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The Future of Digital Payments: Trends and Disruptions

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The Future of Digital Payments: Trends and Disruptions

Abstract: The evolution of digital payments have transformed the global financial ecosystem by providing faster, more secure, and more accessible ways to transact. However, despite the widespread adoption of digital payment systems, gaps remain in understanding the drivers of their evolution, the challenges that hinder their potential, and the implications of emerging trends such as blockchain, AI, and IoT. The rapid pace of technological advancement and regulatory changes underscore the need for a comprehensive overview of digital payment systems. This thesis addresses these gaps by exploring the evolution of digital payment systems, their lifecycle, and the various tools that drive this transformation. Using a systematic literature review, it addresses research questions related to the digital payment types, key drivers, benefits, challenges, and future trajectories of digital payments. The study highlights the role of technological advancements such as blockchain, AI, and IoT and the impact of regulatory frameworks in shaping payment innovations. Emerging trends, including cryptocurrencies, central bank digital currencies (CBDCs), and mobile payments, underscore the shift toward decentralization and financial inclusion. Despite significant progress, barriers such as interoperability, cybersecurity, and regulatory complexity persist. This thesis offers an understanding of the current landscape and future directions of digital payments, providing valuable insights for stakeholders, including consumers, businesses, financial institutions, and policymakers.

Keywords: Digital Payments, Payment Systems, Payment Trends and Challenges, Future of Payments, FinTech

CERCS: P170 Computer science, numerical analysis, systems, control

Digimaksete tulevik: suundumused ja häired

Lühikokkuvõte: Digitaalsete maksete areng on muutnud ülemaailmsed finantsökosüsteemi, pakkudes tehingute tegemiseks kiiremaid, turvalisemaid ja juurdepääsetavamaid viise. Vaatamata digitaalsete maksesüsteemide laialdasele kasutuselevõtule on siiski lünki nende evolutsiooni põhjuste, nende potentsiaali takistavate väljakutsete ja esilekerkivate suundumuste, nagu plokiahel, AI ja asjade internet, mõistmisel. Tehnoloogilise arengu kiire tempo ja regulatiivsed muudatused rõhutavad vajadust tervikliku ülevaate järele digitaalsetest maksesüsteemidest. See lõputöö käsitleb neid lünki, uurides digitaalsete maksesüsteemide arengut, nende elutsüklit ja erinevaid tööriistu, mis seda ümberkujundamist juhivad. Kasutades süstemaatilist kirjanduse ülevaadet, käsitletakse selles uurimisküsimusi, mis on seotud digitaalsete maksete tüüpide, peamiste tegurite, eeliste, väljakutsete ja digitaalsete maksete tulevaste trajektooridega. Uuring tõstab esile selliste tehnoloogiliste edusammude rolli nagu plokiahel, tehisintellekt ja asjade internet ning regulatiivsete raamistike mõju makseuueenduste kujundamisel. Tekkivad suundumused, sealhulgas krüptovaluutad, keskpanga digitaalsed valuutad (CBDC) ja mobiilmaksed, rõhutavad nihet detsentraliseerimise ja finantskaasamise suunas. Vaatamata märkimis-

väärsetele edusammudele püsivad takistused, nagu koostalitlusvõime, küberjulgeolek ja regulatiivne keerukus. See lõputöö pakub terviklikku arusaama digitaalsete maksete praegusest maastikust ja tulevikusuundadest, pakkudes väärtuslikku teavet sidusrühmadele, sealhulgas tarbijatele, ettevõtetele, finantsasutustele ja poliitikakujundajatele.

Võtmesõnad:

Digimaksed, maksesüsteemid, maksetrendid ja väljakutsed, maksete tulevik, FinTech

CERCS: P170 Arvutiteadus, arvanalüüs, süsteemid, juhtimine

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1 Introduction

The evolution of payment systems has been a cornerstone in developing global commerce and financial systems. From barter to coins, paper money to electronic banking, and now to digital payments, the methods for settling transactions have changed over time by adapting to societal changes and technological advancements [1] [2]. Over the past decades, technological advancements have transformed the way financial transactions managed and the way people and organizations interact with money. Due to the global trend toward electronic commerce and increasing consumer preference for convenience and efficiency, digital payments have become a crucial part of this change [1] [2] [3]. This evolution has seen the transition from traditional cash-based methods to different digital payment methods, such as mobile payments, digital wallets, and online banking [3] [4].

Technological advancements like, blockchain, near-field communication (NFC), and AI, have also had a significant impact on the financial landscape. These advancements have not only enhanced the security and speed of transactions but also addressed challenges like fraud and privacy protection, which are essential for enhancing customer trust [4] [5]. Particularly, the COVID-19 pandemic boosted the adoption of digital payment solutions due to concerns over in-person interactions and the convenience of remote transactions that have changed consumer behavior globally [2].

NFC enables seamless contactless payments, making payments more convenient and efficient [6] [2]. On the other hand, blockchain transformed peer-to-peer and cross-border transactions by introducing decentralized solutions which increase transparency and reduce fraud risks [5] [7] [8]. Cryptocurrencies have expanded the boundaries of digital payments, by offering alternative payment mechanisms independent of traditional banking systems [7] [8]. Together, these technological innovations represent a shift from paper-based payment methods toward digital platforms, satisfying the demand for convenience and efficiency while addressing challenges like fraud prevention and global accessibility [5] [6] [4].

At present, there is a lack of a comprehensive overview of the current types of digital payments, the factors driving their evolution, and the challenges and opportunities associated with their adoption. While digital payments have gained significant traction globally, research on their future trajectories, stakeholder benefits, and obstacles remains fragmented. This thesis aims to address these gaps by exploring the key drivers behind the evolution of digital payments, their potential transformations, and their implications for consumers, businesses, financial institutions, and governments.

