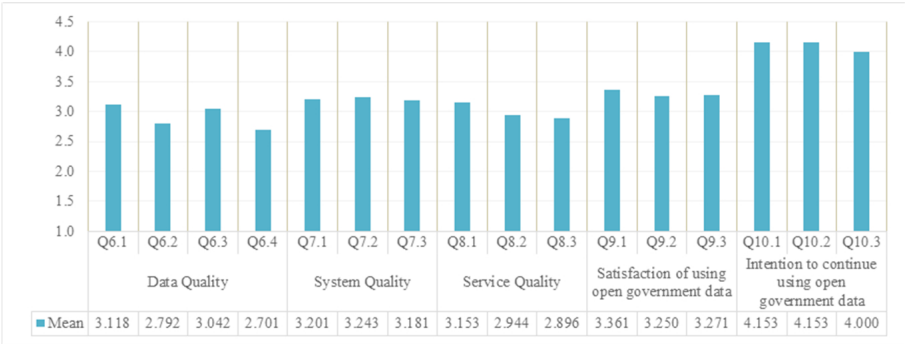


Figure 14: The mean scores of the online survey results.

to 80% of the respondents still maintain a positive attitude toward their intention to use governmental open data. About 15% to 22% of respondents feel neutral, and just about 1.4% to 2.8% of the respondents clearly indicate that they disagree to use governmental open data further.

By employing the constructs of UTAUT and IS Success model, this study uses a quantitative approach through online survey to investigate users' experiences in using governmental open data in Taiwan. It is expected that the preliminary findings can provide some insights to government agencies and policy makers regarding how open data policies can be further developed to encourage open data use. This study conducted in the context of Taiwan open government data can also provide experience sharing to other countries and enrich the current open data related literature. Future work will be the using of other statistical analyses such as multiple regression and structural equation modeling to explore the relationships among the discussed constructs of the study.

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The characteristics of government officials' information seeking in open data policy implementation: The perspective of Ellis' model

Tung-Mou Yang
Dept. of Library and Information Science, National Taiwan University, Taiwan
tmyang@ntu.edu.tw

Chung-Cheh Ma
Dept. of Library and Information Science, National Taiwan University, Taiwan
r02126006@ntu.edu.tw

ABSTRACT

During the process of open data policy implementation, government officials have to conduct a variety of information seeking activities to obtain the needed information for deciding what datasets to open and what datasets can be opened with higher priority. Grounded in the existing information behavior literature, this study explores the characteristics of government officials' information seeking by employing Ellis' model. The preliminary findings, including starting, chaining, browsing, differentiating, monitoring, extracting, verifying, and ending, are briefly presented in this paper.

KEYWORDS

Open Data, Information Seeking, Information Behavior, Ellis' Model

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1 INTRODUCTION

Open government data has been an important policy implementation around the global government administrations [1]. During the process of opening datasets, government officials may encounter the uncertainty of what datasets to open and what datasets to open with higher priority. Accordingly, government officials need to engage in the process of information seeking for implementing open data policy. While there is still limited research exploring the process, based on an information science perspective, this study adopts Ellis' [2] model to explore the characteristics of government officials' information seeking in their open data policy implementation, and the preliminary findings of the study are discussed.

2 ELLIS' INFORMATION BEHAVIOR MODEL

According to Case and Given's [3] survey of the information seeking literature, Ellis' [2] model (see Figure 1) is among the most commonly cited information behavior models. Particularly, Ellis' model focuses on discussing the generic characteristics of an individual's information seeking activities [2, 4]. In the model, there are eight generic characteristics of information seeking, including starting, chaining, browsing, monitoring, differentiating, extracting, verifying, and ending. It is indicated that the eight characteristics are not in a specific sequence depending on the circumstance where information seeking activities take place.

As Ellis [2] indicates, starting is to identify the potential information sources of interest while an individual is aware of an information need. Whether an information source is selected depends on its perceived accessibility and information quality, and whether a seeker is familiar with the source also matters. Browsing is the searching activity in areas of potential interest by scanning tables of content, title lists, subject headings, and abstracts and summaries of information resource. Chaining means the process of following up the connections or references of initial information sources to other related sources. Monitoring is to keep tracking of the development in an area of interest by following and checking related information sources regularly. Differentiating is to select, assess, and filter the information sources by examining the differences in their respective natures and qualities of information offered. Extracting is the activity of systematic examination of information source to obtain the material of interest. Verifying is to check the accuracy of the obtained information from various sources. Lastly, ending is to perform a final search at the end of the task of information seeking.

3 RESEARCH DESIGN AND METHOD

While the government agencies of Taiwan have dedicated efforts to implement open data policy in recent years, the context of Taiwan open government data represents one of the ideal sites for conducting this explorative study. A purposive sampling approach was adopted to recruit government officials for conducting semi-structured interviews. There were fifteen interviewees participating this study. The interviewees all had extensive experience in implementing open data policy so that they provided rich information for the study. Later, the data analysis techniques, including opening coding, axial coding, and selective coding, were adopted in the study for analyzing the obtained qualitative data.

4 THE PRELIMINARY FINDINGS

Ellis' (1989) generic characteristics of information seeking were identified and discussed respectively in the following subsections.

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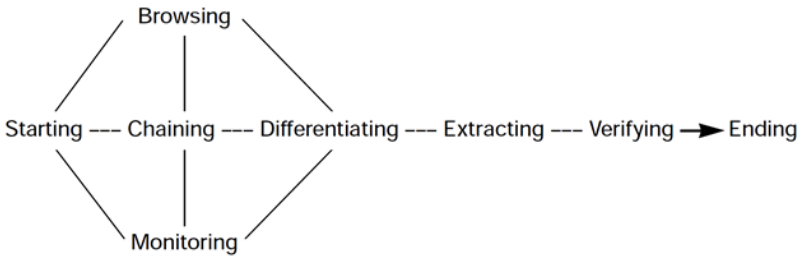


Figure 1: Ellis' eight generic characteristics of information seeking behaviors. Adapted from Wilson, T. D. (1999). Models in information behavior research. Journal of Documentation, 55(3), 249-270.

4.1 Starting

"Starting" is the phase that people begin to look for information. The analysis of the interviews showed that driven by their information needs, government officials first attempt to form the initial information search by identifying potential information sources of interest. Various types of information sources, including personal, internal or external, formal or informal, and oral or written, are considered, evaluated, and selected by using the criteria such as familiarity, trustworthiness, cost, timeliness, accessibility, packaging, and quality.

4.2 Browsing

"Browsing" is a frequently identified information seeking characteristics in the study, particularly during government officials' interactions with information sources such as documents, social networking sites, and open data portals. When interacting with these information sources, government officials usually need to quickly scan through information such as the abstracts of articles, the titles of discussions, or the subject headings and the metadata of datasets to perceive whether the information is of interest and is worth exploring further. A director of a central government agency stated:

"...For instance, if my information sources are documents, I first browse through the directories of the documents to locate needed information. Or, if I browse the open data sites of other government agencies. I usually scan the titles of the datasets listed on the sites. If something catches my attention, I will check further for the details..."

4.3 Chaining

While government officials use information sources, the activity of "chaining" follows up if they obtain information referring to other information sources. The interviewees suggested that after the discussions with colleagues of other business units, they sometimes get referral to contact other individuals or receive recommendations to review some documents for obtaining further information. Similarly, during their browsing of social networking sites and open data portals, government officials very often get references or hyperlinks guiding them to connect to other web sites and online resources that also work as information sources for they to explore further. This chaining activity was found to be iterative while one information source can connect to another source that also connects to others further. A manager of a local government agency indicated:

"...It is very common that we connect from one information source to another during information seeking. For instance, I usually first contact and discuss with the information professional of a department for obtaining information, and the information professional may refer me to contact other colleagues of their business unit..."

4.4 Monitoring

While government web sites, open data portals, and social networking sites of open data community have been recruited as important information sources, it was found that government officials periodically keep track of those web resources to see whether there is any new update that meets their information needs. Just as a chief of a central government agency explained:

"...We continue following some information sources and regularly check back for new information. It is just like using Facebook. If you see someone who usually posts good articles on Facebook, you may continue following that person's activities on Facebook..."

4.5 Differentiating

While government officials usually look for information from several different information sources, they assess and evaluate information sources through the respective natures and qualities of information. Various criteria such as familiarity, accessibility, cost, and quality are employed by government officials to differentiate information sources. For instance, open data symposiums and counseling committees can be the formal information sources providing higher quality and relevant information. Social media such as Facebook and Twitter of open data community can be the less formal information sources providing fast information with easier access; however, the quality and relevance of those information sources to fit information needs may vary significantly.

4.6 Extracting

Extracting is a systematic process to work on information sources for obtaining information of interest in depth, and considerable time may be needed during the activity. Particularly, browsing and

extracting are two closely interrelated characteristics of information seeking. The interviewees indicated that when they locate something that they are interested in knowing further, they need to carefully extract the information that fits their information needs and have the irrelevant information removed. For instance, during browsing, if government officials are interested in knowing the information of certain datasets published on the data portals of other agencies, they need to carefully review the metadata information of the datasets to extract more detailed information such as providers, dataset descriptions, data fields, data types, and data formats. A director of a central government agency indicated:

"...We need to extract the information that we locate on information sources...The located information may contain information of many data fields and data contents. However, we need to extract the information that is related to our needs for dataset publication and the unrelated information is removed..."

4.7 Verifying

According to the interviewees, the qualities of the obtained information from different information sources vary, and "verifying" becomes the necessary process to check the accuracy and appropriateness of information. The analysis results showed that information obtained from sources such as social networking sites usually needs to be verified with other more formal information sources such as an agency's own business units to confirm the acquired information is accurate and appropriate. For instance, government officials may verify whether the suggested datasets are available, whether they have the requested data fields, whether they can update the datasets monthly or weekly, and whether the datasets can be opened publicly. A manager of a central government agency said:

"...For the obtained information, we need to verify its accuracy further. We need to verify its metadata information. We need to set up meetings with related business units to make sure whether our agency has the datasets the information refers to, what dataset details we may have, and at what frequency the datasets are updated..."

4.8 Participating and discussing

While the aforementioned characteristics of information seeking are in line with Ellis' [2] model, two additional characteristics were also identified in this study, which are participating and discussing. While open data has become a popular movement, government agencies and non-profit organizations often hold related symposiums, workshops, and forums. "Participating" in those events then becomes a frequent characteristic of information seeking, and government officials expect to obtain systematic information from the talks delivered by open data experts and stakeholders. A section chief of a central government agency stated:

"...There are open data conferences and workshops held either by government agencies or open data community, which represent information sources to meet with related stakeholders so that it is important for us to participate in those events to acquire information..."

In addition, "discussing" can be conceptualized as a characteristic of information seeking to interact with information sources to obtain in-depth information. In this study, the frequently adopted information sources by government officials also include business units, counseling committees, and officials of other government agencies. Then, "discussing" is the characteristic of information seeking that government officials interact with those information sources. Similarly, in addition to browsing the information posted on social networking sites, government officials sometimes need to engage in discussion threads on the sites for obtaining further information they need. A manager of a local government agency explained:

"...It is impossible for us to know all the core businesses of our agency in detail. Through the discussions with the colleagues of other business units, we can have in-depth understandings of their core business...and know what datasets they may possess. I personally think this is a good approach..."

4.9 Ending

Lastly, open government data is still an ongoing policy implementation in Taiwan, and "ending" was not clearly identified as a characteristic of information seeking in this study. It was found that there is no final search of government officials' information seeking at this point. The analysis results showed that government officials intend to continue their information seeking activities and periodically use the aforementioned information sources to obtain information for satisfying their information needs of open data policy implementation.

5 DISCUSSION

In this study, the generic characteristics of information seeking of Ellis' [2] model were identified. It can be argued that browsing, chaining, and monitoring represent the search processes to explore information sources, differentiating acts as the process to compare and rank information sources, extracting is the process to parse and analyze information sources for acquiring needed information, and verifying is the process to check the accuracy and appropriateness of the obtained information. Nevertheless, while Ellis et al.'s [2, 4] work was mainly developed based on the perspective of researchers' literature search, participating and discussing are the other two characteristics of information seeking identified in this study while government officials also use information sources such as open data symposiums and workshops, and they also interact with other government officials in addition to relying on traditional static information sources such as literature, documents, and web sites. Furthermore, ending is not a clearly identified characteristic in this study while government officials' information seeking activities can be an iterative process to meet new information needs in open data policy implementation. In sum, it is expected that the preliminary findings of this study can enrich the current open government data related literature from the perspective of information seeking behavior.

ACKNOWLEDGMENTS

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Let's Gamify Open Government Data Portals! The GamOGD prototype

Anthony Simonofski
Namur Digital Institute, University of Namur, Namur, Belgium
anthony.simonofski@unamur.be

Antoine Clarinval
Namur Digital Institute, University of Namur, Namur, Belgium
antoine.clarinval@unamur.be

Anneke Zuiderwijk
Faculty of Technology, Policy and Management, Delft University of Technology, Delft, The Netherlands
A.M.G.Zuiderwijk-vanEijk@tudelft.nl

Wafa Hammedi
Namur Digital Institute, University of Namur, Namur, Belgium
wafa.hammedi@unamur.be

ABSTRACT

Government policies focused on Open Government Data (OGD) often aim to stimulate the provision of public, interoperable data towards any user, including lay citizens, through online portals. However, these OGD portals are primarily developed for expert users. This hinders the realization of transparency, empowerment, and equality of access. This system demonstration paper presents GamOGD, an OGD portal prototype tailored to lay citizens that implements fifteen gamification design propositions.

CCS CONCEPTS

• **Requirement Analysis**; • **e-Government**; • **User Studies**; • **Additional Keywords and Phrases: Open Government Data, Gamification, Citizens, Portals**;

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1 CONTEXT: OPEN GOVERNMENT DATA AND GAMIFICATION

Open Government Data (OGD) policies often aim to stimulate the provision of public, interoperable data towards all potential users: lay citizens, developers, researchers, public agents, and other stakeholders. Governments publish this data through OGD portals. A distinction can be made between expert re-users, i.e., having technical expertise and domain knowledge, and lay citizens re-users, i.e., not having this expertise or knowledge. OGD portals are mostly developed for expert users [1]. Indeed, Janssen et al. [2][2] consider that the entry barriers of portals are too high for lay citizens.

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In this paper, we suggest investigating gamification mechanisms as a promising way forward to make OGD portals more usable for lay citizens. Gamification refers to "*a design approach of enhancing services and systems with affordances for experiences similar to those created by games*" (Koivisto & Hamari, 2019, p. 193). By using engaging elements found in games, gamification can increase users' motivation to perform some tasks by making them more fun and improving the user experience [4]. Due to the lack of engagement of lay citizens with OGD, our objective is to apply gamification to the tasks entailed by OGD use (in particular, the interaction with the OGD portal) to make the process more enjoyable and thus improve their user experience.

2 SYSTEM DEMONSTRATION: THE GAMOGD PROTOTYPE

The GamOGD prototype implements eight gamification mechanisms from (Koivisto & Hamari, 2019): Quiz (G1), Badges (G2), Voting (G3), Notifications (G4), Competition (G5), Collaboration (G6), Rewards (G7), and Storytelling (G8). The portal is composed of a welcome page, an exploration page referring to several dataset pages and to the search engine, a quiz page, a scoreboard, a notification tab, and a profile page, all accessible from the navigation bar (Figure 1).

3 RELEVANCE FOR RESEARCHERS AND PRACTITIONERS AT DG.O

The GamOGD portal is directly relevant for practitioners (i.e., portal developers, public servants, political representatives). Through the design propositions integrated into GamOGD, we show that gamification can effectively highlighting the relevance of the portal and introduce proactive feedback mechanisms. Practitioners can use these findings, our gamification design propositions, and our open-source solution, as a basis to improve their own portal to make it more attractive to lay citizens. Researchers can use this system to examine in-depth the relationship between gamification and OGD portals and test alternative implementations of gamified OGD portals. The demonstration will consist in the presentation of:



Figure 1: Navigation bar of GamOGD

A traditional OGD portal (the OGD portal of Namur[1]) to illustrate the problems related to the use of traditional OGD portals for lay citizens.

The GamOGD prototype, to highlight how the gamification mechanisms can help tailoring portals to lay citizens. Specifically, we will show how the eight gamification mechanisms can help tackle key requirements for lay citizens regarding OGD portals.

The evaluation results of GamOGD in terms of ease of use and usefulness. Indeed, we evaluated in-depth the GamOGD prototype with ten lay citizens and identified that, amongst other findings, badges were useful to highlight portal relevance. The full evaluation results can be accessed in [5]

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A High-Level Framework for Green Customs and Research Agenda

Boriana Rukanova*
Faculty of Technology, Policy and Management, Delft University of Technology, The Netherlands
B.D.Rukanova@tudelft.nl

Toni Männistö
Cross-Border Research Association, Switzerland
toni@cross-border.org

Juha Hintsa
Cross-Border Research Association, Switzerland

Yao-Hua Tan
Faculty of Technology, Policy and Management, Delft University of Technology, The Netherlands

Micha Slegt
Customs Administration of The Netherlands, The Netherlands

Frank Heijmann
Customs Administration of The Netherlands, The Netherlands

ABSTRACT

In this paper we propose a high-level framework for Green Customs which links the policy developments related to circular economy (CE), to customs and related stakeholder groups, customs activities, and customs innovative capabilities. The framework allows customs to better understand these links and identify capability gaps for circular economy monitoring and steer the developments in order to be better prepared for the future.

CCS CONCEPTS

• **Information systems**; • **Social and professional topics** → Computing / technology policy; Government technology policy;

KEYWORDS

Green customs, Circular economy, Sustainability, Supply chains, Monitoring

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1 INTRODUCTION

Circular economy (CE) and sustainability are high on the political agenda of governments nationally and internationally. The implementation of circular economy and sustainability measures will require that proper monitoring takes place to ensure that these measures are properly applied [4]. International trade will be affected by measures to achieve sustainability and CE goals. And when borders are crossed, customs will continue to play an important role. As indicated in the report of the Wise persons group[1], Green customs will be a topic that will deserve attention in the future. While the roles and responsibilities of customs as a result of the policy developments will still take time to take shape, customs can already anticipate on these changes and take an active role to prepare for the future.

CE and sustainability measures are likely to affect many product that cross borders. Customs administrations are already facing large volumes, including the enormous eCommerce flows. Adding more responsibility related to CE monitoring may pose further challenges to customs by adding to the complexity and increasing further the volumes of goods to be controlled. And often customs is not acting alone but in collaboration with other government agencies and this requires further coordination. There is also the time dimension that the controls need to be done fast in order not to block the trade flows. It is important to strive for the proper balance, and ensure that costs and burden for customs and trade do not outweigh the benefits brought by the CE monitoring.

Customs can anticipate on these changes and take a proactive role. It can advance its customs innovations, which are currently developed for fiscal and safety and security matters, to include also CE aspects into account. Customs can also actively engage with legislators to provide feedback when new legislations on CE and sustainability are drafted, to ensure that the execution of the legislations for CE monitoring is feasible in practice.

Customs has a long history of customs-trade collaboration to develop innovative solutions, aimed at enhancing customs control while at the same time reducing the administrative burden and facilitating reliable trade flows. Many of these innovations are relevant in the context of CE and sustainability monitoring as well. Examples include scanning and detection technologies, linked data and data analytics, development of business digital trade infrastructures (data pipelines) and voluntary sharing of business information with customs [1–3]. Advancing these innovations towards the operational environment for addressing current challenges of customs requires large investments in IT systems, procedures and organizational transformation. Customs can build upon these developments

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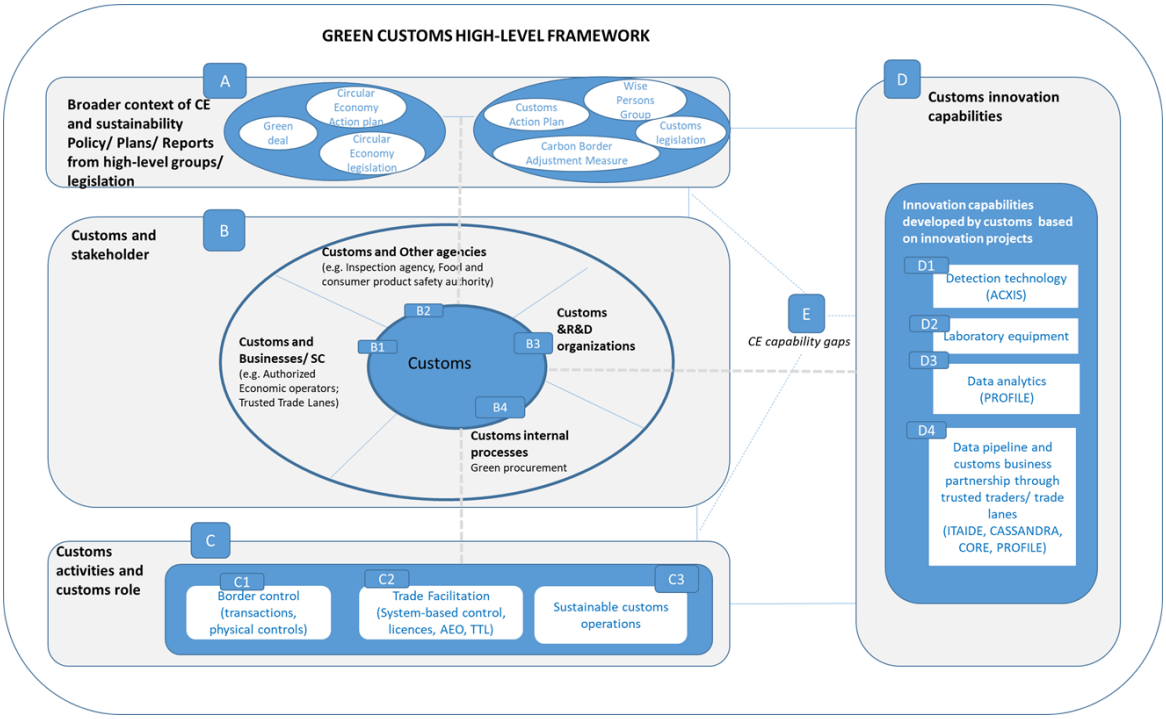


Figure 1: High-Level Framework for Green Customs

and investment and anticipate on the needs for CE monitoring and adapt the innovations to accommodate for the new CE perspective.

2 A HIGH LEVEL FRAMEWORK AND A RESEARCH AGENDA ON GREEN CUSTOMS

In this paper we propose a high-level framework for Green customs (see Figure 1). It can help customs to better anticipate on the future developments related to CE and sustainability monitoring and prepare for the future. It can serve as a basis for deriving a research agenda on the role of customs in CE and sustainability monitoring.

The framework captures:

- The **broader context** of CE/Green policies, legislation, as well as customs reports of high-level groups (Part A of the Framework). In the framework these are represented with different circles as they often cover different practices and procedures that would need to be aligned for CE monitoring.
- The **customs stakeholder** context (Part B) and relationship of customs with these stakeholders. These include: (B1) businesses/ supply chains (e.g. as Authorized Economic Operators (AEO) and Trusted Trade Lanes (TTL); (B2) other agencies (e.g. inspection agencies); (B3) the R&D organizations that collaborate and help customs to innovate, and (B4) internal customs stakeholders for CE aspects.
- **Activities** of customs (Part C) with respect to these stakeholders that can become subject to Green customs. These include (C1) greening border control activities; (C2) system-based control, which allows for trade facilitation of reliable and greener companies; and (C3) customs greening its own operations.

The explicit relationships between the broader policy/ legislative context (A) and stakeholders (B) in the framework indicates that CE policy and legislation can affect customs. These CE policies and legislations need to be aligned with customs procedures. The CE policies and legislations, however also affect other stakeholders as well. Customs can jointly work on solutions with these other stakeholders and provide feedback to the policymakers and legislators.

The right hand-side of the framework (D) is aimed at identifying innovation capabilities of customs. Many of these capabilities such as use of advanced scanning and detection technologies (D1), laboratory equipment (D2), data analytics (D3), use of digital infrastructures such as data pipelines (D4) for fiscal, safety and security purposes and eCommerce offer a lot of possibilities for CE monitoring as well. Analyzing the potential of these innovations and identifying potential CE capability gaps (E) will allow customs to define new innovation pathways, so that it can continue innovating for the immediate priorities of today, while preparing for the CE monitoring challenges of tomorrow and providing feedback to CE legislation that is being shaped.

3 CONCLUSIONS

International trade will be affected by measures to achieve sustainability and CE goals and when borders are crossed, customs will continue to play an important role. Customs has developed a lot of innovations during the last decades but these need to be extended

to allow for CE monitoring. In this paper we provide a high-level framework for Green customs. It sets the basis for a research agenda for Green customs, where topics can zoom in on specific blocks of the framework or their inter-relationships.

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The Verification of Public Health Maturity Framework for E-Government

Jakub Chabik
Faculty of Management and Economics, Gdansk University of Technology
Jakub.Chabik@pg.edu.pl

ABSTRACT

Is WHO's eHealth model, adapted and adopted by European Union, a viable model to assess country's readiness in using digital technologies in healthcare? Based on the example of the country – its policy documents and existing eHealth services – the paper examines the applicability of the model and ease of assessment. The research objective is to validate the model against existing country's public health system, verifying its applicability and uncover any gaps in the model as well as the framework.

CCS CONCEPTS

• **Social and professional topics**; • **Computing / technology policy**; • **Government technology policy**;

KEYWORDS

Digital Government, e-Government, Digitization, e-Health

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1 INTRODUCTION

Digitization of public health services is ongoing and the Covid-19 pandemic was one of the factors that speeded up this process. The eHealth initiative [1] started by World Health Organization (WHO) and extended by European Union (EU), is used as a reference for those e-government policy makers who are assessing public healthcare systems in member countries. The objectives of this study are to a) verify the assessment framework based on the applying the in a country, and b) identify the gaps that are limiting its ability to catch-up with recent development in technology and society. Hence the research questions: A. is the model applicable, and B. What are the gaps in its structure, if any. The approach to the mode validation was through the panel of experts who were assessing a country' system.

2 BACKGROUND

In Europe, health systems are generally a part of public services and therefore their digitization is driven by e-government policy makers. The definition of the WHO eHealth model and its application in EU is a part of [1]. An assessment framework that could allow any country to examine its own system against the model, has been provided by [2]. Its part is a maturity scale based on Process Maturity Framework (PMF) originally described in [3]. Currently the proposal it is limited to the European Union, but there are no implications of extending it beyond member countries. There are publications related to the verification of the country's health system against the model [6], or a group of countries, but in selected categories [5], but the literature review did not present a holistic assessment of a country against the framework mentioned in [2]. Existing publications on the topic either consider fragmentary research (e.g. perspective of a single element in the system), or a single stakeholder [7]. Such publications are also relatively old – out of 33 assessed in the Scopus search, 20 were printed before in 2017 and before. This, however, seems to be a consequence of Covid-19 pandemics and shifted attention of the researchers to this topic as well as government and health systems' response to it.

3 METHODOLOGY

The assessment was carried out by comparing the categories mentioned in the assessment framework [2] with the reality. As per 'reality', the aspects taken into account were (1) policy documents, regardless of their status in the legislation process, i.e. including policy drafts, (2) existing eHealth tools and technologies, (3) existing structures and positions in the ministries. Because the study is related to e-government, the author concluded that practices in private sector cannot be treated as proofs of existing standards in eHealth.

The model consists of three areas (Foundations & Enablers, Governance and Solutions), divided to 3 or more Categories (e.g. Healthcare Service Delivery). The categories are largely distinctive and well defined in [4] paper.

As per maturity framework measurement, the author concluded that the framework presented in [3] and followed in [2] has limited applicability to public governance. He followed the framework developed in [4] as more applicable to e-government services: Level 1 – Initial – the process is not realized; level 2 – Requested – the process is requested in the policy documents but there is no detailed definition; level 3 – Defined – the definition is available; level 4 –Institutionalized – in addition to definition, there is also clear responsibility and review process; and level 5 – Optimized – the actual execution of the process leads to analysis and conclusions are applied for improvement.

Poland was selected as an example because of being a home country of the researcher and the example on which the seniors' e-government assessment framework was developed [4]. The panel of three experts was involved to agree answers, citing sources – regulatory documents or existing practices. If the consensus wasn't

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https://doi.org/10.1145/3543434.3543589

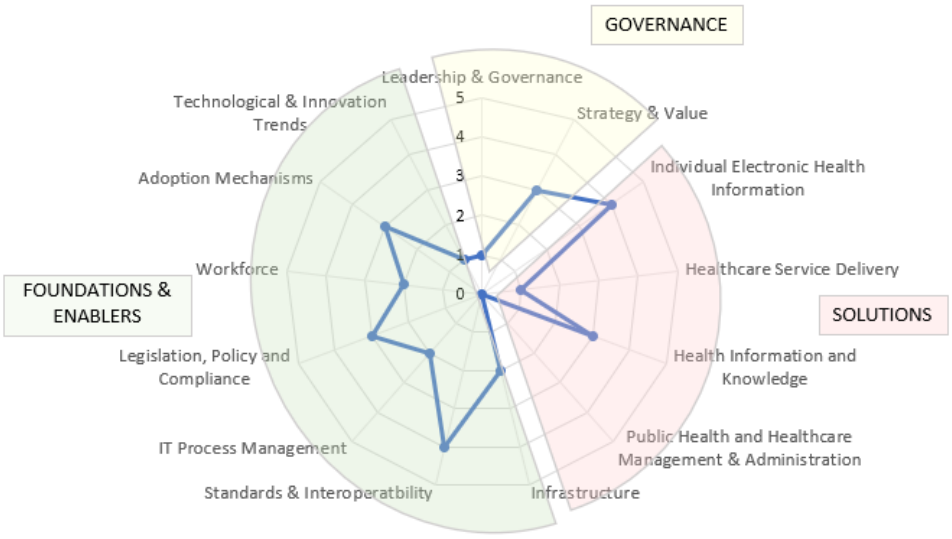


Figure 1: Assessment of eHealth Maturity for example country

reached, the category was marked as N/A. After that, a discussion was held about missing components of the WHO/EU eHealth model that experts considered relevant.

4 FINDINGS

The average assessment score was 2,42. Most frequently represented maturity was 3 (Defined). There are no areas at the level 5 (Optimized). The figure 1 presents the results of the assessment in the form of radar chart.

As one can see, the only on category (infrastructure) was marked as N/A, which means that the experts could not reach consensus. The panelists pointed out a single area they believe was a gap in the eHealth assessment model – analyzing health records, combined with e-government data, and thus enabling predictive data analytics in order to improve public health.

5 CONCLUSIONS

As only one area reached no consensus among panelists, the WHO eHealth assessment model prepared in [2] is applicable, which answers research question A. The uncovered gap spans data utilization for predictive analytics, which answers question B.

The areas of a future research can be extending the model towards this direction, further validation of the model through other countries. The most important utilitarian goal in e-government is extending the country public health systems to improved their maturity in eHealth.

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MEXIN: Multidialectal Ontology supporting NLP approach to improve government electronic communication with the Mexican Ethnic Groups

Fernando Ortiz-Rodriguez*
Universidad Autonoma de Tamaulipas
Mexico
ferortiz@uat.edu.mx

Sanju Tiwari
Universidad Autonoma de Tamaulipas
Mexico
sanju.tiwari@uat.edu.mx

Ronak Panchal
Vidyabharti Trust College of BCA
Gujarat, India
ronak.panchal@vtcbb.edu.in

Jose Melchor Medina-Quintero
Universidad Autonoma de Tamaulipas
Mexico
jmedinaq@uat.edu.mx

Ruben Barrera
Universidad Autonoma de Tamaulipas
Mexico
a2113245102@uat.edu.mx

ABSTRACT

The government services usually target all citizens, but sometimes physical services nor technology-based services do not cover all people. This research aims to tackle services given to underrepresented citizens in Mexico (Indigenous people) and apply NLP techniques supported by ontologies to achieve accurate translation to most dialects spoken in Mexico. The scope of this paper only tests with Mayan dialect spoken primarily in the Mexican peninsula.

KEYWORDS

eGovernment, Semantic Web, Ontologies, NLP

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1 INTRODUCTION

Mexico has 112.3 million Mexicans, 15.7 million are considered indigenous, and approximately 6.6 million speak a dialect, according to the 2010 Population and Housing Census, conducted by the National Institute of Geography and Statistics (INEGI). In addition to the Spanish language, there are 11 linguistic families and 68 ethnolinguistic groups, according to the National Commission for the Development of Indigenous People. The Electronic Government (eGov) is a significant application field [6, 7] for the transformation governments and public administrations will undergo in the following decades.

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2 RELATED WORK

Nowadays, the joint efforts put in by different research communities have made possible the birth of the semantic eGov. Since eGov ontologies are still in their initial state, only a few works carried out in this field are known and in Mexico are scarce.

2.1 Government and Law within the Semantic Web

Currently, the Semantic Web [1, 10] is an important area of research and applications within the legal system and eGov domains and is a promise for the web of the next generation; currently is used mainly to communicate with people but not with machines.

2.2 NLP

Natural Language Processing [5] is a branch of Artificial Intelligence that is responsible for providing computers with techniques and tools that allow them to understand words or text in a similar way to how people do.

2.2.1 BERT. BERT, Bidirectional Encoder Representation of Transformers[3]. Technique based on neural networks for the pretraining of natural language processing (NLP) applications. The BERTs interpret the entire context of a word using the rest of the words in the text, either before or after, this allows knowing the intention of the word when it was used by the user.

2.2.2 RigoBERTa. Spanish language model of the Institute of Knowledge Engineering is trained to understand Spanish in a general way. It is used to improve NLP applications in specific fields since it can be adapted to various specialized domains of the language such as the legal area, the health area, among others [3].

3 REFERENCE MODEL

A reference model [8, 9] was used to focus on and build a shared understanding of the problem stated, figure 1 shows the different actors within the eGov. In the Back-office, the leading actor is the Public Administration; it has many processes that should work properly to provide efficient services. The implementation of eGov ontologies and applications is crucial.

3.1 Ego Model

The EGO Ontology Model[7] reuses parts of the first two layers of the LRI-Core model[2] and is being adapted to the legal system of the Spanish and Mexican governments. The EGO Ontology Model is one of the first efforts not intended for a legal domain but eGov domain instead.