Given the increasing reliance on digital payment systems and their transformative potential, it is essential to systematically investigate the various types of digital payments currently in use, as well as their anticipated developments. Furthermore, it is crucial to examine the benefits digital payments offer to diverse stakeholders while identifying the barriers that hinder their widespread adoption. These insights are necessary to navigate

the evolving landscape of digital payments. So, the primary aim of this thesis is to build upon existing academic and gray literature and provide answers to the following research questions:

- **RQ1:** *What are the current types of digital payments?*
- **RQ2:** *What are the key drivers behind the evolution of digital payments?*
- **RQ3:** *How might digital payments evolve?*
- **RQ4:** *What is the value of digital payments for different stakeholders?*
- **RQ5:** *What are the challenges of adopting and integrating digital payment solutions?*

By addressing these questions, this thesis aims to contribute to the understanding of digital payment systems and offer insights for future innovations and implementations. To accomplish the research objectives, the outlined research questions are addressed using a Systematic Literature Review (SLR) methodology. This approach provides a structured and unbiased review of academic and gray literature, enabling an understanding of the trends, challenges, and technologies shaping the future of digital payments. The research contributes to the understanding of digital payment systems, including their current forms, drivers of evolution, and potential future trajectories. Another contribution of this study is a structured overview, which is developed based on findings and illustrates the SLR findings in a structured and accessible manner. Students, researchers, and industry professionals can use the overview to explore the digital payments landscape and identify key trends and constraints.

The structure of this thesis is as follows. Section 2 dives into the background of digital payments to understand the topic. Section 3 outlines the methodology adopted for this study. Section 4 presents the results, systematically addressing each research question. Section 5 discusses the findings found in the previous section. Section 6 offers conclusion and recommendations for future research and policy development. Finally, section 7 outlines the limitations of the study, highlighting areas where additional research is needed.

2 Background

In the following subsections, we will discuss the evolution of digital payments, the general lifecycle of payment, and different digital payment instruments.

2.1 Digital Payments Evolution

The evolution of digital payments has impacted how transactions are conducted globally. Beginning with the introduction of electronic fund transfers (EFT) by Western Union in 1871, the transition from cash to digital payments has gained momentum over time [9]. EFTs provided the foundation for digital payments by enabling the safe transfer of funds across distance [9]. Over the following decades, this foundational technology was improved and expanded with innovations like automated teller machines (ATMs) and point-of-sale (POS) systems, which became popular in the 1970s and 1980s, making cashless payments a part of daily life [9]. In the 1990s, PayPal was introduced, which made online payments easier by allowing transactions through email and digital wallets [9] [10]. In the early 2000s, mobile payment innovations, like Square, made it even easier for businesses and consumers to handle transactions, driving the growth of digital payments even further [9] [10]. The COVID-19 pandemic boosted the trend of using contactless and digital payment methods as people looked for safer ways to conduct transactions, leading to a massive increase in online and mobile payments [2]. The rapid development of digital technologies, such as NFC and mobile wallets like Apple Pay and Google Pay, played a crucial role in this shift [2] [10]. In recent years, the increased automation and digitalization of payment systems have been driven primarily by a desire to reduce risk and operational costs. In the past 20 years, reducing friction for end-users has also become an important driver, as seen with the rise of platforms like PayPal and Stripe, which prioritize convenience, speed, and ease of use for both businesses and consumers [9].

2.2 Payment Lifecycle

In the most straightforward example involving a traditional banking system, payments typically contain four participants [11]:

The payer: The one who makes the payment, whose bank account is charged for the transaction.

The payer's financial institution: It handles and processes the payment on behalf of the payer.

The payee: The one receives the payment, which is credited to their bank account.

The payee's financial institution: It manages the transaction for the payee and usually holds the payment amount in their account.

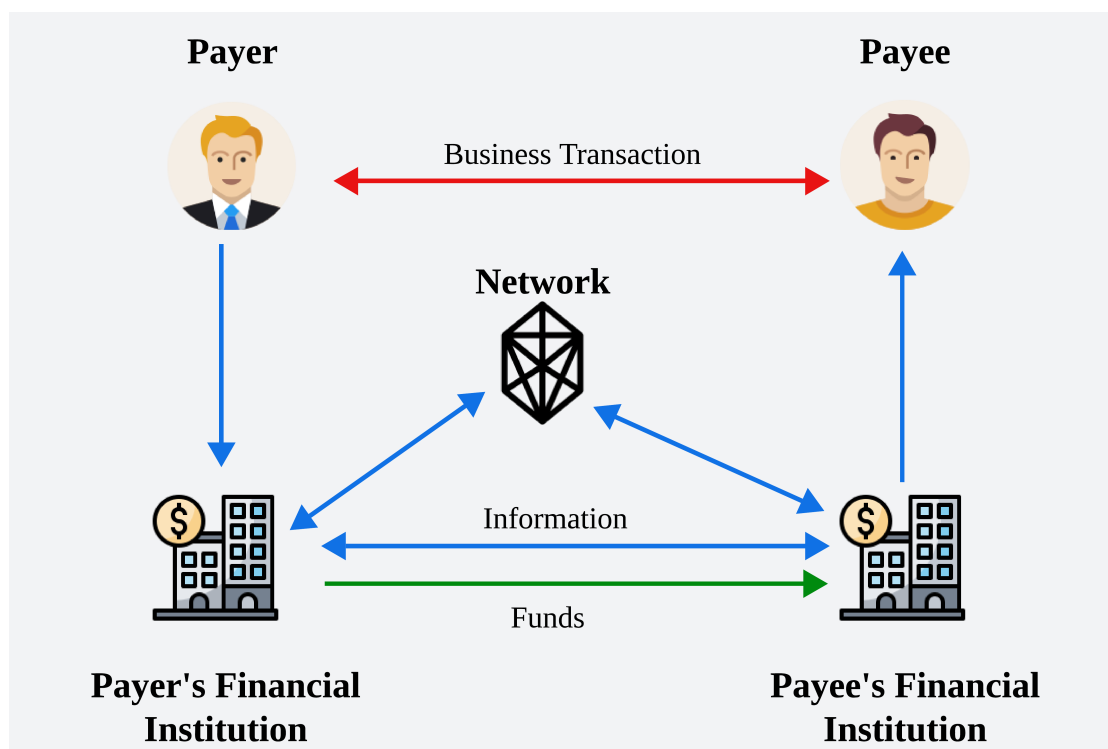


Figure 1. Four corners payment model

In the simple example illustrated in Figure 1, which is adapted from [12], the two banks might decide to exchange payment instructions and funds directly with each other. This direct payment method involves the payer's and the payee's banks handling the entire transaction themselves without the involvement of any intermediaries. Once the payer initiates a transaction, the bank sends the payment instructions directly to the payee's bank, which then processes the funds transfer. However, they can also use different intermediaries to assist in processing the transaction. These intermediaries are called the "network" in the diagram [13]. Payment networks refer to the system of institutions, rules, and technologies that facilitate the transfer of funds between consumers, merchants, and banks. It provides the infrastructure for enabling financial transactions, ensuring that funds move securely and efficiently between involved parties [14] [15]. Payment networks play a crucial role in processing card transactions, verifying the availability of funds, and authorizing payments between the cardholder's bank and the merchant's bank [16] [17]. When a consumer makes a purchase at a store or online, the payment network is activated. The transaction details are sent to the payment processor, who passes it to the relevant payment network, such as Visa or Mastercard. The payment network then communicates with the cardholder's issuing bank to verify the availability of funds and approves or declines the transaction based on the bank's response. Once the transaction

is approved, the payment network facilitates the transfer of funds from the cardholder's bank to the merchant's acquiring bank, completing the payment cycle [15] [16]. There are numerous well-known and globally accepted payment networks such as Visa and Mastercard, American Express, and Discover [14] [15].

Payment lifecycle refers to the different stages a financial transaction goes through after it is initiated to the point at which it is settled. This process can involve different parties with their own role to increase the transaction's accuracy and security [18]. In the following paragraphs, we will describe each stage payment goes through.

Payment Initiation: The process begins when the payer selects a payment method and submits the payment instructions to their bank which can be done through several instruments such as card-based, mobile wallets, or bank transfers [19]. [11] [18] [20]. For mobile wallets, the transaction starts when the payer selects a payment method from their mobile app, while for bank transfers, it begins when the payer authorizes a transfer from their bank account to the payee's account [19]. Payment initiation triggers the rest of the payment process, which includes authorization, clearing, and settlement [20].

Authorization: In this stage, the payment processor verifies if the payment can be processed. This involves confirming the payer's details and checking that sufficient funds are available [19] [11]. In card-based transactions, the acquiring bank sends the transaction request to the card network (e.g., Visa, Mastercard), which forwards it to the issuing bank for validation [19]. In mobile payments, the mobile payment service provider or bank validates the credentials provided [18]. Before approving or declining a transaction, the issuing bank verifies the cardholder's balance and ensures it passes security and anti-fraud checks [19] [20].

Clearing: Financial institutions exchange transaction data in the clearing process to settle their positions. It ensures that the payer's bank and the payee's bank communicate the necessary financial details once the transaction is authorized [18] [19]. In card payments, card networks handle the clearing process to ensure that the transaction data is passed to the acquiring bank [19]. For mobile payments and bank transfers, clearing involves service providers ensuring the amounts to be debited and credited are reconciled [18]. By confirming the transaction details between involved parties, this step prepares the stage for the final settlement [20].

Settlement: Settlement is the final stage where the actual transfer of funds from the payer's account to the payee's account takes place [19] [11]. In card payments, the issuing bank transfers the authorized funds to the acquiring bank, which then deposits them into the merchant's account [19]. For mobile and interbank payments, settlement happens when the bank or payment service provider credits the recipient's account [18]. Some payment systems, such as Real-Time Gross Settlement (RTGS) systems, ensure immediate and final settlement, reducing risks associated with delayed payments [20].

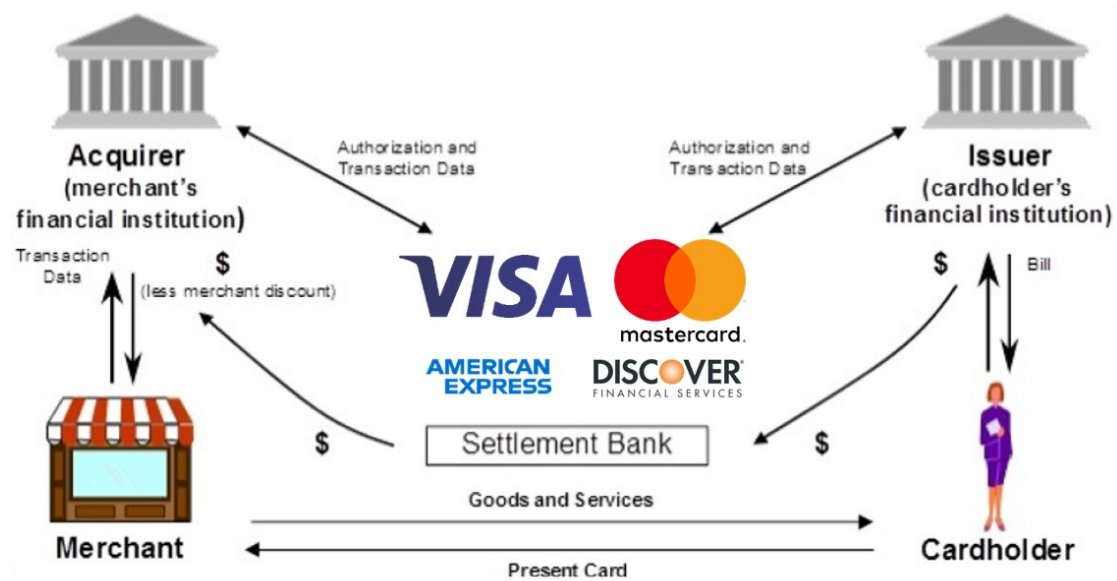


Figure 2. Card-based payment process

2.3 Payment Instruments

Payment instruments have a crucial role in the finance industry as they enable transactions. These systems are rapidly developing, especially with the advancement of digital technologies. In this subsection, we are going to dive into several digital payment methods, such as card-based payments, mobile payments, cryptocurrency payments, and interbank payments.