4 MEXIN

There are many things to manage at governments, one forgotten by Mexican governments is the electronic communication from government to ethnic groups. This work focuses on having an approach to tackle the different dialects across Mexico. All the existing dialects and the considerable amount of federal government websites in Spanish have created an increase in inaccessible information for indigenous citizens. The Multi dialectical Ontology MEXIN aims to cover a difficulty in translation management at the government. The main objective of this Multi dialectical Ontology is to make all websites, regardless of the format, accessible to Mexican ethnic groups; a secondary objective is to assemble an NLP system to help access them.

4.1 Ontology Conceptualization

We provide the conceptualization of the ontology based on the set of intermediate representations proposed in METHONTOLOGY[4]. The intermediate representations used in this document are the concept classification tree and the ad-hoc relationships between different concepts. The central concept is 'Government Documentation,' which is organized according to the nature of the document (Official Documentation or Nonofficial Documentation) within the taxonomy (shown in (*Figure* 1)).

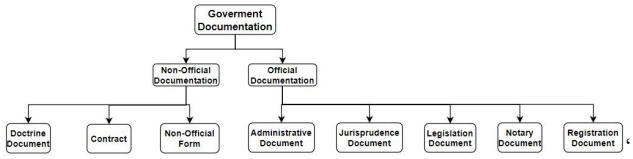


Figure 1: MEXIN Taxonomy

4.2 MEXIN SYSTEM

We now share an application that is under development that employs the proposed Multi dialectical Ontology MEXIN. In detail, we present the application with Mayan Dialect examples. The system used an object-oriented methodology in the design and implementation of the machine translator. The languages Java and Python were used to develop the software. The computational linguistics dispositions and potential methods to automate natural language were explored and applied to develop a machine translator.

4.2.1 Translator. The translator (*Figure* 2) was modeled using the transfer-based approach to machine translation to restore the meaning of a Spanish text in a translated verse. The scope of implementation was Spanish to Mayan translation.

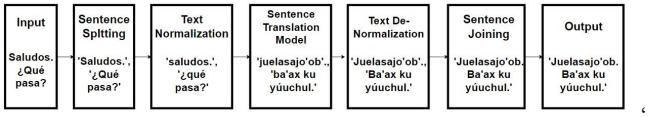


Figure 2: Translation Process Spanish-Mayan

4.2.2 Architecture. For the system to work a lexical dataset of the Mayan dialect was created. (*Figure* 3). RNN is a variation of the neural networks, best at processing sequential data. Natural languages are considered sequential data. The encoder-decoder architecture. In machine translation, the encoder-decoder architecture is often used because the source and target texts do not always have a one-to-one match.

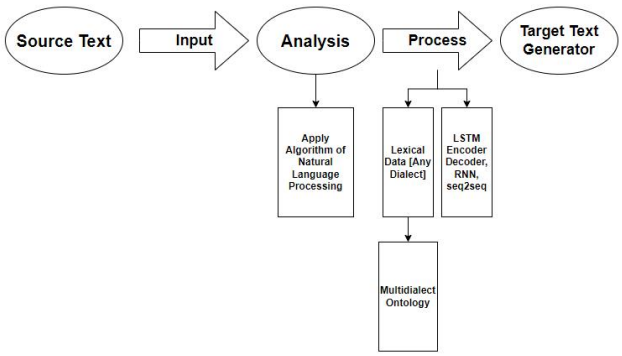


Figure 3: System Architecture

5 CONCLUSIONS

In this paper, we have presented the Multi dialect system MEXIN; even though this ontology is at its initial state, it has well-defined goals to support delivering services from the public administration (within the government) to citizens. We must add here that the multi dialect environment is very complex. We will focus on further enhancement and evaluation of the MEXIN; we will be centered on the multi dialect capabilities of MEXIN to provide a holistic service to all government needs. Further research will be implemented in real environments and add and test the other different dialects in Mexico besides Mayan.

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Public Values of Trustworthy Peer-to-peer (P2P) Lending System

Reni Sulastri
Delft University of Technology, The Netherlands
R.Sulastri@tudelft.nl

Marijn Janssen
Delft University of Technology, The Netherlands
M.F.W.H.A.Janssen@tudelft.nl

ABSTRACT

Governments want to improve the economy by extending the market of financial credit. Recently, Peer-to-peer (P2P) lending credit scoring systems have gained more attention for advancing society; however, the role of governments in ensuring fair access to such a system is not known. This work aims to understand better the public values for trustworthy P2P lending systems. Public values should provide the basis to which a P2P lending system should adhere. Credit scoring in P2P lending is not merely about the technology in creating a profitable system for all participants. Several public values are of relevance. Understanding credit scoring in P2P lending is crucial to ensure inclusiveness, trustworthiness, fairness, equal treatment, and accountability.

CCS CONCEPTS

• **Artificial Intelligence for Governments of the Future**;

KEYWORDS

Public values, Credit scoring, P2P lending, Trustworthy AI

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1 INTRODUCTION

Entrepreneurship in society is crucial for economic growth. Governments want to ensure that access to the lending system for individuals and companies is possible, and small companies and entrepreneurship can be stimulated. Traditionally, people apply for credit in the banking system. With the rise of AI-based technology, it has become possible to create Peer-to-peer (P2P) lending systems that provide more opportunities to serve unreached market segments. Governments want to develop policies to guide these developments. However, the public values that should be adhered to are not known.

The term credit scoring has been used in both traditional banking and P2P lending system to assess the creditworthiness of the customer. Several aspects differentiate P2P lending from banking credit. The first is information asymmetry, which results from the anonymity of participants and the unavailability of a financial intermediary to conduct risk assessments. In contrast with the banking credits that rely on the appraisal of financial risk managers, risk assessment in P2P lending is conducted by the lenders which are mostly inexpert. Therefore, data quality and the reliability of the analytical process are crucial in supporting proper investment decisions. The second is inclusiveness. The governments encourage P2P lending companies to extend credit coverage to unbanked markets and middle to micro-level enterprises. The governments believe that micro-small-medium enterprises play a vital role in supporting economic growth. Third, compared to the banking system that must comply with The Basel Committee on Banking Supervision, the regulation and supervision of P2P lending Fintech is a growing discourse, and there is no available global standard and guidelines.

We review five public values in P2P lending systems: inclusiveness, trustworthiness, fairness, equal treatment, and accountability. We conclude that credit scoring for P2P lending is not merely about the technology and information system. It is beyond the aims to create maximum financial profit.

2 PUBLIC VALUES

We derived the following values based on the overview of public values in Jørgensen (2007).

The first value is inclusiveness. P2P lending systems appear as alternative funding to individuals or enterprises with difficulties in banking credit access or approval. P2P lending quickly penetrates the unserved market segment due to a faster approval process and non-mandatory collaterals. With their ability to process and analyze various alternative data sources, such as data from social media and social networks, the P2P lending system improves the credit score and expands the opportunities for unbanked people to access the funding facilities (Jagtiani & Lemieux, 2019). The implementation of AI-based analytical modeling provides the system with an improvement in prediction accuracy and profitability.

The second value is trustworthiness. Why is trustworthiness crucial in P2P lending? It could be tied to the uncertainties issue. P2P lending is an immature industry with various risks and uncertainties (Zhang & Wang, 2019). Information asymmetry is considered a source of uncertainties that could lead to moral hazards. Each participant is unaware of others' preferences and motivations, and lenders can not verify the validity of the information provided by borrowers. But then, how to define trustworthiness in credit scoring P2P lending? There is no standard definition of trustworthiness in an AI-based system. One common understanding is that trust is different from trustworthiness. We define trustworthiness in this context as the ability of the system to perform based on the pre-defined requirement and criteria of reliability and validity. The relationship between trust and trustworthiness could be reciprocal, conditional, or contextual. A person or an agent could trust a

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Table 1: Public values in P2P lending credit scoring

Public value	Explanation
Inclusiveness	Equal opportunities for everyone to utilize the products and services provided by the system regardless of demographic aspects and social class
Trustworthiness	The system's behavior aligns with the pre-defined criteria. The requirements and measurements of trustworthiness are defined in advance as the baseline of evaluation.
Fairness	The system is not arbitrary and can provide fair financial schemes to all participants. The recognition of fairness could be contextual and influenced by stakeholders' view
Equal treatments	The system should be able to mitigate various sources of bias, such as prediction bias, taste-based bias, and decision bias, which could be affected by technical issues or social issues
Accountability	The stakeholders' acts that reflect their roles and obligations

system that is not trustworthy; on the other hand, a trustworthy system might not be trusted by a person or an agent.

The recognition of fairness in credit scoring P2P lending could be contextual and influenced by stakeholders' views. It is a challenge to develop a publicly accepted system as fair by all the participants. We could expect a trade-off between fairness and systems' accuracy or between individual fairness and community fairness. Li *et al.* (2020) introduced two contexts of fairness in credit scoring prediction: individual fairness and counterfactual fairness. Their experiment concluded that social features improve the accuracy of model predictability; however, social features disrupt individual and counterfactual fairness.

The next value is equal treatment, the ability of the system to mitigate various sources of bias, such as prediction bias, taste-based bias, and decision bias. A variety of research has been conducted to handle bias in P2P lending credit scoring by utilizing artificial intelligence and various statistical methods. Proper data pre-processing and the choice of algorithms play important role in handling bias.

The fifth value is accountability, which reflects one's expected role and responsibilities. The sources and the impacts of unexpected behavior in P2P lending systems are varied. Moral hazard has commonly been recognized as one of the risks in P2P lending, as a part of the post-contractual risk (Collier & Hampshire, 2010). Shi, Wu, & Hollingsworth (2019) recognized two causes of moral hazards: different goals between participants and the unavailability of a monitoring mechanism. Lack of formal monitoring, on the one hand, provides an innovative environment for industrial growth. However, on the other hand, triggers moral hazard.

3 CONCLUSIONS

The majority of credit scoring model development aims to improve the technical aspects—we plea for taking public values as the starting point. Several public values are of relevance in P2P lending. First, is inclusiveness - ensuring the systems provide equal opportunity of access to everyone. The second is trustworthiness. A limited study has been conducted to address the trustworthiness of P2P lending—several research addresses the trust issue, but do not explicitly discuss the trustworthiness. Trustworthiness is tied to the property and the behavior of the system. In contrast with trust that is contextual and conditional, trustworthiness requires pre-defined requirements and quantitative measurements. The third is fairness, which is highly dependent on the stakeholders' concerns. So far, there is no standard definition of fairness in AI-related systems; some trade-offs are to be expected. The fourth value is equal treatment, dealing with various potential biases in the system. The last one, accountability, is strongly related to one of the unintended impacts of P2P lending, moral hazard. Parties involved in P2P lending could have different goals and concerns and might misrepresent their abilities to fulfill the intended purposes.

Reflecting on the public values in credit scoring for P2P lending, the government and authorized parties are encouraged to define rules and regulations that ensure the maximum benefits to society.

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OpenIllinois: An Information System for Transparency in Illinois State Electoral Finances

Andong Luis Li Zhao
Andrew Paley
andong@u.northwestern.edu
andrewaley@u.northwestern.edu
Northwestern University
Evanston, Illinois, USA

Rachel F. Adler
r-adler@neiu.edu
Northwestern University
Evanston, Illinois, USA
Northeastern Illinois University
Chicago, Illinois, USA

Kristian Hammond
Kristian.Hammond@northwestern.edu
Northwestern University
Evanston, Illinois, USA

ABSTRACT

Governments have pursued political transparency through open data availability; however, even with these barriers addressed most people cannot make use of raw data. To address this issue we designed and created a platform that does data analytics in the realm of political campaign contributions in Illinois. Through this work, we will show that we should be developing tools to enable not just *open data*, but rather *open information*

CCS CONCEPTS

• **Information systems**; • **Human-centered computing** → *Usability testing*; Natural language interfaces; *User centered design*; • **Computing methodologies** → *Artificial intelligence*; • **Applied computing** → **Computing in government**;

KEYWORDS

transparency, data analytics automation

ACM Reference Format:
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1 INTRODUCTION

Transparent political systems have long been sought, with a popular modern approach being Open Government initiatives that provide the infrastructure and practices for open data. However, even if all data is open and available, itself a significant challenge, it alone is not enough to achieve transparency in government. Only a small subset of the public, i.e. technical and domain experts, can take advantage of open data.

Addressing this problem is of utmost importance since regardless of how open and documented the data is, the information behind it will still be gatekept by technical expertise requirements. Rather than relying on teaching all citizens how to code, we can bridge the gap between users and information by democratizing data-driven analysis.

We aim to answer the following

(1) How can we design and build a scalable, usable political information system that meets users' needs?
(2) How do we validate that said system is fulfilling its purpose?

We developed a platform for doing data analytics to understand political data; we focus on the domain of political campaign contributions in Illinois, USA. We will validate our approach by doing correctness testing of the platform (are the answers of the system correct) as well as usability testing (is the system intuitive enough for non-technical users to use).

2 RELATED WORKS

Government transparency has recently been a significant topic of research, especially regarding open data portals and their evaluation metrics [7, 8]. Though important, these metrics generally focus on how easy it is to get data rather than information [3, 5]. There has been some initial work looking at the requirements of political transparency information systems [6], rather than just open data portals, which we utilize as a basis for evaluating our system.

Beyond open data portals [1, 2], there has been some work in building analytics platforms for government data [4, 9]. Socrata (https://dev.socrata.com/) and CKAN (https://ckan.org/) are well known examples of platforms that make open government data more intelligible and available for use. Though impressive, these are still largely focused on providing access to data.

[10] introduced a framework that allows non-technical users to ask questions about the US federal court system. By defining ontologies over SQL databases, they provide semantic context to the databases. Additionally, they build an engine that can utilize the ontologies to define the space of possible questions for that domain. However, their work is limited to the US federal court system.

3 METHODOLOGY

3.1 Data

In this project, we focus on Illinois state political campaign contributions. Though this data is made publically available by the Illinois State Board of Elections (ISBE) (https://downloads.elections.il.gov/), it is still challenging to handle. Instead, we utilized Reform for Illinois' (RFI) database (https://illinoissunshine.org/api-documentation/), which ingests the ISBE campaign finance data into a controlled schema. Through RFI's API, we populate a local copy of their database. As of April 11, 2022, there were 3,212,697

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Requirement from [6]	Reform for Illinois Web Portal	SCALES	OpenIllinois
Documentation	✓	✓	✓
Access to and interoperability with other data			
Access to up-to-date data	✓		✓
Accommodate different ontologies			✓
Integration of user preferences and knowledge			
Adherence to UX best practices	✓	✓	✓
Allow follow up questions and flexible analyses paths		✓	✓
Analysis of unstructured data			
Attend to different levels of user technical background	✓	✓	✓
Export analysis	✓		
Transparent analysis and processing	✓	✓	✓
Identification and communication of limitations		✓	✓
Allow verification of results by domain or technical experts			

Table 1: Summary of [6] political information system requirements. RFI and SCALES [10] meet 6 of them, whereas our system meets 8 of them.

contributions and 2,745,150 expenditures across 24,620 committees in our database. Additionally, we also conducted preliminary named-entity recognition on political interests groups. Based on VoteSmart's interest group classification [11], we do exact regular expression matching on donors. Out of 1,053,880 entities that were identified as organizations, 13,435 of them were classified as part of the 163 interest group defined by VoteSmart.

3.2 System Design

We utilized [6] as a guide to consider the requirements for the design and capabilities of our political information system. Though [10] only meets 6 of the 13 requirements (Table 1), it notably meets the "flexible analysis paths" requirement, which is not met by most open data portals. Hence, we adapted [10] design and defined our own ontology of the Illinois State Campaign Finance domain, paired with expanded analytics (e.g. allowing different granularities on timeseries, allowing users to change the main searchable entity). In Figure 1, we show a screenshot of an analysis done on our system.

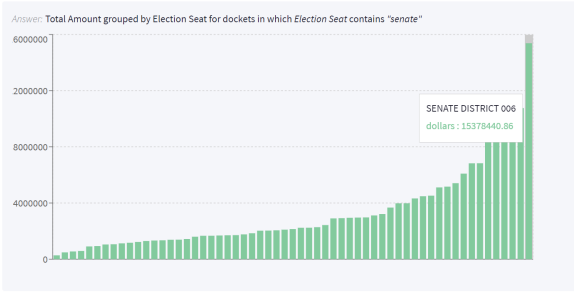


Figure 1: Example of an analysis aggregating all contributions grouped by election seat

4 PROPOSED EXPERIMENTS/VALIDATION

Validation of our platform is tricky given the few suitable alternatives that allow users to answer the same questions that our system can answer. To that end, we evaluate our system on two different criteria: correctness and usability.

4.1 Answer Correctness

We test correctness by validating numeric and presentation correctness. For the former, we define a set of questions over a static version of our database, have a data scientist compute the correct answer for each question, and compare their answer to that of our systems. For presentation correctness, we plan on having data scientists evaluate how our platform presents its answers.