2.3.1 Card-based payments

Card-based payments are a popular and widely accepted method of cashless transactions, particularly in regions such as the European Union, where they are commonly used for daily consumer transactions [13]. They involve the use of debit, credit, or prepaid cards to make payments for goods and services. In this system, payments are made at a physical or virtual Point of Sale (POS), and transaction data are securely transferred between the merchant's bank (acquirer) and the consumer's bank (issuer) via card payment networks Visa or MasterCard [21] [22]. This ecosystem is supported by various stakeholders, including payment gateways and processors, who ensure that these transactions are handled smoothly [13] [21] [22]. As illustrated in Figure 2 the card-based payment process contains several key stages. It starts when the cardholder initiates a transaction by providing card details at a POS or online [13] [21]. The merchant sends this data to an

acquiring bank, which forwards it through a payment network like Visa or MasterCard for authorization by the issuing bank [21] [22]. The issuing bank checks the validity of the card and the availability of funds, then approves or denies the transaction, sending the response back through the network [13] [22]. After authorization, there is a clearing stage, where the transaction details are forwarded to the acquiring bank, and finally, the settlement takes place, where funds are transferred to the merchant's account, minus transaction fees [13] [23]. The main use case of card-based payments is in retail, where consumers use credit or debit cards to buy goods and services both in physical stores and online. With the growth of e-commerce, card-based payments have become essential in facilitating online transactions, particularly as consumers seek secure and efficient payment methods. Additionally, innovations such as NFC and mobile-based cardless payments have made card-based payments more convenient and faster for consumers [22].

Card-based payments have several advantages, such as fast transactions, less reliance on cash, and improved security measures including tokenization and encryption of sensitive data throughout the transaction process. This minimizes the danger of fraud by protecting user data at various stages. In addition, consumers benefit from rewards programs linked to their cards, giving rewards for frequent use. Card payments simplify merchant operations by providing detailed transaction information and analytics, leading to improved financial management and planning. [21] [23]

However, one of the main drawbacks of card-based payments is the cost involved in processing these payments, particularly for merchants. Interchange fees are charged by the issuing banks and paid by the acquirer. These fees charged depend on some factors such as the network being used, the card type, the industry, the size of the merchant, the region, etc. While the security of card transactions has improved with advancements like the Payment Card Industry Data Security Standard (PCI DSS), data breaches remain a concern, as demonstrated by high-profile incidents like the Heartland Payment Systems¹ breach, where millions of card details were compromised. In addition, the reliance on personal data in card-based payments raises privacy concerns, especially regarding the traceability of consumer purchases [21] [23].

2.3.2 Mobile Payments

Mobile payments allow consumers to complete transactions using their mobile devices. Mobile banking apps, contactless payments, and digital wallets such as Apple Pay and Google Pay are all examples of mobile payments [11]. Digital wallets are platforms that securely store the information needed to verify your identity and authorize transactions for purchasing goods and services. Essentially, they link your bank account, credit, or

¹<https://www.darkreading.com/attacks-breaches/heartland-payment-systems-hit-by-data-security-breach>

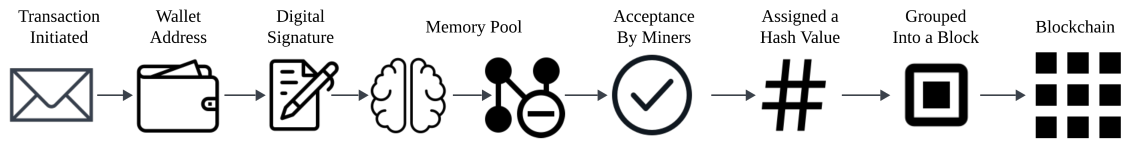


Figure 3. Cryptocurrency payment process

debit card to make payments easier and more convenient [24]. Contactless payments with smartphones enable to make purchases by tapping or waving the phone over a payment terminal [24] [25]. These transactions use different technologies like NFC, which allows devices to exchange payment information wirelessly over short distances. For example, services like Apple Pay use NFC to send payment data from an iPhone to a PoS terminal, while Android phones use host card emulation technology which creates virtual versions of cards [24] [25]. The lifecycle of mobile payments starts when consumer initiating a transaction with a mobile device to transfer funds or purchase goods, either remotely or locally [26] [25]. Transactions are processed using technologies such as SMS, NFC, or Bluetooth, and can be classified as macro or micropayments based on their value [26] [27]. Payment providers verify the credentials, authorize the transaction, and funds are transferred, completing the process [11] [27]. Security measures, including encryption and authentication, ensure the safety of the transaction [26] [27]. It makes it super easy for users to make purchases or transfer funds from any location with network availability. They can make transactions quickly without physical cards or cash, and sensitive data is protected by safe encryption technology. For businesses, mobile payments reduce transaction costs and simplify record-keeping which improves efficiency in operations [11] [28].

However, mobile payments rely significantly on device security, so users must keep their phones password-protected and use secure connections. They may encounter issues like fraud, unauthorized transactions, or data breaches, which can reduce trust in the system. Additionally, the need for reliable internet access and advanced smartphones can limit the accessibility of mobile payments, especially in rural or underdeveloped regions [11].

2.3.3 Cryptocurrency Payments

Cryptocurrency payment systems are a significant innovation in digital transactions, as they use blockchain technology to provide decentralized and secure payment mechanisms [29] [30]. Despite traditional payments relying on intermediaries such as banks, cryptocurrency transactions are conducted directly between peers using distributed ledger technology, removing the need for centralized control [29]. Bitcoin, released in 2009, was the first cryptocurrency to demonstrate the peer-to-peer transaction model, opening the path for other cryptocurrencies such as Ethereum and Ripple [29] [30] [31]. In cryptocurrency payments, as Figure 3 that adapted from [12] displays, the payment

process starts as usual when the payer initiates a transaction by entering the payee's wallet address and the desired amount, typically including a transaction fee [32] [33]. After that, the payer signs the transaction using their private key to ensure its security and prevent fraud. This is done before being broadcasted to the network's memory pool, where it awaits confirmation [32] [33]. Then miners accept this transaction, group it into a block, and solve a complex cryptographic puzzle to find a proof of work and assign that block a hash value to map it into the blockchain. As the transaction is confirmed, it's accepted as a valid transaction within the network, and the payee receives the funds in their wallet [33].

Industries such as gaming, luxury products, and tourism increasingly use cryptocurrency as a payment method. Major corporations, such as Starbucks, Microsoft, and Gucci, have joined to crypto revolution by offering customers to purchase goods by using crypto wallets [29] [34].

Cryptocurrency payments have several benefits over traditional payment such as lower transaction fees, enhanced security, and faster processing times. As transactions are processed on a decentralized blockchain it eliminates the need for intermediaries which results in reducing costs for both consumers and businesses. For example, merchants accepting crypto often pay lower transaction fees, typically around 1%, compared to 1.5-3% for traditional credit card payments [29]. Blockchain's transparency also helps prevent fraud because every transaction is recorded in an immutable ledger that all network participants can verify [34] [30] [35].

Cryptocurrency payments face some significant challenges, and the primary issue is the volatility of major cryptocurrencies like Bitcoin and Ethereum, which can experience drastic price fluctuations, making them less reliable as a store of value for everyday transactions [30] [34]. Stablecoins aim to solve this by pegging their value to fiat currencies, however, concerns about the stability of their underlying assets remain [29]. Another significant barrier is regulatory uncertainty, as many nations still lack clear procedures for regulating and taxing cryptocurrencies. This uncertainty makes it risky for both businesses and consumers to adopt cryptocurrencies at scale [29] [34]. Additionally, there is a technical challenge, especially for smaller businesses that may lack the resources to integrate cryptocurrency payment systems without the help of third-party providers [29] [34].

2.3.4 Internet Banking Payments

Internet banking payments allow customers to do financial transactions via a bank's online platform, providing services such as fund transfers, bill payments, and account inquiries with speed and convenience [36] [37]. To take these actions, consumers usually have to log into a mobile app or web interface, enter transaction details, and confirm with secure protocols like Secure Socket Layer (SSL) encryption to protect sensitive information [37]. Reduced transaction times, 24/7 access, and cost savings

for both banks and clients are the main benefits of online banking [37]. However, it also comes with some drawbacks, including security risks, such as fraud and identity theft, and technological challenges like downtime or poor user interface design, which can negatively impact the user experience [36] [37]. Additionally, there is often a slow adoption rate in some regions because of concerns about the complexity of transactions or lack of trust in digital systems [38].

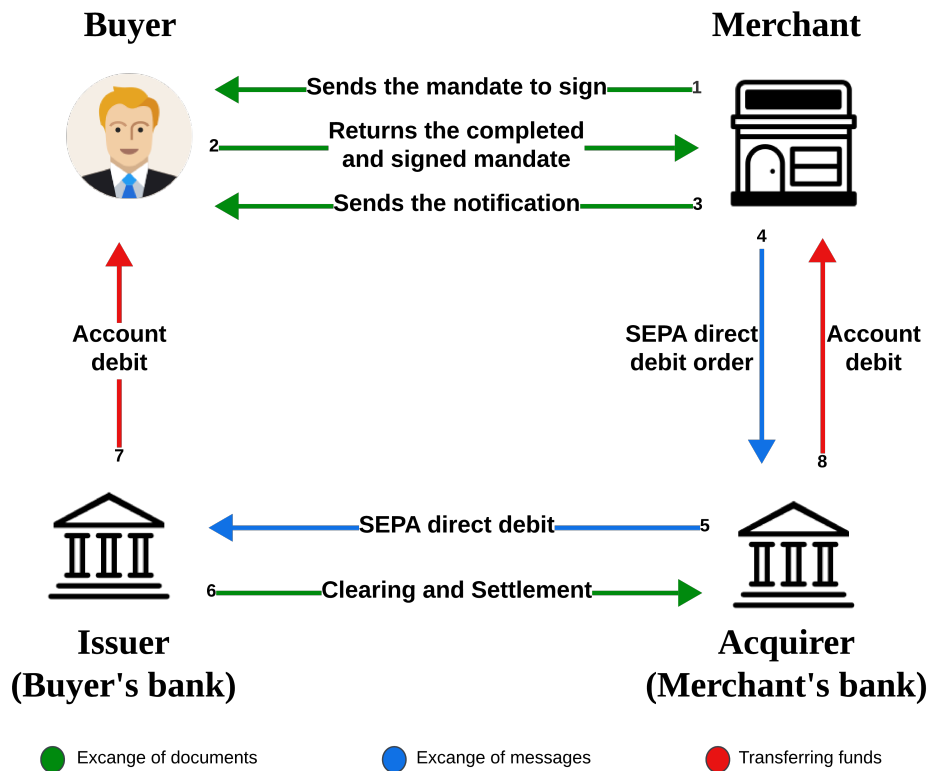


Figure 4. General exchange process for a SEPA Direct Debit

2.3.5 Direct Debit

Direct debit enables businesses and individuals to automatically transfer funds from the payer's account to the payee's account on a regular basis. This is especially useful for regular payments like utility bills and loan payments [39] [11]. Before the account is debited, the payee or the payer's bank is required to provide advance notice to the payer [40] [11]. When the direct debit request is processed and if there are not enough funds in the payer's account, then the bank usually is not required to complete the payment, instead, it will return the unpaid direct debit to the payee [39] [11]. The general exchange process for SEPA direct debit is illustrated in Figure 4 motivated from [41].

One significant benefit of direct debit is that customers do not have to remember payment due dates, and businesses are guaranteed timely payments [39] [11]. Businesses have the flexibility to adjust the amount and payment dates [39] [11] [40].