4.2 Usability Testing

We will test the usability of the system by having users answer a set of defined question scenarios on our platform and on a control platform. We then ask users to answer questions about the usability of our platform compared to the alternatives. We will randomly assign the order of the platforms they use. Since there are few suitable control platforms, we will utilize RFI's platform and their API. For questions that can be answered through the platform, we will ask users to search and obtain the answer. For questions that can only be answered through API data, we will ask users if they could answer the question by doing their own analyses; if they could, we will ask them to walk us through their process and estimate used time and resources to compute the answer.

5 LIMITS AND CONSIDERATIONS

Though our system fulfills most requirements laid out in [6], it does not meet all the requirements, most notably "interoperability with other data", "integrating user knowledge", and "allowing verification by experts". Additionally, the named entity recognition is currently focused on precision rather than recall, limiting the scope of analyses. Lastly, there are important concerns of privacy for and misinformation about donors and politicians. We chose to utilize the ISBE (through RFI) data to ensure that we are dealing with already public data. However, incorrect or decontextualized analyses are still possible. We believe that with proper contextualization and

expert input, we can reduce misinterpretations. Nevertheless, these issues will continue to be strongly considered as we move forward with this work.

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Benchmarking the Digital Government Value Chain

Jaromir Durkiewicz
Department of Informatics in Management, Gdańsk University of Technology, Poland
jaromir.durkiewicz@pg.edu.pl

Tomasz Janowski
Department of Informatics in Management, Gdańsk University of Technology, Poland and Department for e-Governance and Administration, Danube University Krems, Austria
tomasz.janowski@pg.edu.pl

ABSTRACT

Digital Government (DG) benchmarking is an academically vivid topic and, equally important, a tool with the potential to provide valuable insights to policymakers and public managers responsible for digital policies at the level of countries and international bodies. Alas, this potential remains largely untapped in the current DG benchmarking practice. In our study, we identify the reasons and propose a way of mitigating them. By referring to the managerial roots of benchmarking – to identify a unit's problems and help it find a way toward performance improvements, we postulate to: 1) extract information coming from various measurement projects, 2) apply a process perspective to DG measurement – DG follows a series of value-generating transitions comprising a value chain, and 3) map the results to particular managerial or policy problems. We argue that the outcome, a comprehensive framework for country-level DG benchmarking built upon existing DG measurement instruments, offers a much higher diagnostic value than if such instruments are applied individually.

CCS CONCEPTS

• **Applied computing** → Computers in other domains; Computing in government; E-government; • **Social and professional topics** → Computing/technology policy; Government technology policy.

KEYWORDS

Digital Government, Benchmarking, Value Chain

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1 DIGITAL GOVERNMENT – A MEASURABLE CONCEPT?

"Digital Government" or "E-Government" has established its role as an umbrella term for the use of digital technology by governments. Being such a generic term, it is not very useful for practical purposes. When trying to particularize, an abundance of definitions, often incompatible with one another, emerges. See the compilation in [1] or an extraction of the DG's semantic core in [2]. While this abundance may not to be a big problem when applied in the popular discourse, it is highly problematic when approaching the topic from the technical or policy angle.

For instance, when designing any measurement scheme, it is key to first identify what to measure. In the DG practice, however, one relies on more or less arbitrary operationalizations: the United Nations' E-Government Development Index (EGDI) calculates the mean of online service quality and two purely "analog" indicators [3]; the European E-Government Benchmark (EGB) considers selected qualities of digital services, e.g. user-centricity [4]; the Waseda University's Digital Government Rankings (DGR) spreads the focus from management optimization to cybersecurity [5].

Given such a diversity of views, it is doubtful if DG could be easily expressed and assessed in terms of a single indicator. Thus we could seek a balance by integrating information produced by various instruments, selected based on the relevance and reliability of their frameworks, and the transparency of data processes and produced by them. This integration, however, requires a common understanding on various DG relationships.

2 DIGITAL GOVERNMENT RELATIONSHIPS

As of 2022, DG is no longer a technological novelty but a persistent element of the global and individual countries' sociotechnical landscape which forms various relationships with other elements in this landscape. By tracing the literature, we can extract three general classes of such relationships, shown in Figure 1

First, the readiness for DG implementation. The UN instrument, for instance, identifies three main categories of readiness: technical, connectivity and human [3]. Second, within the DG implementation is an interaction between services offered (supply side) and their users (demand side), referred to as the problems of use, uptake or adoption, e.g. [6]. Third, DG is meant to bring tangible benefits to the state and society at large, as confirmed by various impact studies: streamlining of public administration [7], improvements in governance [8], reduction of corruption [9], enhancement of democracy and civic engagement [10], supporting sustainable development [11], etc.

3 DIGITAL GOVERNMENT BENCHMARKING AS MANAGEMENT TOOL

Originally, benchmarking was conceived as a managerial tool aimed at recognizing an organization's market position, comparing it against competitors, identifying problem areas, and boosting performance [12]. Benchmarking makes sense when it provides

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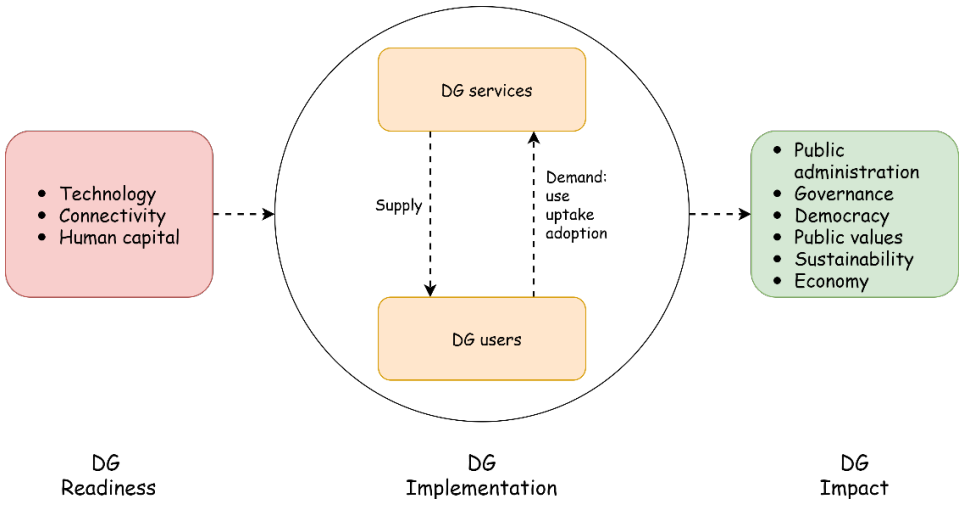


Figure 1: Conceptual scheme of DG relationships

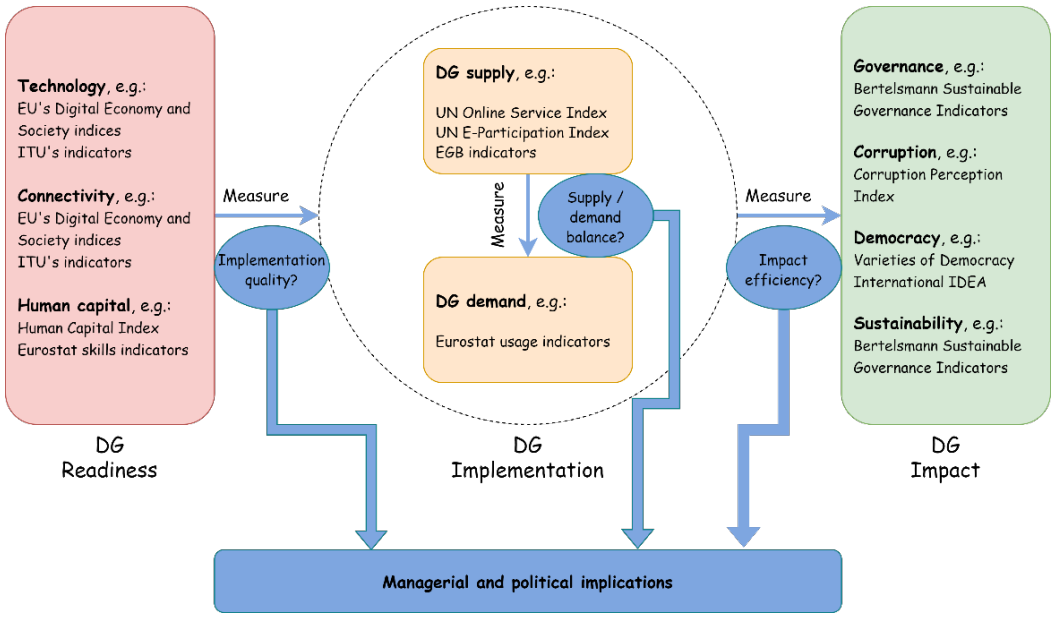


Figure 2: Conceptual scheme of the DG benchmarking framework

applicative feedback; the range of comparisons is sensible, i.e. not comparing organizations in totally different markets [13]; and there is a well-defined performance horizon to head towards [14].

DG benchmarking is an established research direction [15] but also a constant subject of critique [16]. It struggles with the question if the recognizable instruments, such as EGDI, EGB or DGR, really play their role as benchmarking tools? The answer is negative: the scorings and rankings based on incompatible DG operationalizations can supply some interesting trivia for popular reading but their compatibility with the core benchmarking assumptions – their managerial usefulness – is limited. Also, they generally neglect the natural scope of DG evaluation, i.e. the performance in relationships identified before, e.g. [17]. Finally, how can the least developed countries apply the conclusions coming from a global, e.g. EGDI, ranking? Heading towards high-performance DG in many developed countries is as appealing as unrealistic.

However, designing a new instrument with tailor-made datasets and algorithms is a serious organizational and financial effort. Instead, we propose a framework for DG assessment based on reusing and rearranging existing data, and capturing DG performance in a process-oriented way, i.e. focused on the state of relationships, to produce managerial value. The framework, summarized in Figure 2, develops the ideas from [18] and realizes the DG value chain concept [19].

The arrows indicate what is measured, e.g. implementation quality or impact efficiency. The outcome provides diagnostic feedback with specific managerial and/or political implications. The measurements are relative to the value of input, e.g. to the level of readiness or the quality of implementation. Thus worth considering are the techniques of input-output efficiency measurement, such as Data Envelopment Analysis (DEA) [20]. We assume that the whole effort makes sense when it is applied to a group of countries at a comparable stage of development, e.g. member states of the European Union.

4 CONCLUSIONS

We motivated and described the DG benchmarking framework concept based on the DG value chain. The next steps are to operationalize this framework, and to design and perform an application/validation study. The outcomes should be beneficial to public managers, policy-makers and researchers interested in DG benchmarking. The DG.O attendees will be interested in exploring various options for implementing and applying the framework, in line with their own research areas.

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Shared services for digital transformation in government: a case study

Illugi T. Hjaltalin
Hallur Th. Sigurdarson
illugi20@ru.is
hallursig@ru.is
Reykjavík University
Reykjavík, Iceland

ABSTRACT

Shared services may lead to improved organizational performance through better resource utilization. This management idea has been widely adopted in the public sector in the past two decades, e.g. for digital excellence in the Nordics and elsewhere. This research applies systems theory and public value theory to explore organizational capabilities required for public value creation in government digital shared-services centers (GD-SSCs). This paper contributes to the public value and public sector innovation literature by examining a case of a GD-SSC and its adoption by the government. The findings are relevant for policymakers and public managers who are interested in accelerating digital transformation in government. GD-SSCs have been widely adopted and the results can thereby apply to cases beyond the current context.

KEYWORDS

digital government, shared services, innovation, systems theory, public value

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1 INTRODUCTION

Public organizations (POs) are under pressure from elected politicians and the public to deliver high-quality services and to use resources efficiently. To this end, governments have invested heavily in ICT. Correspondingly, the boundaries between public management and ICT management are becoming increasingly blurred, especially in POs gone digital. At the same time, different management ideas have been adopted by POs to meet performance-related objectives including shared services. This idea has been widely adopted because it increases synergy and enhances service quality [6]. Similar services once provided by different public agencies, such as ICT services [2], have been relocated and organized into shared-services centers (SSCs). This has reduced costly duplication in public administration and made the use of ICT infrastructure more effective.

> Depending on the shared-services center's primary goals, they divide into different types of centers. Among them are centers of excellence, which focus on professional and advisory services and provide expert knowledge on specific tasks. [It involves] moving existing specialists from decentralized units into one common center for service provision [6, p. 251].

This study explores GD-SSCs by addressing the general research question, i.e. what influences the adoption of a GD-SSC at the adopting government? An additional aim is to assess innovation outcomes from a public value perspective. Chapters 2-5 outline the research design and methods, followed by a short summary of results and conclusion, respectively.

2 THEORY

Viewing a system as a whole is vital to understanding its functioning and how it operates. This is done by examining the subsystems and their interrelations, e.g. by observing the overall system's input, throughput (process), and output. Organizational systems theory is common in e.g. strategic planning and change management. In this study, the system's performance is assessed in public value terms. The motives are public value-driven. This understanding is based on Moore's [4] definition of the term, i.e. public value can be seen as the equivalent of shareholder value in firms. Special attention is paid to points of resistance to expose issues causing sub-optimal systems performance.

Rogers [5, p. 11] defines innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption". Here, the innovation and unit of adoption are represented by the shared services idea and the government, respectively. In a similar study, the adoption of a shared-services idea by a PO is examined [6]. It finds that the idea or innovation is not merely adopted but transformed "into a specific configuration that reflects the organization's individual conditions" (p. 249). Furthermore, political support was needed such as a change to policy, concerning lifelong tenure for relocating staff and voluntary collaboration, in the innovation of the agencies involved. Adopting the idea required systemic changes which demonstrate how impactful this kind of innovation can be for the operation of a PO.

A review of public sector innovation research suggests limitations in previous research [1]. From a systems theory perspective,

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many studies are limited because they focus only on a few system components (e.g. administrative culture in POs or availability of organizational resources). My study applies systems theory and public value theory to explore organizational capabilities required for public value creation in a GD-SSC (service delivery, resource acquisition, co-production, and collaboration), by examining a case of GD-SSC adoption in Iceland. It contributes to public value and public sector innovation literature. First, empirically by examining a concrete case of public value realization in government and theoretically by combining public value theory with aspects of systems theory to study the adoption of GD-SSC in government. Second, the study scrutinizes outcomes of innovation in public value terms rather than solely efficiency and effectiveness terms, which has been overrepresented in the literature hitherto [1].

3 METHODS

3.1 Case study

A case study approach was adopted. Data was collected leveraging multiple sources as suggested by Yin [7]. Interviews were conducted with employees at the GD-SSC (SÍ) and its associated ministry (FJR), inquiring about their motivations to work at SÍ, challenges, successes, the work environment, etc. General open questions were used in the interviews to allow the respondent to formulate their own response and to freely articulate their lived experiences. Observation data were collected from SÍ meetings, online media discussions, and reporter interviews with SÍ's CEO. The objective was to get a better perspective on the public's perception of SÍ. Finally, government documents and information from government websites were used where appropriate.

3.2 The case

SÍ is a young GD-SSC, launched in 2020, with 10 employees. SÍ's shared services consist of e-gov applications, consulting, training, and support to POs. SÍ has an important role in the national digital strategy [3]: "The implementation of the policy and actions is with [FJR], as well as [SÍ] in close cooperation with government institutions, other ministries, municipalities, the general public, NGOs, and companies."

4 RESULTS

An expert at FJR (Respondent 10) describes SÍ as "a center of excellence" in the digitalization of government offering advice on best practices when it comes to the digital transformation of POs and public services. Adopting shared services involved both relocating civil servants (3) and hiring new ones (7). One of the relocated members started working for SÍ in the beginning as part-time while also working at the PO from where he was migrating. The transition for him posed a policy challenge for the PO concerning manager tenure causing delays in his full contractual agreement with SÍ. The other members did not mention any issues in their transition. Interestingly, one of the trio initiated a transfer to SÍ and is currently part of its senior management team.

SÍ's responsible for making its e-gov applications accessible to POs including a secure data sharing platform (API), application system, citizen e-portal, etc. Furthermore, it offers hosting services for POs which allows them to leverage its e-service platform. In 2021, SÍ onboarded the District Commissioners to its platform. It is a large PO with multiple agencies country-wide. Most of SÍ's services are voluntary except for its mailbox service which is mandatory for POs (cf. law no. 105/2021).

Initially, SÍ approached a selection of prospective POs and introduced its shared services idea. Some respondents mentioned points of resistance in a particular initiative instigated by SÍ that they described as a lack of buy-in from the client-side. There must be stakeholder buy-in for the successful adoption of a shared services idea. Lack of buy-in could lead to unsatisfactory outcomes for all stakeholders involved thereby posing a major challenge for the creation of public value.

Nonetheless, outcomes reported by SÍ are generally positive such as increased cost efficiency and improved public services. Moreover, respondents claim environmental efficiency gains as citizens no longer have to drive between POs due to data being effectively shared between them. SÍ's senior management intends to develop performance measurements to effectively assess the outcomes of future digital initiatives. There is a need to (a) calculate the increased cost efficiency at an institution adopting the shared services and (b) decide whether the saving should be directed back into the core business or used for something different (Respondent 9).

5 CONCLUSION

One of the strengths of this study is also a limitation. It is a longitudinal case study which is appropriate when examining a process like the adoption of an innovation. However, it is also a limitation as it is partially retrospective that involves relying on events as respondents remember them. To overcome this limitation the author will rely on triangulation of evidence [7].

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Crowdsourcing platform acting as an intermediary role in Collaborative governance

In Hae Noh
Rockefeller College of Public Affairs & Policy, State University of New York at Albany
inoh@albany.edu

ABSTRACT

Digital platforms are increasingly involved in the public sector as a means to facilitate and coordinate institutions and resources for public projects. These platforms offer alternative forms of public services by creating social and public innovation through cross-sectoral collaboration. Out of various types of platforms, crowdsourcing platforms pool and aggregate resources from the public to generate more creative solutions. This paper examines seven different crowdsourcing platforms in the public sector and demonstrates how they can promote and facilitate collaboration, creating bridges between diverse actors. The paper also discusses the barriers that have hampered the growth of these digital platforms in public projects in the past. These findings thus contribute to the improvement of conceptual frameworks of crowdsourcing platforms as enablers and facilitators, playing the role of intermediary between government and citizens, in collaborative governance.

KEYWORDS

Crowdsourcing platforms, collaborative governance, digital platforms, collaborative platforms

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1 INTRODUCTION

Platforms are increasingly being used everywhere in our lives, as a management phenomenon or as a metaphor [1]. In the organizational literature, a platform is understood as a place that stores an organization's resources and capabilities [2]. [3] is one of the first authors to argue that organizations are platforms. The platform concept also influences technology and is often associated with e-government. The idea of "Government as a platform" —put forth by [1]— suggests that government should depart from the traditional role of government as a marketplace that provides public services to customers. Instead, the government should become an open platform where people inside and outside of government can interact and innovate in providing services. Recently, there is more work being done to bring the concept of the platform to the governance and public administration field [4, 5]. [4], for example, argue that platforms are one way of thinking about collaborative governance as a policy instrument that facilitates many to many collaborative relationships.

Building on the understanding of platforms, this paper particularly focuses on crowdsourcing platform that is "online, distributed problem-solving and production model that leverages the collective intelligence or energy of an online community to serve an organizational goal" [6], p.5. Crowdsourcing has been accepted as a technology-enabled form of public participation [6] but not full-fledged collaborative governance because there is no consensus-oriented decision-making process [4]. Yet, this paper reviews crowdsourcing platforms in terms of collaborative governance because they have some key elements of collaboration and co creation of knowledge. The role of government changes from service provider to collaborator in services, using platforms as an intermediary, and the citizens are not just consumers but collaborators whose experience and knowledge contribute to problem-solving [7]. In fact, crowdsourcing can be a form of open collaboration in which individuals or organizations participate voluntarily [8]. There have been limited studies that specifically pay attention to governance structure and collaboration within these platforms that enable them to be successful. Therefore, my research aims to answer: What is the role of government and government policy in the success of collaboration in crowdsourcing platforms? How do crowdsourcing platforms support the collaborative process and in what ways? This research will offer implications for the practitioners as well as academics on advancing the topic of collaborative platforms.

2 METHODOLOGY

Given the complexity of the collaborative process within these platforms, I chose multiple platforms to account for variability and distinct features of different crowdsourcing models and return(s). My choice of the platforms is guided by three selection criteria. First, I chose platforms that focus on public projects including community projects, or the platform that is created and run by the public sector. Second, the platforms had to be crowdsourcing platforms that entail crowdfunding. There are different types of civic technology platforms that engage the government and the public, but I wanted to particularly focus on platforms that have crowdsourcing features. Finally, I selected platforms with adequate contextual information on the projects including collaboration between the government and the citizen. Following these criteria. I selected seven cases in the US as Table 1 below shows because they have distinct collaboration components.

The platforms can be classified based on the crowdsourcing model and return(s) as Table 2 shows. I plan to conduct case studies

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Table 1: Seven cases of crowdsourcing platforms in public sector

Case	Description
Challenge.gov	A grant-based platform to crowdsource innovative solutions from the public on governmental challenges
We the People	An e-petition site that enables citizens to create any petition and speak directly to the Administration
10 X	A platform that crowdsources ideas from federal employees regarding how to use technology to improve public service
Citizenscience.gov	Official government website designed to involve the public in scientific research by gathering, analyzing, sharing environmentally related data and information
IOBY	A crowdfunding platform that connects local leaders with resources of the communities for communal projects
Change.org	A largest platform for social change that allows the public to start, sign, and support petitions that may influence the public decision-makers to address that issue
MIT-climate CoLab	A crowdsourcing platform to solve climate-related challenges by hosting contests and challenges

Table 2: Crowdsourcing models based on the type of return(s)

Case	Crowdsourcing model	Return(s)
Challenge.gov	ideas	social
We the People	petition	social
10X	ideas	social
Citizenscience.gov	data and information	social
IOBY	donation	material/financial
Change.org	petition	social
MIT-climate CoLab	ideas	social

Table 3: Collaborative process characteristics (preliminary)

To what extent does the platform have?
Do participants engage in face-to-face dialogue? (ie. webinars, workshops)
Does the process concentrate in a single forum?
Do participants invest in knowledge sharing (videos, resources, guidelines, tips)?

Values ranging from 1 to 5, with 1= 'very low' and 5='very high'

using a balanced sample of successful and unsuccessful projects in each platform.

Past crowdsourcing frameworks were limited in not treating the citizens and government as true collaborators [9]. To illustrate the importance of collaboration between them, I use the collaborative governance framework by [10] to explore case studies in a descriptive manner. There are key components and conditions that have been validated to achieve successful collaboration such as the presence of antecedent conditions, leadership, and collaborative process. I plan to code each project using these common collaborative governance elements. For example, I will use Table 3. 11] collaborative process characteristics to examine different levels of collaboration. Also, I will include projects with different levels of success within each platform to analyze potential barriers that could impede the achievement of goals.

3 CONCLUSION AND FUTURE WORK

The level of collaboration between government and citizens may vary depending on the cases. However, this research aims to identify the potential role of the platform as an intermediary- brokering and managing partnerships and collaboration with actors in the project. We expect to find additional key elements of success and extend current understanding of success based on transparency, openness, and information sharing [12], exploring the effects of other variables such as participation of various actors, collaborative problem-solving through communication, engaging in easy process for shared motivation, thereby embracing various knowledge and creating new pattern of knowledge production. Therefore, the success of crowdsourcing platforms may depend on the collaborative nature of the governance among actors.

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Smart Cities and Decision Support Systems - A literature review within the domain of blight properties

Carlos, B. Paiva Neto*
Rockefeller College of Public Affairs & Policy, University at Albany (SUNY)
cpaiva@albany.edu

ABSTRACT

Blighted properties management and prevention is a known wicked problem. Due to the multi-dimensional nature of the issue and the solutions needed, the literature on smart cities and decision support systems (DSS) could shed light on developing more effective policies to address this challenge. This poster does a literature review to identify to what extent and how smart cities, DDS, and blight properties have been articulated. The study finds a low number of texts. Nonetheless, they present a considerable variability in approaches, methodologies, and perspectives.

CCS CONCEPTS

• **Information systems** → Information systems applications; Decision support systems; • **Applied computing** → Computers in other domains; Computing in government; E-government.

KEYWORDS

Smart cities, Decision support system, Group decision support system, Information and communication technologies, Blight properties, Literature review

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1 INTRODUCTION AND THEORETICAL BACKGROUND

Since 1998, when the term "smart cities" first appeared [1, 2], it has been used in different ways to describe how governments can make the best of current information and communication technologies (ICT) to improve public policies, either by integrating critical infrastructure monitoring city processes [3, 4] or gathering data from other sources that allows for "smarter" government. The trend is a confluence of the increasing complexity of urban challenges and the perception that ICT usage improves decision making in public organizations.

Smart cities make intensively use of Decision Support Systems (DSS). Initially conceptualized by [5], DDS aim to improve the gathering and use of relevant information for management [6]. It aspires to compensate for the bounds of "rational" decision making [7], to augment individual and group abilities to process information and circumvent inherent limitations and biases, either by supplementing or supplanting the decision-making process [8].

[6] list critical considerations to avoid a naive use of DSS. For individual decision-making, [6] caution for: evaluation of task-technology given how structured a topic is [9, 10]; unintended consequences of DSS assisting novice decision makers in accessing expert's tacit knowledge [11] such as decrease in learning [12]; uncritical overconfidence due to perception of unwarranted objectivity [13, 14] not considering the human signature behind every system design, with the accompanying creators' limits and biases.

For group decision support systems (GDSS), [6] highlight opportunities such as increasing the quantity and quality of member participation and allowing technology-mediated transactive memory. On the other hand, [6] warn for unintended consequences such as social influence hindering participation, possible information overload, anonymity undermining credibility and productive engagement.

Given the mixed findings in the use of DSS, it would be expected that smart cities initiatives would take these critical factors into consideration when enacting any ICT to improve municipal policies.

Due to the wide range of domains by which the interaction of smart cities and DSS can be investigated, this poster narrows the analyses on works related to blight property management policies.

Blight can be characterized as social decadence of a neighborhood area or as physical decay of properties, and both are usually intertwined. This poster uses the latter perspective. [15] defines it as "abandoned or poorly maintained real properties, often characterized by overgrowth, litter, abandoned vehicles, junk, and dumping." (p. 1)

Ground-level inspections can identify blight properties. Nonetheless, it takes data from multiple sources and a multi-department analysis to decide which properties should be prioritized to avoid spreading harm, or to predict which properties might become blighted. [47] The nature of the problem demands cross-departmental collaboration and data-analytic capability [16], making this a typical problem that smart cities and DSS could address.

2 METHODOLOGY

To conduct this literature first, I searched a combination of keywords shown in 1 within Science Direct, Web of Science, Psychology and Behavioral Sciences Collection, Public Administration Abstracts, ACM Digital Library, and Google Scholar.

*PhD Public Administration student at the Rockefeller College of Public Affairs & Policy, University at Albany (SUNY).

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Table 1: Search key words

Domains		Policy topic
“smart city” OR “smart cities” OR “decision support system” OR “group decision support system”	AND	"blight properties" OR "problem properties" OR "distressed properties"

Table 2: Search Results

	Initial results	No clear relationship	Policy topic was peripherical	Final results
Journal Article	12	2 [17, 18]	5 [22–26]	5 [34–38]
Book/Book Chapters	6	-	4 [27–30]	2 [39, 40]
Conference Proceedings	7	2 [19, 20]	-	5 [41–45]
Reports	4	-	2 [31, 32]	2 [46, 47]
PhD/Master Theses	5	1 [21]	1 [33]	3 [48–50]
TOTAL	34	5	12	17

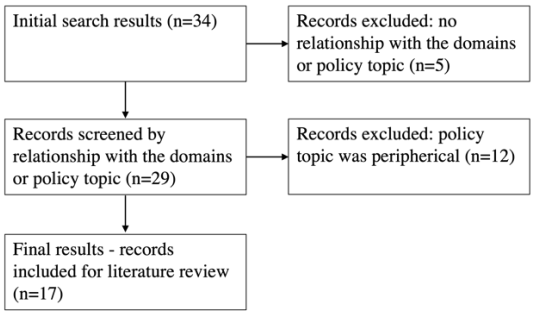


Figure 1: Flowchart: process of text selection

The result yielded 34 texts. After screening abstracts and full text, 5 had no clear relationship with the domains or policy topic, 12 the policy topic was peripherical, resulting in 17 final texts, as shown in 2 and 1(see references of search results in **Appendix 1**).

3 PRELIMINARY RESULTS

The number of articles within the smart cities and DSS literature that address the problem is surprisingly low, given the conceptual fit between the aspirational concept of smart cities, the many decades DSS has been used and discussed in many domains, and the wicked nature of problems that blight properties represent.

Nonetheless, the few texts identified present a wide diversity of methodologies and conceptual perspectives, confirming the multi-dimensionality nature of the problem and its possible solutions.

Five articles take a constructivist, sociotechnical stance. The authors use both objective and subjective variables to develop a cognitive mapping as the base to identify possible determinants of problem properties and develop alternatives to control them [34–38].

Two texts have a critical perspective: one bases its analysis on the theories of feminist care ethics and caring democracy, [41] and the other on data science for social good, within the science and technology studies (STS) [43]. Both seek community engagement or protagonism.

Five texts are less focused on proposing solution models and and more concentrated on exploring the dimensions of problem formulations, critical thinking regarding ICTs, and warning against taking data solution propositions at face value [39, 45–47, 50]. They base their arguments on cases [45, 47], mixed-methods (involving ethnographic fieldwork and use of a data matrix), and creative geographies [50].

Finally, four texts offer solution prototypes based on specific cases, some offering open codes to be adapted to other contexts [42, 44, 48, 49].

4 LIMITATIONS AND CONCLUSION

One limitation of this poster is that the literature search did not use a snowball approach by reviewing the references from the 17 identified texts. Therefore, the number of identified texts should be taken with some caution. Nonetheless, we expect that the texts identified and analyzed are a good representation of how the topic of blight properties is understudied in the light smart city and DSS literatures.

With the growing urbanization rate and the dynamic nature of how cities evolve, the demand to develop the ability to prevent or address blight properties should increase. Considering its wicked nature, multi-dimensional diagnoses and solutions are needed. To that end, the critical work from the last decades on smart cities and DSS should allow a more effective use of ICT in this problem with greater critical awareness for potential pitfalls.

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How did discourse shift among Afghan citizens during the fall of republic: Early insights using conversational AI platform

Jawad Haqbeen
Department of Social Informatics,
Kyoto University, Japan
jawad.haqbeen@i.kyoto-u.ac.jp

Sofia Sahab
Department of Social Informatics,
Kyoto University, Japan
sahab.sofia@i.kyoto-u.ac.jp

Takayuki Ito
Department of Social Informatics,
Kyoto University, Japan
ito@i.kyoto-u.ac.jp

ABSTRACT

Abstract. Facing the increasing demand for conversational informatics to facilitate scalable meaningful online discussion, many government organizations in war-ravaged countries as Afghanistan recently adopted these tools to strengthen deliberative democracy. However, a comparative study on its social impact in view of latest development in Afghanistan is yet to be clearly articulated. Guided by a comparative case study approach to trace the people's thoughts and attitudes during a tumultuous time on the withdrawal of US troops from Afghanistan using conversational AI platform, which included over 150 participants in the Kabul area using open call. The first study conducted during the final 15 days of the republic, and the second study conducted during the first 15 days following the republic's fall using same tool. There was a statistically difference in responsiveness, concerns and uncertainty while comparing both studies. We found that people more likely talking about their concerns and future uncertainty about their future in Afghanistan, while seeking or suggesting help for each other during second study. The output of this research can be used for policy making.

KEYWORDS

Afghanistan, US Withdrawal, Fall of Kabul, Civic Participation, Online Forum, Collective Intelligence, Conversational AI

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1 INTRODUCTION

Online discussion systems based on facilitation play a promising role in the functioning and improvement of democratizing of online social networks [1]. Particularly, such platforms allow communities in crisis like Afghanistan to take part in developmental issues by sending their concerns and ideas to authorities while the system integrate and leading them to achieve insightful consensus[2]. While such system has been widely deployed in countries facing crisis like Afghanistan [2], however, they have not been used to explore the public discourse during the critical crisis like the fall of Kabul 2021 [3].

After 20 years of presence and spending $145 billion with the goal to fight against extremisms and rebuilding Afghanistan [4], Biden administration in April 2021 announced that all American troops would be withdrawn from Afghanistan by September 11, 2021 [5]. The decision encouraged Taliban to launch waves of attacks and infiltrate the provinces' which government-controlled by the end of May 2021. Despite this shocking speed of the Taliban advance to capture Afghanistan provinces, the US withdrawal remained underway. As a result, it took less than three months to capture all Afghanistan and on August 15 mark the fall of the elected Afghanistan government, which had been supported by billions of dollars and sustained by hundreds of thousand people causalities [6].

This paper adopts a comparative case study approach to examine the social impact of the digital society platform in gathering opinions from citizenry in communities in crisis as Afghanistan [7]. This case study was conducted with over 156 participants which come from Afghanistan online population on the challenges that might be posed from US withdrawal during the final 15 days of the republic with the 15 days following the republic's fall using conversational AI platform called, D-Agree [1]. The study responds to the following research question:

How did online discourse changed during the fall of republic and following the republic fall in Afghanistan?

Note that our initial plan was to conduct experiment during the final month presence of US forces with a month following the withdrawal of US from Afghanistan. However, due to latest development in Afghanistan [3] the Biden administration later moved the deadline from September 11 to August 31. Our initial plan was likewise changed with this objective in mind to compare republic final 15 days with the 15 days following the republic's fall.

2 METHODS

Our research's general methodology conducts comparative experimental case studies using conversational AI platform [7], with the objective of verifying number of participation and people opinions during the final 15 days of the republic with the 15 days following the republic's fall in Afghanistan. We selected Kabul as representative city of Afghanistan. Those who were active on social platform like Facebook were agreed to participate in our discussion were subject of this study. We send to undefined network of people as open calls using Facebook Ad. We recruited people who indicated they lived in Kabul on Facebook, so Facebook Ads considered to be in Kabul city. The open-call is unified as an invitation for anyone to participate in online discussion in our both studies [2]. All respondent gave consent for taking part in this study while login into

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our system. The consented citizens joined predefined workspace to discuss the following theme for a period of 15 days during each experimental study.