2.3.6 Credit Transfers

Credit transfers, also known as "direct credits", are the funds transferred from a payer's account to a payee's account, typically with electronic means. They are commonly used for both domestic and international transactions [11] [42] [19]. Credit transfers are highly secure and efficient for large-value payments, as funds can be transferred from one bank's account to another [42] [43]. Another benefit of credit transfers is that they can be used to make one-time payments such as rent or purchasing goods from a merchant [42]. However, processing times can vary, particularly for international transactions, which may lead to additional fees and delays [43]. Credit transfers are generally accepted as a reliable payment method for large, non-urgent payments. [19] [11]

2.4 SWIFT

SWIFT (Society for Worldwide Interbank Financial Telecommunication) is a global messaging network that allows financial institutions to securely exchange financial information like fund transfer instructions [44] [45]. SWIFT was founded in 1973 and it connects approximately 11,000 banks and financial organizations throughout the world by offering a standardized system for exchanging messages such as payment instructions, securities transactions, and currency exchanges [44] [45].

Each institution using SWIFT is assigned a unique SWIFT code, also known as a Bank Identifier Code (BIC), SWIFT ID, or ISO 9362 which helps to accurately route transactions across borders [44] [45]. SWIFT is only a messaging system so it does not directly transfer funds but rather enables the secure exchange of messages that authorize and initiate payments [44] [45].

One of the main use cases for SWIFT is international wire transfers, which allow a payer in one country can send money to a payee who is in another country, even if the banks are on separate networks [44] [45].

SWIFT's benefits include security, speed, and widespread adoption, making it the leading platform for international financial communications. However, it has some drawbacks such as processing time that sometimes can take two to three days due to various security checks and verifications [44] [45].

Overall, SWIFT is a popular and relatively quick way to send money internationally. By evaluating factors such as ease of use, security, and transaction fees, companies can develop strategies for incorporating SWIFT into their daily business operations [44] [45].

2.5 Technologies

Technological advancements have shaped the landscape of digital payments. This subsection discusses the most commonly used technologies driving the evolution of digital payment systems.

NFC is one of the most well-known technologies that is used in card-based payments and mobile wallets such as Apple Pay and Google Pay [22] [21] [46]. It enables users to purchase by tapping their card or smartphones at a POS terminal [21] [24]. Magnetic Secure Transmission (MST) technology is another technology used in mobile wallets that emits a magnetic signal to connect mobile wallets to regular card readers [46].

Embedded chips and POS systems work together to enhance security by generating unique cryptograms for each transaction [22]. In this ecosystem, payment gateways and processors play a crucial role in ensuring smooth transactions. Payment gateway providers like PayPal, Square, and Stripe are widely used to facilitate these processes. The payment gateway encrypts transaction data and sends it to the payment processor, which then forwards the data to the issuing bank for authorization [23] [47].

Mobile payment services such as Google Pay and Apple Pay use biometric authentication like fingerprint or facial recognition and tokenization to secure transactions [24] [26]. In regions where NFC technology is less developed, alternatives such as QR code-based and SMS-based payments are commonly used.

Blockchain, which serves as a foundation for cryptocurrency payments, is another significant technology in digital payments. It records all transactions in a distributed ledger, simplifying decentralized transactions while ensuring transparency and security [29][32][33]. To improve security, cryptocurrencies use consensus techniques such as Proof of Work (PoW) and Proof of Stake (PoS) to protect the network and validate transactions [33].

3 Methodology

This section outlines the methodology used to investigate the future of digital payments, as well as the trends, challenges, and technologies influencing these developments. A systematic literature review (SLR) is selected as the primary research method to achieve these objectives. The SLR offers a systematic way to comprehensively review the existing literature by providing a balanced approach, capturing general trends and the deeper details essential to this research.

3.1 SLR

In [48] Kitchenham identifies planning, conducting and reporting the review as three primary stages of review. The first stage includes describing the motivation for the review, defining research questions, and developing the review protocol. Identifying relevant papers, making a primary selection of studies, and assessing their quality, by extracting and analyzing the important data are all parts of the second phase. The last phase consists of reporting the findings in a structured way. Kitchenham claims that SLRs are different from regular reviews as they follow a predefined methodology and they use a transparent search strategy to minimize bias. SLRs require using of inclusion and exclusion criteria and detailed quality assessment to ensure the reliability and relevance of the selected data [48].

3.1.1 Motivation

The SLR method was selected to provide a structured approach to analyzing the state of digital payments. The SLR enables a focused review of both academic also known as peer-reviewed and gray literature such as government documents, and publishings from banks, audit companies, and other financial institutions. To understand the current landscape and emerging trends in digital payments, SLR was chosen as the main research method. The SLR is well-suited to this goal since it enables a structured and unbiased review of peer-reviewed academic studies and gray literature, including reports and papers from banks, financial institutions, and government organizations. By analyzing these sources systematically, the SLR helps to understand the major trends and developments in digital payments.

3.1.2 Research Questions

With the help of the analysis of the existing literature on digital payment systems and related technologies, the following research questions have been formulated.

RQ1: *What are the current types of digital payments?* This research question aims to classify and explore the different forms of digital payments that are currently in use, as well as those anticipated to emerge soon. As many studies have divided digital payments into different categories, this question seeks to provide an up-to-date summary of the key types, like card-based payments, digital wallets, crypto payments, and mobile payments.

RQ2: *What are the key drivers behind the evolution of digital payments?* The primary goal of this research question is to identify and analyze the forces that are pushing the evolution of digital payment systems. Key drivers such as efficiency, convenience, cost reduction, and security have been frequently highlighted in the literature. In this study, the focus will be on understanding the broader factors influencing the adoption and innovation of digital payment solutions in various industries.

RQ3: *How might digital payments evolve?* This question aims to provide an outlook on the future of digital payments, emphasizing trends such as the rise of central bank digital currencies, blockchain integration, AI-driven personalization, and IoT-based payment solutions. It will also explore potential shifts in consumer behavior and regulatory adaptations.