- What do you think about the withdrawal of united states troops from Afghanistan?
- How do we keep up the public safety?

D-Agree, a previously self-implemented conversational AI platform was the instrument for this study, since it can involve opinion-gathering, facilitate and -analyzing at large-scale, ready for use in any way and at any time. The system was deployed in many countries, such as Afghanistan [2], Indonesia, Japan [1] and Myanmar [8] through conducting social experiments. The overall agent platform is composed of four agent modules: a conversational agent, a proactive agent, a Natural Language Processing (NLP) engine, and an argumentation engine [6].The agent platform was deployed on Amazon's EC2 infrastructure with each module being allocated to a separate EC2 instance (Amazon 2020).

2.1 Data analysis.

The discussion data was annotated and digitized with the help of D-Agree. We relied on a quantitative method that combines annotated data, and statistical analyses of the argumentative data generated from the discussions [1] as early study. We particularly looked at how many IBIS (issues, ideas, pros, and cons) elements are generated in each experimental study.

3 EXPERIMENTAL SETTING

Each study was conducted for a period of 15 days and facilitated by conversational agent. The first one was started from August 1 to 15, 2021, following the second one from August 16 to 30 2021, respectively. The themes were selected to specially discuss about the challenges that might be posed during and after US withdrawal from Afghanistan, also how to keep Afghanistan democracy and past 20 years achievement after US withdrawal. Participants used their real name however, due to latest development over their privacy we anonymized their IDs in second study.

The interaction between the participants and the conversational agent was controlled with two parameters: a 1 min period specific to Amazon CloudWatch, and a threshold of three people (1:3). This threshold sets the number of human messages that the conversational agent must count before joining the discussion. The agent identity was revealed as AI facilitator [2].

4 RESULTS

The results of the discourse quantified data are shown in Figure 1; and Figure 2In our first finding, the people were more likely browsed discussion theme (n =433) compared the first experiment (n =149). Furthermore, the number of participants (n =109); threads (n =82); and replies (n =287) were higher than number of participants (n =95); threads (n =60); and replies (n =266) for second study. We assumed that people in crisis (in this case second experiment) are more likely to have voices and people seek to help and support using online technology. This aligns with the fact and chaos raised after 15 August.

From the quantified data, our second finding suggest that the number of ideas (n =470) were higher compared to issues (n =317) for both experimental studies, because the effect of proactive agent, where the agent set the behavior of conversational AI moves with a deliberation towards consensus building. Thus, motivate user to post solution of raised issues. However, if we compare two studies, issue was higher (n =175) in second study than number of issues (n =142) for first study. This aligns with the fact that chaos raised after 15 August.

5 DISCUSSIONS AND CONCLUSION

First, the evolution of IBIS counts and metrics on contents in Figure 1 suggests that there was a difference in the sharing gap between issues, pros and cons during two studies. The autonomous facilitation is centred around raising ideas and pros in both experimental studies.

This evolution shows the success of NLP, extraction and agent facilitation of our system. However, the number of concerns (issues) increased after 15 August 2021. This aligns with concerns and future uncertainty in Afghanistan which happens during second study. The responsiveness rate of participants for second study suggests that the development after 15 August increased the activeness of the participants to not only browse the theme but also to messages issues and to seek support by visiting the system. Thus, it is aligned with the fact on the ground that people needed much support during second study. The possible explanations for why more participants signed up for the second study is that more people want to raised their voice for seeking help and support and considered the system as reliable and trusted source.

Our study faced several limitations and challenges that must be addressed in future works. We believe that selecting the study area and methodology have many limitations which will be considered in the future. In first study, we assumed the that participant engaged non-anonymously while changed it anonymously during second study, thus, this potentially bias the data, particularly after the fall of the republic which we anonymized the discussion. However, this was done in order to maintain the privacy of our subjects, particularly after the fall of the republic. Furthermore, as our study IBIS extraction currently operate in English, we ignored the IBIS element written in local languages (Farsi and Pashto) during first study (n =89) and second study (n =102). We need to train node and link extraction in the future.

In addition, while the results provide quantifications of the tagged topics appearing in both studies using english, this paper would benefit from further elaboration and explanation of these results. A qualitative analysis would strengthen the discussion or, at minimum, a qualitative substantiation of some of the conclusions drawn in the results. For example, the results section makes claims that responsiveness during second study align with concerns and future uncertainty in Afghanistan while seeking or suggesting help for each other without showing any of the qualitative data supporting this claim. We will try to go deeper in analysis of the data in the future's full version of paper to study and investigate this claim.

To conclude, we used D-Agree, a previously self-implemented online discussion forum, to solicit opinions from Afghans during a tumultuous time on the withdrawal of US troops from Afghanistan and maintenance of public safety in Afghanistan, comparing attitudes from the final 15 days of the republic with attitudes from

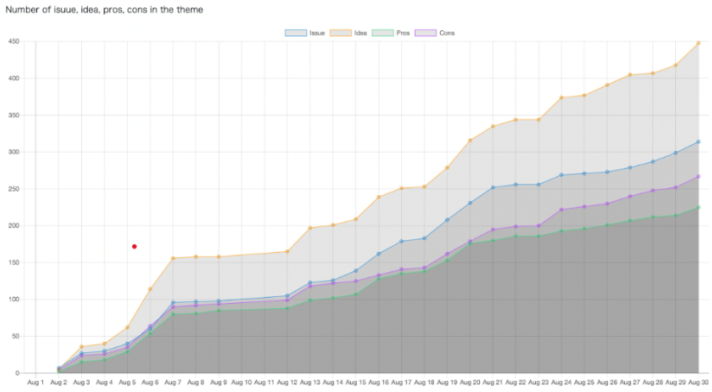


Figure 1: Number of IBIS coming from two studies for a period of 30 days.

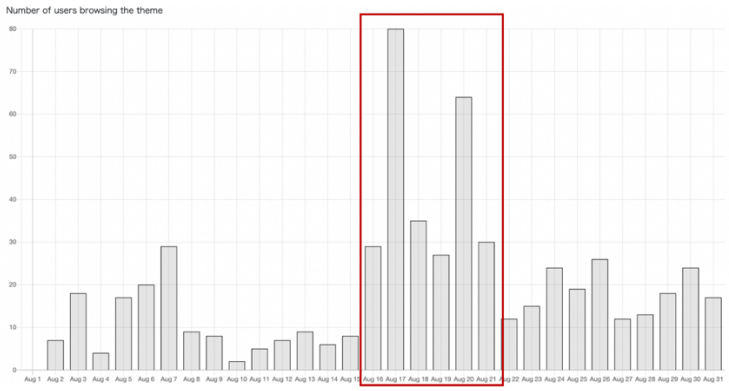


Figure 2: Number of browsing in the themes coming from two studies.

the 15 days following the republic's fall. We recruited over 150 participants in the Kabul area via Facebook Ads through open call, who participated non-anonymous during first experiment and anonymously during second experiment on the D-Agree platform to discuss the above issues.

Our next direction is to apply deeper exploratory analysis of the data to clearly understand the addresses of the shifting of Afghan public sentiment pre- and post-collapse, and then use/share the collected data with nonprofit organizations (NPOs) to help Afghans. These insights would allow NPOs to establish and evaluate a public policy that would increase both responsiveness and raising solution to issues in Afghanistan.

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The Structure of an Innovation Ecosystem in Relationship between Individual Technology Startups and the Government: Evaluating the Foundations for Government Challenge

Yu-Sheng Yang
Department of POSC, NCKU, Tainan, Taiwan
U18091021@ncku.edu.tw

Lichun Chiang
Department of POSC, NCKU, Tainan, Taiwan
lcchiang@mail.ncku.edu.tw

ABSTRACT

New technological enterprises are developed gradually to influence the transformation of the national industry and the entrepreneurial challenge. The government has provided the strategy of technological innovation to guide the market in order to establish a complete "Innovation Ecosystem". Through the establishment of the innovation ecosystem, enterprises can avoid risks and competition in the market in isolation, and help members jointly cultivate various capabilities and technologies under the concept of innovation. The achievement of the research serves Taiwanese continuous optimization of technological innovation and provides effective suggestions to breed local unicorn enterprises.

KEYWORDS

Technological innovation ecosystem, Technological industry innovation policy, Unicorn enterprises of tech startups, Triple helix theory

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1 INTRODUCTION

Innovation is to create new value, and the so-called "value" broadly includes all things that can reduce costs or improve utility for customers [3]. The government uses the strategy of technological innovation to guide the market and establish a complete "Innovation Ecosystem". It not only focuses on the relationship between individual technology start-ups and the government, but also builds an overall external environment for technological innovation, which is conducive to cultivating emerging unicorn enterprises, and the transformation of national industries. Then, effectively it guides the innovation part of the technology industry in the market.

In the functional part of innovation, innovation can not only expand industrial boundaries, and create new products, but even develop new types of industries, assisting national industrial transformation [4]. Briefly speaking, innovation can create value at the enterprise level, expand boundaries at the industry level, and finally contribute to industrial transformation and economic development at the national level. In 2021 in Europe, there were 98 new unicorns established, bringing the total number to 321 companies. For example, if the population in Sweden is less than 10 million, it will be with three new unicorns Spotify, King & Klarna, so the success of new ventures is closely related to the active guidance of the EU policy. What are the functions and types of corporate innovation? Type of innovation [5] is classified into products, production methods, organizational manpower, and organizational structure. The innovation part of the service industry [6] pointed out that innovation can include four levels: (1) innovation of service concept (2) innovation of contacting customer interface (3) innovation of service delivery system (4) Different technology options. Forster and Kaplan [7] emphasized that the competitiveness of enterprises comes from the ability of enterprises to innovate, rather than the technology of enterprise management. Innovation has increased product sales and reduced costs, which was an important factor affecting investment [8]. That is, through the transformation of products, processes, concepts, etc., to strengthen the competitiveness of the enterprise itself and the ability to adapt to the market. Through the establishment of the innovation ecosystem, enterprises can avoid risks and competition in the market in isolation, and help members jointly cultivate various capabilities and technologies under the concept of innovation [9]. Yuanxi [10] pointed out that the complementary and symbiotic innovative ecosystem model makes members stronger. Leading consultancy Ernst & Young surveyed 570 companies around the world during the pandemic and found that as many as two-thirds (68%) of business leaders believe that "ecosystems and partnerships" are the only way to succeed in the current market. All business owners have deeply realized that the survival and growth of enterprises are not only in the improvement of their own enterprise competitiveness; but also in the improvement of the external environment.

Therefore, innovation is not only highly important to enterprises, but also has obvious positive benefits to the country's economic development. The paper aims to analyze the nature of scale-up for a startup (the problem of scaling up after it has been established), and the association with the government support policies for a successful startup in Europe. The construction of an innovation ecosystem not only makes the government's industrial policy more complete; but also, is the only way to effectively improve the overall industrial resilience.

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Figure 1: The analysis of the interactions among the three [11].

2 RESEARCH METHOD

Innovation can create value, coordinate management, and also is closely related to the competitiveness of enterprises in the organization. The research method is based on the "Triple Helix Theory" proposed by Etzknowitz and Leydesdorff [11] as the theoretical framework to analyze and evaluate the best suitable solution for the roles of the three in technological innovation to government. The state intervention model is centered on government intervention. However, industrial policy involves dynamic market trends and high knowledge and technology connotations. It still needs to be continuously tested and adjusted in the market. It is difficult to achieve this goal with the state as the core. The laissez-faire model overemphasizes the self- correction mechanism of the market. However, due to insufficient private-sector output, it is also inappropriate to meet public interests and forward-looking needs and to correct market failures. Therefore, most commentators believe that a balanced configuration is the most suitable environment for cultivating innovation. Under the balanced configuration model, the cyclic interaction among industry, government, and academia will be continuously strengthened, considering the goals of improving market efficiency and maintaining public interests. The analysis of the interactions among the three is as follows:

Based on EU policy to successfully support unicorn enterprises, while improving the innovation ecosystem, policymakers in Taiwan should develop systematic support measures for the expansion of the innovation ecosystem, and thus support new start-ups.

This study is used the qualitative study with six European Union Service Innovation Center (ESIC) demonstration areas as the evaluation scope, including Spain's Canary Islands, Italy's Emilia Romagna, Austria, Luxembourg, Northern Ireland, and the Netherlands' Limburg.

Furthermore, the data is collected from the EU's 8th EU framework plan which currently is implemented by the European Union, also known as Horizon 2020. It discusses relevant scientific and technological innovation research and development policies during the 7-year period (2014-2020) of the implementation of the plan. Based on the "Triple Helix Theory" proposed by Etzknowitz and Leydesdorff [11] as the theoretical framework for research, we try to analyze the role allocation among the government, academia, and industry in the process of technological innovation. We try to evaluate the best plan of scientific and technological innovation, and make a comparison with my country's scientific and technological innovation policy. The comparison of innovation policies between the EU and Taiwan is shown in the bellowed Table 1

Notes: X means the subject lacks this system or institution; √ means the subject has this system or institution.

1) Dedicated innovation agency, 2) Assist in the development and marketization of new startups, 3) Provide financing channels for new ventures, 4) Communication and resource sharing, 5) Develop new ventures according to local characteristics, 6) Cooperate with international partners.

3 RESEARCH FINDINGS AND RESUTLS

A series of innovation policies for the technology industry in the EU not only correct structural inertia, but also help to build a resilient innovation ecosystem. It has always been an important policy of our country for the government to carry out forward- looking technology research through plans to help create new industries or enhance the technological capabilities of existing industries. Whether it is the Ministry of Economic Affairs' "Industry-University-Research Value Creation Program" or the Ministry of Science and Technology's "New Type of Industry- University-Research Linkage Program", both aim to create and assist start-ups. However, the number of unicorns in my country's new start-up enterprises has always had a significant gap with my country's digital technology strength, and it still remains at zero. Some commentators say that the small domestic market is an important reason. However, by 2022, Israel,

Table 1: The comparison of innovation policies between the EU and Taiwan

Items		EU	Taiwan
1	Central-level innovation research institutions	√	X
2	Central-level Accelerator	√	X
3	Central-level Fund	√	√
4	Industry-Government-Academic Cooperation	√	√
5	Develop innovation based on local advantages	√	√
6	International link	√	√

Source: Processed by researchers.

which is also a small country, will have 20 new unicorns, and Singapore will have 12. The domestic market size and digital technology strength of these countries are not stronger than the countries. Based on this, this research intends to review the system, refer to the successful cases of the European Union, and provide specific and effective suggestions from the policy aspects such as subsidy benchmarks, talent cultivation, university participation, and incentive mechanisms, and hope to build a complete innovation ecological settlement for Taiwan. Continue to optimize technological innovation and nurture local new unicorns, and make contributions. The achievement of this research can serve as Taiwan's continuous optimization of technological innovation and provides specific and effective suggestions to breed local unicorn enterprises.

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Trust and Distrust in e-Democracy

David Duenas-Cid
Gdańsk University of Technology
david.duenas.cid@pg.edu.pl

Tomasz Janowski
Gdańsk University of Technology and
Danube University Krems
tomasz.janowski@pg.edu.pl

Robert Krimmer
University of Tartu
robert.krimmer@ut.ee

ABSTRACT

In the digital government research literature, the concept of trust is typically used as a precondition for the adoption of digital technology in the public sector or an outcome of a roadmap leading up to such adoption. The concept plays a central role in many decisions linked to the planning, adoption and management of the public sector technology. In contrast, the concept of distrust is almost neglected in such literature but, when approached, it appears as the opposite logical side of the trust-distrust dichotomy. However, we conjecture that the path to building trust is different than the path to building distrust and both concepts should be regarded as different theoretical constructs. The workshop aims to prove this conjecture drawing on the insights from the field of e-democracy including internet voting. Given its technical breadth, political and societal implications, and layers of complexity, e-democracy is a good benchmark for exploring this topic. The workshop will confront the main conjecture using examples, research and experiences contributed by participants, conceptual and methodological tools introduced by the organizers, and a discussion shared by everybody. The outcome – elements that help build trust or distrust in various forms of e-democracy – will have practical and theoretical implications, aiming at further research by the participants and collective publication of the results in a special issue in a top ranked journal, preferably Government Information Quarterly.

CCS CONCEPTS

• **Applied Computing**; • **Security and Privacy**; • **Human Centered Computing**;

KEYWORDS

Trust, Distrust, e-Democracy, Internet Voting, Privacy, Security, Perception

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1 INTRODUCTION

The concept of trust is a foundation for the functioning of the democracy. The depersonalization of the social life demands trust-building with individuals and institutions to secure social order and handle complexity [10, 14]. The use of technology for government purposes, while searching for more convenient ways of interacting with citizens, brings along a new set of complexities and challenges [6]. e-Democracy follows a similar trend, aimed at keeping citizens engaged in decision-making processes [1, 16] by interacting with convenient and efficient systems [7], but also facing challenges that make implementation [9] and adoption [15] difficult. One of such challenges is assuring trust.

Following Luhmann [10], we understand trust as the bridge that connects the known with the unknown and allows taking decisions that might entail risks; in other words, it is a mechanism of dealing with complexity and uncertainty. When putting this definition to work with e-Democracy, the relevance of collective decision making and power delegation, and the complexing of the technological environment involved, make the comprehension of the working of trust more relevant than ever. Although several efforts have been undertaken to understand trust, this concept is often regarded as a logical outcome of the presence of a set of factors such as, e.g. transparency [3], usability [2], security [13] and verifiability [8]. In contrast, the concept of distrust is generally left out of the analysis or, when considered, placed at the opposite end of the trust-distrust dichotomy [4]. A negative outcome that should be actively avoided in order to ensure the success of technology [5], despite its usefulness for detecting problems [11] or vulnerabilities [12] in implemented systems.

The key premise of this workshop is tackling the separate nature of trust and distrust in the field of e-Democracy. While related, the concepts are separate theoretical constructs and should be subject to separate analysis. In other words, the paths that bring about the creation of trust and distrust co-exist but are different: the opposite to "trust" is "not to trust" and not "distrust", while the opposite of "distrust" is "not to distrust" and not "trust". This distinction makes possible understanding which arguments contribute to the creation of trust, distrust or both, and how they contribute. An example is a voting system which technical robustness is contributing to the creation of trust due to increased safety but also distrust due to the general population not understanding the complex working of such systems [13]. Thus both paths should be approached separately but allowing individuals or institutions to negotiate their positions on the trust-distrust dichotomy on the use of technology in democracy and how such use influences the collective outcome, i.e. the quality of the democracy itself.

While studying the trust-distrust dichotomy is relevant to various fields of Digital Government, we chose e-Democracy for two

main reasons. The first is the need to better understand the functioning of our democracies, particularly when the use of technology changes the democratic rules of the game. The second is that e-Democracy projects, due to their diversity, allow collecting different perspectives on the topic, from specific contexts where local dynamics of social interactions serve as good explanatory elements, to the use of internet voting systems in elections. This diversity affects the comprehension of the elements that might help understand the creation of trust and distrust. Not the same elements are relevant when we are talking about social participation, which is diverse, localized and less demanding on technical requirements and time constraints, than when we approach the electoral field, which is more standardized internationally, imposes strict time constraints and requires high levels of security, privacy and integrity.

2 GOAL AND OBJECTIVES

The workshop will be organized under the umbrella of the ELECTRUST project "Dynamics of Trust and Distrust Creation in Internet Voting" funded by the European Commission's Horizon 2020 program over the 2022-2023 period. The workshop will contribute to the project goals by debating the notions of trust and distrust in the field of e-Democracy by inviting experts in the field who can share their expertise in the use of technology for democratic purposes. The organizers will introduce conceptual and methodological tools to study trust and distrust in e-Democracy, the tools will be applied to the examples, research and experiences contributed by experts, leading to the creation of trust or distrust in e-Democracy, and the workshop will be concluded by discussion and synthesis of findings.

The workshop results will contribute to the creation of a common ground of knowledge to be shared amongst the participants and to be continued in further venues. The expected outcomes will be of interest to researchers but also to practitioners and decision-makers. They will also contribute to the development of the theoretical framework of the ELECTRUST project, and will lead to the creation of a network of participants and to potential common publications. In particular, the organizers will aim at developing a special issue of Government Information Quarterly.

3 WORKSHOP STRUCTURE AND PARTICIPANT PROFILES

The workshop is expected to cover a wide range of experiences in the field of e-Democracy. The profiles should be selected amongst participants who can unfold their knowledge by providing an analysis of cases where the trust-distrust dimensions might be relevant: implementation of new projects, analysis of successful or failed experiences, theoretical analysis of elements bringing trust or distrust, etc. Given the diverse nature of e-Democracy, the participants will not be restricted to one single type of contribution. The conditions for the implementation of technological solutions to transform social participation systems are very different than when such solutions are proposed for elections. The different realities will enrich the comprehension of the elements affecting each of them.

- Welcome participants and self-introduction – 15 mins
- Electrust Project introduction – 15 mins
- Contributions from participants – 30 mins
- Open Discussion – 20 mins
- Conclusions – 10 mins

For the discussion, and using the presented cases as a benchmark to relate to, the workshop will pose questions including but not limited to the following:

- How does the creation of trust or distrust affect democracy and e-Democracy?
- How is the technological transformation of democracy and public administration contributing to the creation of trust or distrust?
- What actors are involved in the creation of trust or distrust? How is the use of technology changing them?
- How is trust and distrust distributed amongst technology users?
- How to assess the impact of a given technology on the creation of trust or distrust? Which indicators can be used?
- What are the most successful or unsuccessful elements for the creation of trust?
- How would they work in a different technological, institutional or cultural context?

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Validating the Rules of Government Automation

Elsa Estevez
Department of Computer Science and Engineering, Universidad Nacional del Sur (UNS) and Institute of Computer Science and Engineering, UNS-CONICET, Argentina
ecestevez@gmail.com

Tomasz Janowski
Department of Informatics in Management, Gdańsk University of Technology, Poland and Department for e-Governance and Administration, Danube University Krems, Austria
tomasz.janowski@pg.edu.pl

Benjamin David Roseth
Inter-American Development Bank
broseth@iadb.org

ABSTRACT

There is growing evidence on the benefits and risks of government automation, and how should government organizations proceed with automation when the benefits outweigh the risks. This evidence was recently consolidated into the "rules of government automation", part of the project funded by the Inter-American Development Bank. The project uncovered that the combined nature of government work and its transformation into digital government create many opportunities for automation. However, such opportunities can be only realized when the right automation technology becomes available and when government organizations are willing, capable, and authorized to introduce it, considering the impact on the organization and its stakeholders and the balance of benefits and risks brought about by this impact. The aim of the workshop is to validate the above "rules of government automation". To this end, the participants will bring to the workshop their own government automation cases, from practice or research, establish thorough inspection and guided reasoning whether the rules hold for their cases, refine them otherwise, and iteratively agree on the refined rules across all cases. The workshop will also initiate the planning of a special issue of Government Information Quarterly to advance the theory and practice of government automation.

CCS CONCEPTS

• **Applied computing** → Computers in other domains; Computing in government; E-government; • **Social and professional topics** → Computing/technology policy; Government technology policy; Professional topics; Computing and business; Automation.

KEYWORDS

Trust, Distrust, e-Democracy, Internet Voting, Privacy, Security, Perception

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1 BACKGROUND

1.1 Automation and digital government

Automation represents the application of machines to the tasks previously performed by humans or increasingly to tasks that no human being is able to perform [1]. Unlike mechanization which entails merely replacing human labor by machines, automation integrates machines and humans into self-governing systems. Due to their capacity to operate without or with little human intervention, such systems rely on digital technology for sensing, processing, control and feedback. Increasingly, with the digitalization of human labor, automation concerns the performance of all-digital tasks.

Government has to serve large populations in cities, provinces and countries, while complying with formal rules, and upholding public values such as efficiency, effectiveness, inclusiveness, accountability, etc. To this end, government provides infrastructure, services and other public goods; passes laws, enforces rules and resolves conflicts; engages the public through crowdsourcing and co-decision-making; and performs administrative action to respond to public needs and aspirations. The latter often comprises many information- and communication-intensive tasks that join together institutions and roles, public and non-public, in producing data-based decisions [2].

Given a large volume of social, economic and political activities taking place digitally, governments are implementing public policies and exercising their governance responsibilities in the digital world to the same extent as in the physical world. They provide digital public infrastructure, digital public services and digital public goods, interact with citizens through digital channels, and ensure direction and oversight over digital development of the entire nations and sectors. To this end, government must be able to digitize their internal processes, digitize interactions between organizations [3], acquire digital capabilities, and transform themselves and their relationships with citizens into "digital government" [4].

1.2 From digital to automated government

The combined nature of government work and its transformation into digital government create many opportunities for automation. The potential varies across areas, from high potential in "administration", "information and data processing" or "complex and technical activities", to low in "reasoning and decision making" or "coordinating, developing, managing, and advising" [5]. When government

seeks to maximize the automation potential within digital government transformation, we call the result "automated government" [2]. Immersed within "digital government", "automated government" also brings more possibilities and risks to government than "digital government" alone. For instance, it allows digital public services to be delivered fully automatically and proactively, i.e. without citizens requesting them.

Automated government is also reinventing traditional government concepts. For example, street-level bureaucrats – government representatives that directly interact with citizens and make on-the-ground decisions concerning them [6] are reinvented as street-level algorithms – automated systems that interact with citizens and make decisions about them [7]. Both street-level bureaucrats and algorithms apply government policies to various decision situations in front of them. They translate "defined policies" into "effective policies", for instance when a policeman issues a speeding ticket to a driver, a teacher agrees to waive course prerequisites to a student, a doctor prescribes follow-up examinations, or a judge decides to keep a defendant in jail without bail. In such cases, the decisions have direct impact on people's lives but street-level bureaucrats and street-level algorithms approach them differently and with different outcomes.

1.3 Rules of government automation

Technology and organization constitute key aspects of automation. Both are dynamic – technological and organizational capabilities vary in time; created – they require conscious planning, development and maintenance; and interrelated – in the process of introducing technology and searching for the best organization-technology fit, both will change.

However, the presence of suitable technology and the potential for creating public value when automating part of government with such technology are insufficient for government automation to take place. As governments operate in a political and not economic marketplace, any strategy pursued by them must simultaneously: deliver public value; receive authorization and resources from the higher authority; and take place within the operating environment which is capable of implementing this strategy [8]. When implementing any strategy, public managers must assure that these elements align. For instance, when the authorizing environment is unwilling to support the public value proposition, the managers may try to convince them or upgrade the value proposition and renegotiate, if the operating environment is unable to implement the value proposition, the managers may want to upgrade the capabilities or downgrade the value proposition, etc.

Government automation, like other government strategies, has to follow such tactics/rules. But the fundamental nature of change required by automation also calls for automation-specific tactics/rules. Such rules were identified by the authors under the research project "Under what conditions does automation thrive (or flounder) in government?" funded by the Inter-American Development Bank. To answer this question, the project developed 12 case studies from eight countries – Argentina, Chile, France, Norway, Paraguay, Singapore, Spain and Sweden and from the European Union, and seven government sectors – administration, border control, finance, justice, procurement, registry and welfare. Using those case studies and the literature, the project identified the benefits and risks of government automation, and the factors that contribute to achieving the benefits and reducing the risks. The factors comprise institutional prerequisites, in-house capacity, process innovation and whole-of-government affairs. Intended as "rules of government automation", they serve as recommendations for government organizations involved in the automation initiatives.

2 WORKSHOP

The aim of the workshop is to validate and possibly refine the "rules of government automation" using evidence and insights contributed by the participants, and to plan a collective publication to advance the frontiers of this topic.

To fulfill this aim, the organizers will share with the workshop participants the background, instructions and templates to document original case studies in government automation before the workshop. The workshop will consist of three parts.

The first part will comprise the presentation, discussion and feedback on the "rules of government automation". The rationale and evidence in support of the rules will be presented as well. The discussion and feedback will cover the questions of soundness, consistency and applicability of the rules, individually and systemically.

The second part will include the presentations of the cases of government automation contributed by the participants, and the analysis whether the rules hold for them. The analysis will use inspection and guided reasoning, and apply conceptual instruments brought by the organizers. If the analysis establishes that some rules fail for a case, possible explanation will be formulated and a refinement proposed and discussed, considering the impact of such changes on all cases, and on the soundness, consistency and applicability of the entire framework.

The third part of the workshop will include a discussion and planning of the special issue of Government Information Quarterly to comprise articles that utilize the insights produced during the workshop to advance the theory and practice of government automation. Participants will be asked to declare their interest and propose thematic focus, followed by the discussion of the process, timeline and the integration of the entire special issue.

The organizers will solicit participation in the workshop considering the invitees' research record, proximity of interests to digital and automated government, diversity of backgrounds allowing different perspective on the main theme, diversity of experiences with the theme, the possibility of gaining access to case study data, and the interest and availability to prepare for the workshop, attend the workshop, and engage in the development of the special issue.

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A Framework for Integrated Public Services Co-Creation and Sustainability

Noella Edelmann
Universität für Weiterbildung Krems
noella.edelmann@donau-uni.ac.at

Efthimios Tambouris
University of Macedonia
tambouris@uom.edu.gr

A.Paula Rodriguez Müller
KU Leuven
anapaula.rodriguezmuller@kuleuven.be

Trui Steen
KU Leuven
trui.steen@kuleuven.be

Natalia Oprea
Deloitte
noprea@deloitte.it

CCS CONCEPTS

• **Social and professional topics** → Computing / technology policy.

KEYWORDS

co-creation, integrated public services, sustainability

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1 INTRODUCTION

The H2020 project "Inclusive Governance Models and ICT Tools for Integrated Public Service Co-Creation and Provision" (inGov) aims to provide innovative ICT-supported governance models as well as mobile apps including chatbots, which will enable stakeholders' collaboration in co-producing inclusive and accessible Integrated Public Services (IPS) thus increasing trust and satisfaction. The vision of the H2020 inGov project is to enable European public authorities to co-create user-friendly, integrated public services accessible via mobile devices to all, particularly the disadvantaged, resulting in increased adoption, efficiency, effectiveness, trust and satisfaction. The aim is to support Integrated Public Service (IPS) co-creation by exploiting co-creation methods, the adoption of mobile devices and the benefits of the benefits of eGovernment principles (once-only, digital-by-default, interoperable-by-default, user centricity, etc). The comprehensive IPS Framework will include (a) IPS governance(structure), (b) IPS agreements between stakeholders (e.g. interoperability agreements, service level agreements, outsourcing, bilateral agreements etc), (c) stakeholders' involvement, (d) implementation and migration guidelines, and (e) an agile roadmap. This framework will enable identifying and addressing all legal, cultural and managerial challenges. In addition, a sustainability plan is to safeguard the long-term use of the IPS framework and policy recommendations based on the project findings are to enhance existing EU work.

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2 WORKSHOP AIMS

This workshop has the following aims: to present the H2020 inGOV project; to discuss with participants the role of co-creation within the European Interoperability Framework, the Integrated Public Services (IPS) holistic framework and sustainable co-creation for policy development; to collect the participants' opinions and expertise.

3 WORKSHOP STRUCTURE

The 3-hour workshop will be structured as follows:

- Overview of the H2020 inGov project: project, topics, context of the packages (Efthimios Tambouris, UOM)
- The Role of Co-Creation within the EIF (review EIF, conceptual model) (A. Paula Rodriguez Müller, KUL)
- The IPS Framework (recommendations) (Natalia Oprea, Deloitte)
- Sustainable co-creation in the public sector and policy development (Noella Edelmann, UWK)

Part 1: H2020 inGov project (Efthimios Tambouris, University of Macedonia)

Focus: overview of the project's aims and the pilots conducted in Austria, Greece, Croatia and Malta.

Part 2: The Role of Co-Creation within the EIF (Ana Paula Rodriguez Müller and Trui Steen, KUL)

- Focus: Enhancing the IPS conceptual model proposed in EIF (European Interoperability Framework) to accommodate stakeholder's collaboration and co-creation of Integrated Public Services (IPS) Questions to be addressed:
- How can we move IPS provision forward by the involvement of public service users through co-creation rocesses in the design, creation, and implementation of IPS?
- How can the EIF interoperability principles be tailored to take into account IPS and co-creation?

Part 3: The IPS Framework (recommendations) (Natalia Oprea, Deloitte)

Focus: adopting a holistic perspective on the coordination mechanisms to support stakeholders' and service users' active engagement in the provision of Integrated Public Services

Questions to be addressed:

- How should governance be revisited, in terms of structures and procedures, to enable stakeholders' contribution, including their roles and responsibilities, during the key phases of IPS provision?
- What means should be adopted to leverage on stakeholders' expertise throughout the whole IPS life-cycle?
- What mechanisms can help govern the challenges related to political, legal, technical and organisational aspects?

Part 4: Sustainable co-creation in the public sector and policy development (Noella Edelmann, UWK)

Focus: ensuring the long-term sustainability of co-creation within the IPS conceptual model and the holistic framework

Questions to be addressed:

- What factors contribute to long & short-term sustainability in the public sector?
- How can we ensure that the co-created outcomes and capacity building are sustained beyond a specific project and can even have multiplier effects?
- What factors facilitate (or inhibit) sustained outcomes of co-creation initiatives?

4 SUMMARY

The discussions will be summarised by the workshop organizers and contribute to the continuous evaluation of the H2020 inGov project.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement 962563.

Project website: https://ingov-project.eu

New Forms of Delivering Public Goods through Inclusive, Interoperable and Integrated Public Services: Enablers, Benefits, and Barriers

Robert Krimmer
University of Tartu
Tartu, Estonia
robert.krimmer@ut.ee

Trui Steen
KU Leuven Public Governance Institute
Leuven, Belgium
trui.steen@kuleuven.be

Matteo Gerosa
FBK
Bolzano, Italy
gerosa@fbk.eu

Enrique Areizaga
Tecnalia Research and Innovation
Spain
enrique.areizaga@tecnalia.com

Jon Shamah
EEMA
Belgium
jon.shamah@eema.org

ABSTRACT

In this panel we will be discussing the advent of new forms of delivering digital public services which aim at integrating Europe and its digital single market (DSM). Representatives from five European research projects will discuss enablers, benefits and barriers to.

CCS CONCEPTS

• **Social and professional topics → Computing / technology policy**.