RQ4: *What is the value of digital payments for different stakeholders?* This question seeks to explore the advantages that digital payment systems provide to different stakeholders, such as consumers, companies, financial institutions, and governments. When it comes to consumers, the research will evaluate conveniences, security, and accessibility as benefits. For businesses, the study will investigate cost savings, enhanced customer engagement, and improved transaction efficiency. Additionally, it will analyze how financial institutions utilize digital payments for profitability and innovation and how governments view digital payments concerning financial inclusion, taxation, and monetary policy.

RQ5: *What are the challenges of adopting and integrating digital payment solutions?* The focus of this question will be on identifying the challenges and obstacles preventing the fast global adoption and integration of digital payments. These barriers may include technological, regularity, infrastructural, or social. The research question aims to examine issues such as security vulnerabilities, lack of trust, regulatory hurdles, cost of implementation, and other issues, all of which may limit the spread of digital payments across different regions or sectors.

3.2 Data collection

A detailed search strategy was applied to provide a proper review. This strategy involved defining keywords and search strings, selecting publications databases, and applying inclusion and exclusion criteria in order to filter relevant studies.

3.2.1 Keywords and search strings

Based on the scope of digital payments and the research questions, the following keywords were selected: "digital payments", "trends", "technologies", "disruptions", "challenges" and "future".

With the help of boolean operators, the following search string for this research was selected, which combined the above keywords to provide a focused review of relevant literature:

"Digital Payments" AND ("Trends" OR "Disruptions" OR "Challenges" OR "Technology" OR "Future")

To query the gray literature, the same search string was used, but in order to filter out irrelevant sources, an additional phrase, "filetype: pdf," was appended to the search query to keep only PDF materials.

3.2.2 Databases used

For this research, the data was collected from two source types: academic and gray literature. Google Scholar database is used to collect academic literature. Google Scholar offers an extensive set of papers that is sufficient for the needs of this research. On the other hand, for gray literature, searches are conducted using advanced Google² search settings. In this research, the gray literature includes sources like government reports, industry white papers, and publications from financial institutions and audit firms. While the majority of the literature was sourced through Google Scholar and general Google searches, the snowballing method was also employed. This approach involved identifying new sources by examining the references cited in relevant papers [49]. Table 1 shows the number of papers from each source.

In this study, two artificial intelligence tools were used to enhance some aspects of the work. Grammarly [50] was used to correct grammatical and punctuation mistakes within the text. ChatGPT [51] was also used as an AI tool for brainstorming ideas and generating alternative phrasings. Thus, no AI-generated text was directly used, these tools served only to enhance the writing quality rather than the source of data.

²<https://google.com>

| Source | Number of papers |
|-----------------|------------------|
| Google Scholar | 154 |
| Gray Literature | 138 |

Table 1. Number of papers

3.3 Study Selection and Quality Assessment

To improve the search results and focus on the most relevant studies, several exclusion and inclusion criteria were used. The main objective of applying these criteria is to narrow down the number of papers by excluding irrelevant papers, which ensures that only studies directly related to the research questions on digital payments were considered.

Since the field of digital payments is rapidly evolving and the main goal of this research is to investigate the future of digital payments, papers before 2020 were excluded as they may lack relevance to address current trends and technological developments. Afterward, the papers that were not in English were filtered out. The main reason for this exclusion is to ensure understandability, as only English-language papers were selected to allow for accurate analysis and interpretation. The next exclusion is studies that were not accessible, including papers that were not commonly available through university subscriptions, not available on authors' web pages, and papers requesting payment were removed from the result set. The last step contains extracting duplicates from findings. Taking these factors into account, the following exclusion criteria were applied to filter out the papers:

- **EC1:** *Papers published before 2020.*
- **EC2:** *Papers are not in English.*
- **EC3:** *Papers are inaccessible.*
- **EC4:** *Duplicate papers.*

In addition to these exclusion criteria, two inclusion criteria were also applied to ensure the relevance of the result set. The first criteria is that the main focus of the paper must be on digital payments, addressing this topic in sufficient detail to provide meaningful insights. Sources that only mention general statements without elaboration on use cases or examples will not meet this criteria. The next criteria requires that the papers should discuss at least one of the research questions of this research. Thus, the inclusion criteria applied are:

- **IC1:** *Papers in which digital payments are the main topic.*
- **IC2:** *Papers directly related to at least one of the research questions.*

The paper focuses on new or emerging digital payment solutions (i.e., not concerning digital payment solutions that are widely implemented and adopted today)

The paper discusses technologies underpinning or aspects concerning business perspectives, values, or adoption of new or emerging digital payment solutions.

After applying all inclusion and exclusion criteria, the obtained papers will be the final result set that we reviewed throughout the literature review process. Table 2 demonstrates the initial number of papers and how that number changed as each inclusion and exclusion criterion was applied.

| Stage | Remaining Papers |
|---------------|-------------------------|
| Initial stage | 292 |
| EC1 | 155 |
| EC2 | 143 |
| EC3 | 127 |
| EC4 | 112 |
| IC1 | 98 |
| IC2 | 93 |
| Total | 93 |

Table 2. Final number of papers after each stage applied

3.4 Data extraction

Following the practical and quality screening process, a final selection of 93 articles was confirmed for the review. After reading all the findings, the data extraction process began. An Excel-based data extraction form, designed during the protocol, was utilized to ensure precise information recording. To answer the research questions, the extraction process involved identifying and documenting the types of digital payments (RQ1), the key drivers behind their evolution(RQ2), and the possible future trends (RQ3). Additionally, the benefits of digital payments to different stakeholders (RQ4) and the limitations to widespread adoption (RQ5) were also gathered. This structured approach ensured a thorough analysis aligned with the research questions.