KEYWORDS

Single Digital Market, Integration

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1 INTRODUCTION

The 2009 'Malmö Declaration' and 2010 'Digital Agenda' were central elements to push digitisation in Europe, especially within the European Union. They established several core aspects for the setup of the Digital Single Market (DSM) in the EU, e.g. a plan to develop a digital single market, enhanced interoperability and standardisation as well as a new focus on creating trust and security. The '2017 Tallinn Declaration' and the '2016-2020 eGovernment Action Plan' fostered the ongoing development of the 'European Digital Single Market'. Bothe initiatives enlarged the scope of the DSM by adding the once-only principle (OOP) to the European digital landscape that was set by previous initiatives like '2011-2015 eGovernment Action Plan. It can be concluded that one of the main aspects of these initiatives was setting up a cross-border and interoperable environment in Europe.

The panel will present projects that offers solutions that support the goals that are described by the aforementioned plans and declarations. Furthermore, it will be shown how the open government approach may reinforce trust in public institutions, which is strongly associated with citizens' satisfaction from full deployment of inclusive digital government. The panel will also contribute to establishing a culture of co-creation and co-delivery, transparency, accountability and trustworthiness as well as of continuous consultation promoting overall digital accessibility.

Overall, the presented projects will showcase how the results contribute to the widespread recognition of the need for and benefits of an inclusive Digital Single Market.

2 THE PROJECTS

2.1 mGov4EU

mGov4EU pushes forward the practical use of inclusive mobile Government services in Europe, bringing such services in line with EU citizens' expectations for safe, resilient and sustainable mobile communication. Innovating electronic identity management, storage of data and the exchange of electronic documents are key elements. Starting from the foundation of Single Digital Gateway Regulation (SDGR), mGov4EU provides new ways of cross-border service provision correlated and interlinked with eIDAS Regulation on cross-border identification and authentication. mGov4EU leverages for the first time both together, SDGR and eIDAS for mobile-device usage.

2.2 INTERLINK

INTERLINK aims to overcome the barriers preventing administrations to reuse and share services with private partners (including citizens) by developing a novel collaborative governance model that merges the enthusiasm and flexibility of grassroot initiatives with the legitimacy and accountability granted by top-down e-government frameworks. To enable this, INTERLINK will provide a set of digital building blocks, called "Interlinkers", that implement

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the defined governance model and standardize the basic functionalities needed to enable private actors to co-operate in the delivery of a service (organization, communication, scheduling, monitoring, etc.). In this way, the new shared service will maintain the effectiveness of digital solutions adopted in grassroots initiatives to support self-organization and make collective decisions, and at the same time fulfill the technical and legal requirements necessary for adoption by Public Administrations (PAs). The solution will be customised, deployed and evaluated on three use-cases within the partner PAs: the Italian Ministry of Economy and Finance, the Latvian Ministry of Regional Development, and the City of Zaragoza.

2.3 ACROSS

The main goal of ACROSS is to provide a holistic solution that allows public administrations to deliver a user-centric interoperable cross-border mobility service compliant with the current European regulations where the private sector can also interconnect their services while ensuring the data sovereignty of the citizens. To this end one of the ACROSS objectives is to provide a set of connectors and data harmonization tools that will facilitate the actual interoperability of the cross-border mobility services through the connection of public services so that they can interoperate with services from other countries as well as with those of the private sector also to include their services and offerings.

2.4 GLASS

GLASS creates a new paradigm for the sharing and transfer of personal information, with the citizen in control. It will provide a distributed framework for sharing common services of public administrations across the EU for citizens, businesses and governments. It introduces novel governance services facilitating free movement to citizens and businesses, producing strong social, societal, economic, technological and scientific impact and leading to an advanced egovernment solution aligned fully with the EU eGovernment Action Plan 2016-2020 and the EU Digital Single Market strategy.

2.5 inGOV

The inGOV project aims to enhance existing relevant EU work on policies, models, frameworks, roadmaps etc (e.g. EIF, CPSV, EIRA) by adopting best research and practice (e.g. in public service co-creation) and by exploiting relevant technologies particularly mobile apps, virtual assistants (chatbots), knowledge graphs, and linked data. The vision of the inGov project is to provide innovative ICT-supported governance models as well as mobile apps including chatbots, which will enable stakeholders' collaboration in co-producing inclusive and accessible Integrated Public Services (IPS) thus increasing trust and satisfaction. For that purpose, multidisciplinary scientific methods will be used including design science, multiple case study and variants of the technology acceptance model. The project results will be piloted in Malta to modernise the digital family household public service, in Austria to deploy IPS for collecting tourism tax, in Greece to digitise the disabled card renewal service and in Croatia to create AI-driven virtual assistants and services.

3 PANEL ORGANIZATION AND PANELISTS

The panel will consist of five participants representing the five projects outlined above. First, the panel will be start with short presentations about the projects and the current landscape around the Digital Single Market in Europe. It will be followed by a discussion between the panelists. During the presentation, the moderator will facilitate and collect experiences and questions from the audience. In case the conference will be held in a hybrid format, enough time will be dedicated to the questions from online conference participants. Enough time will be given to derive lessons learnt from integrating the European Digital Single Market for other single market initiatives around the world.

The panelists are as follows:

Robert Krimmer is Full Professor at the Center for IT Impact Studies (CITIS) at University of Tartu. He serves as the scientific coordinator of the mGov4EU project. In the past he was the coordinator of the Once-Only Principle Project (TOOP), which laid the basis for the Once-Only Technical Systems described in the European Single Digital Gateway Regulation.

Trui Sten is Full Professor at the KU Leuven Public Governance Institute in Belgium.

Enrique Areizaga is a European project manager within Digital Transformation Unit at Tecnalia Research and Innovation. He is also the CEO of the start-up GPONDoctor, focused on Test solutions for Fiber to the home networks.

Matteo Gerosa is a PMP certified project manager and the head of the Project Management Group (PMG) in FBK. He received his PhD degree in Computer Science from the University of Trento, Italy, in 2006. He worked as a Research Assistant at the Speech Analysis and Interpretation Laboratory, University of Southern California and in the Human Language Technology group at FBK. In March 2010, he joined the eGovernment group at FBK as a project manager, and in 2013 he founded his own Project Management Group under the FBK-ICT Director. He is an expert on Digital Transformation, public services and AI for the public sector. He has been involved in more than 20 national and EU projects with the public sector since the sixth Framework Programme, leading several of them like H2020 Projects SUPERSEDE, SIMPATICO and SMALL. He is currently the Project Coordinator of H2020 projects 5G-CARMEN and INTERLINK.

Jon Shamah is the Managing Director of EEMA.

4 QUESTIONS

The panel will deal and discuss with the following (non-conclusive) set of questions:

- Can novel governance services be created to facilitate free movement to citizens and businesses, producing strong social, societal, economic, technological and scientific impact

- What can we learn from best practice cases and from piloting innovative ICT-supported models for enhancing policies, models and frameworks that help advance truly integrated public services?

- How can Public Authorities be engaged during the process of their Public Services digitalization with the aim of achieving a homogeneous transition throughout Europe? How can the organizations silo's problem be addressed?

- What actors are interesting to involve in order to promote the adoption, maintenance and support of the innovative solutions after the life of the project?

- How can the Digital Single Market be opened up in order to integrate also private services?

- What are enablers and barriers for engaging stakeholders in the co-creation of integrated public services?

- How can citizens easily be centric and in control of the consensual sharing and transfer of personal information between government, citizens and business?

- What kind of valorization/monetary mechanisms can we use to promote sustainable development and delivery of co-produced public services?

- How can we evaluate the quality of co-produced public services? How can we encourage wider adoption?

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Democratizing co-production of sustainable public services

D. López-De-Ipiña*
University of Deusto, Faculty of Engineering, Bilbao, SPAIN
dipina@deusto.es

T. Brandsen
Radboud University, The Netherlands
taco.brandsen@ru.nl

T. Steen
KU Leuven, Belgium
trui.steen@kuleuven.be

P. Misikangas
Cloud'N'Sci Ltd
pauli@cloudnsci.com

D. Sarasa
Fundación Zaragoza Ciudad del Conocimiento & PhD candidate at Polytechnic University of Madrid (UPM-ETSAM), SPAIN
dsarasa@gmail.com

A. P. Rodriguez Müller
KU Leuven, Belgium
anapaula.rodriguezmuller@kuleuven.be

N. Edelmann
Danube University Krems
noella.edelmann@donau-uni.ac.at

ABSTRACT

This panel would like to debate about some of the challenges behind the vision put forward by "TRACK 4: Human-centric innovation in smart cities", i.e. how to give place to novel public services truly addressing the needs and demands of citizens to facilitate their interactions with public administrations. Smart Governance is undoubtedly a key area of Smart Cities. Hence, this panel will explore how co-creation methodologies and supporting digital tools can be leveraged to give place to more widely adopted public services, driven by either bottom-up and top-down innovation initiatives. Firstly, this panel will describe some research progress achieved by projects belonging to H2020 topic "DT-GOVERNANCE-05-2020 – New forms of delivering public goods and inclusive public services", namely INTERLINK and inGOV. Secondly, it will open the debate to the public to get their views on important key topics and barriers that have usually impended co-production of public services, e.g., sustainable models for public services, continuous engagement of stakeholders or quality assurance of public services. Finally, reflections from the invited panel members and the public will be summarized and reflected on a post-event report.

KEYWORDS

Open Government, co-production, public services, stakeholder engagement

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*Corresponding author.

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1 INTRODUCTION

Projects within H2020 topic "*DT-GOVERNANCE-05-2020 – New forms of delivering public goods and inclusive public services*", such as INTERLINK or inGOV, aim to research new methodologies and supporting techniques to deliver more inclusive and highly adopted public services. The hypothesis of some of these projects, namely, INTERLINK and inGOV, is that co-production might be the driver to truly deliver more widely adopted and sustainable public services, which will survive even after the cease of funding from public administrations or research projects.

INTERLINK's project partners will coordinate this panel and will also count with fellow experts from inGOV project. The panel will tackle the following objectives:

- Clarify the concepts of co-production and co-creation, aiming at the co-design, co-delivery and co-assessment from citizens' point of view.
- Introduce novel co-production methodologies aiming to deliver inclusive and sustainable public services.
- Showcase inclusive web-based tools that support collaborative multi-stakeholder co-production of public services.
- Explore why continuous long-term engagement in co-production processes is so difficult, and analyze whether novel forms of valorization of co-production tasks may help in this regard.
- Reason about the remarkable distinguishing features for a co-produced public service to be regarded as high quality.
- Propose novel business models to sustain long-term delivery of co-produced public services.

Given those objectives, the panel will be structured in the following steps:

- INTERLINK will provide answers through ongoing research results addressing the above objectives. It will expose their results a maximum of 15'.

- inGOV will provide an alternative and complementary approach to again give answer to the same set of questions. It will expose their results a maximum of 15'.
- Audience will be asked several questions using a tool like sli.do, where they will have the opportunity to give their opinions about proposals from these two projects to the above objectives. The activity explanation will span for 5'.
- Panel attendees will provide further insights about the research challenges behind effective and sustainable co-production of widely adopted public services. Panel members will be challenged with different questions from the panel moderator and, more importantly, from the public. Dialogue among panel members and the public with the aid of the moderator will span for 20'.
- The event will be concluded analyzing the results of the questions regarding co-production models, tools and business models that will have been delivered to the public in step 3. The last 5' of the session will be used by the moderator to sum up the conclusions achieved by the session, as result of the debate and answers to the polls issued to the audience.

The result of this panel will be the open access publication of the conclusions of it, jointly contributed by INTERLINK and inGOV partners. A joint paper will be written with those conclusions.

2 INTERLINK APPROACH TO CO-PRODUCTION

This section offers a short summary of the innovations brought forward by the INTERLINK project, as an example of the topics that will be explored in the panel.

2.1 Co-production definition

The use of the terms 'co-creation' and 'co-production' is varied and there is no uniformly accepted standard, although some definitions are regularly used (e.g. [3] or [4]). Co-creation refers to a process in which services are jointly designed and/or delivered by public authorities and other stakeholders. The term 'co-production' is in practice often used interchangeably with co-creation but is generally seen as referring to the delivery stages of a service. The addition of the prefix 'co' to concepts implies that there must be active involvement of users of a service at one or several points in the process:

1. Co-design concerns of activities that incorporate "the experience of users and their communities" into the creation, planning, or arrangements of public services" ([2]).
2. Co-delivery is a joint effort by public authorities and stakeholders to provide and improve public services ([1,5]).
3. Co-assessment is the monitoring or evaluation of public services after their delivery in an effort to learn from it and to rethink and improve future services ([5, 6]).

2.2 Co-production in INTERLINK

According to INTERLINK view, co-production teams should listen to the ideas and requirements introduced by potential end-users and use tools to co-product a new service which satisfies the recognized needs. During this work co-production teams may specify new requirements for a new public service, e.g. express a need for a certain kind of missing enabler (termed as INTERLINKER in this project), which should be provided to address the new public service functionality.

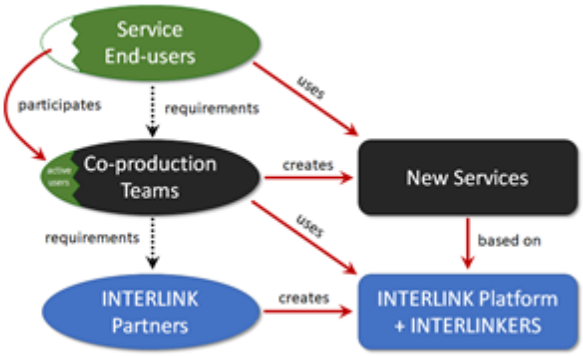


Figure 1: CO-PRODUCTION approach in INTERLINK

It is important to understand that only a small portion of the potential service end-users will participate in co-production - majority of them are just "silent" or "passive" end-users who will never give any feedback. However, the small group of "active/proactive users" which volunteer to help / contribute is the key to success and, hence, INTERLINK gives the best possible support to enable smooth cooperation with them.

Possible participants of the co-production team can be divided into four main groups (according to the Quadruple Helix approach for innovation) 1) public authorities, 2) citizens, 3) businesses and private non-profit organizations and 4) research organizations. They can be divided further into sub-groups that each have different motivational factors to join the work. It is very important to understand why these stakeholders would become interested in co-production.

2.3 Co-production methodology in INTERLINK

INTERLINK is creating a platform aiming at providing support - in terms of knowledge, facilitation tools and reusable components - to networks of stakeholders during the co-production of public services. For this reason, the identification of which knowledge and software resources (or INTERLINKERs) are most valuable to be offered within the INTERLINK platform needs to start from an analysis of the co-production process of public services and the related governance models to make sure that the design of the platform fits the actual needs and information flows.

The INTERLINK co-production model (see Figure 1), where end-users and co-producers take part to deliver new services, focuses on the two different phases of the co-production process (see Figure 2) that are further specified in sub-phases:

- **co-design phase**: co-design concerns activities that incorporate "the experience of users and their communities" into the creation, planning, or arrangements of public services" [2]. In this phase the co-production team is created and starts working together to define the service to be co-produced.

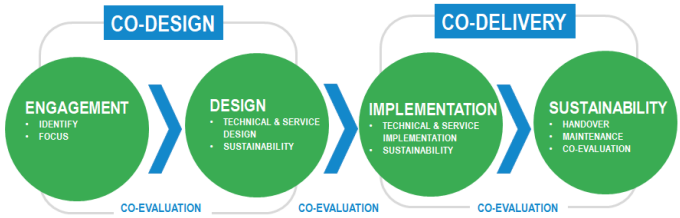


Figure 2: INTERLINK CO-PRODUCTION methodology

The co-design phase entails two main sub-phases: a) Engagement and b) Design.

- **co-delivery phase**: co-delivery is a joint effort by public authorities and stakeholders to provide and improve public services [1] where the service is implemented and delivered in a sustainable manner. The co-delivery phase entails two main sub-phases: a) Implementation and b) Sustainability.

Iterative phases of co-evaluation are also necessary to check and monitor whether the co-production team is ready to proceed to the next phase. At all times, technical feasibility and economic viability need to be explored to ensure final public services are sustainable.

3 PANEL PARTICIPANTS

The following people will take part in the panel, which coincides with the panel authors. The panel will be moderated by Prof. Diego López-de-Ipiña, University of Deusto, representing INTERLINK project. Governance model experts from INTERLINK and inGOV projects will take part, namely Prof. Trui Steen from KU Leuven, A. Paula Rodriguez Müller, from KU Leuven and Dr. Noella Edelmann, Danube University Krems, all three representing inGOV project and Prof. Taco Bradsen from Radboud University, representing INTERLINK project, respectively. Besides, we will get the views of two representatives of key stakeholder groups in any public service co-production initiative. Daniel Sarasa from Zaragoza City Knowledge Foundation will represent public administrations stake on co-production, whilst Pauli Misikangas from the Finish SME CNS, will represent the interest and needs of private sector organizations to take part in co-production and co-exploitation of public services. This panel will deal with the challenge of giving place to sustainable and integrated public services where public service providers work together to meet end-users' needs and to provide public services that end-users may access in a single seamless experience.

4 CONCLUSION

This panel aims to discuss and reflect about why co-production should help us progressing towards more inclusive and sustainable, more widely adopted, and integrated public services, as result of the collaboration of different types of stakeholders.

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