4 Results

This section presents the SLR findings, which are structured around the primary research questions. The section will be divided into multiple subsections, each addressing one of the research questions by containing insights from the literature. The first part will be classifying the various digital payment types currently in use and those expected to emerge (RQ1). This is followed by an examination of the key factors influencing the development of digital payments (RQ2). The following sections discuss the observed future trends of digital payments (RQ3) and stakeholder values (RQ4). Finally, the last part focuses on barriers to the widespread adoption of digital payments (RQ5).

4.1 Digital Payment Methods

Digital payment types have improved financial transactions by making them faster, more secure, and accessible from diverse platforms [52]. They address consumer needs related to convenience, speed, and security and contribute to economic development by embracing financial innovation. The following subsections explore the most discussed types of digital payments that are indicated in the literature review, including digital wallets, mobile payments, online banking, cryptocurrency payments, and card payments. The following subsections are ordered based on the data found for each category, from most to least.

4.1.1 Digital Wallets

Digital wallets are a convenient way consumers can carry out payment transactions and no longer require using physical cards [53] [54]. [55]. The e-wallet app can be connected to BANK accounts or credit cards, making small transactions convenient, whether online or physically. Users of e-wallets also have extra features such as loyalty points, splitting bills with friends, and even one-tap payments [56]. In [6], authors state that technological advancements and a shift towards cashless transactions have increased the adoption of digital wallets, especially during the COVID-19 pandemic, which accelerated digital payment adoption globally.

Authors mention in [54] that digital wallets have three key types such as closed, semi-closed, and open wallets. Closed wallets are offered by particular companies that enable users to make transactions only within the issuing company's ecosystem. Flipkart, Jabong, and Make My Trip are some of those companies that offer closed wallets [54]. On the other hand, semi-closed wallets facilitate payments at multiple merchants contracted with the wallet provider [54]. Open wallets can be issued only by banks with the support of both merchant transactions and cash withdrawals at ATMs [54].

Philip Benton et al. [57] discusses the European Payment Initiative (EPI), which seeks to develop a unified, pan-European digital payment solution in order to reduce dependency on non-European payment providers like Visa and Mastercard. The primary plan was called for card payments, but after 20 banks out of 33 withdrew from the initiative, it shifted its focus toward a digital wallet and instant account-to-account (A2A) payments [57]. [58] states that by using a digital wallet, the EPI digital wallet, known as Wero, seeks to enable European consumers and retailers to make next-generation payments for every possible scenario in retail transactions. Wero was recently introduced in France, Belgium, and Germany, enabling instant peer-to-peer (P2P) payments in under 10 seconds using phone numbers or email addresses [59] [60] [58]. Aligning with the broader goals of SEPA, Wero improves European financial sovereignty by replacing national systems like Paylib [58].

4.1.2 Cryptocurrency Payments

Cryptocurrencies are digital assets that function on decentralized blockchain networks, providing a secure and anonymous way to make transactions without traditional financial intermediaries [61]. Cryptocurrencies such as Bitcoin and Ethereum use cryptographic techniques to ensure privacy and security, which appeal to users seeking a high degree of confidentiality. However, they remain a highly volatile form of money, primarily due to market speculation and limited regulation. Despite the risks, cryptocurrencies are being eagerly embraced, particularly for cross-border transactions where they reduce costs and processing times compared to conventional methods [62] [63]. Their decentralized nature is especially advantageous when traditional financial systems are inefficient or inaccessible [56].

Authors in [64] and [65] discuss Central Bank Digital Currency (CBDC) which is a digital form of money issued by the central bank. It serves as legal tender and maintains the same credibility as traditional fiat currencies, with digital tokens or accounts accessible to individuals and businesses for retail or wholesale purposes [64] [65]. Unlike cryptocurrencies such as Bitcoin, which are decentralized and rely on blockchain technology, CBDCs are centrally controlled and inherently tied to state monetary policies [65] [66]. Cryptocurrencies often lack the stability and legal status of CBDCs. However, their popularity and technological innovations have significantly influenced the development of CBDCs, as central banks aim to integrate the benefits of digital payments while maintaining control over monetary policy [67] [65] [68].

As an example of CBDC, Franklin Allen, Xian, and Julapa discuss the development of China's digital currency introduced by the People's Bank of China (PBOC) called e-CNY [64]. It operates through a centralized system where the PBOC oversees its issuance and

distribution, while commercial banks and authorized intermediaries facilitate user access and transactions [64]. Authors note that e-CNY aims to enhance financial inclusion, reduce transaction costs, and improve payment efficiency, particularly in a rapidly digitizing economy [64].

4.1.3 Mobile Payment

Mobile payments represent a significant advancement in digital payment technology due to the increasing accessibility of mobile phones and the need for convenient cashless transactions [54] [6]. The ease of use, security features, and integration with a wide range of devices and merchants have made mobile payment platforms such as Apple Pay, Google Pay, and Samsung Pay extremely popular [6]. These platforms enable quick and contactless payments through the use of QR codes and NFC technology [6].

As discussed in [6], NFC is widely used in mobile payment platforms, enabling contactless transactions by allowing devices to communicate over short distances. It provides a secure and efficient method for completing payments at POS terminals by eliminating the need for physical interaction with payment terminals [6] [69].

Mobile payments with QR codes involve using an app on your mobile device to complete a transaction by scanning a printed or digital QR code offered by the merchant [70]. This payment method is highly efficient and does not require sophisticated hardware, which makes it especially accessible for small and medium-sized enterprises (SMEs). Merchants can simply generate a QR code, which can be scanned by the customer using a payment app to initiate a transfer [71]. QR codes are popular because they allow payments without the merchant having to purchase costly point-of-sale (POS) terminals, which helps reduce overhead costs and makes digital payments more accessible, even in remote locations [69].

Authors in [72] discuss Short Message Service (SMS) payments which remain relevant in regions with limited internet connectivity, allowing users to initiate and confirm transactions via text messages between mobile devices. SMS payments employ communication protocols such as GSM, GPRS, and UMTS for messaging and they can operate on basic mobile phones [72]. Authors also state that SMS payments have some drawbacks like lack of encryption, absence of delivery confirmation, and the reduced capacity of transmission as messages are limited to 160 characters [72].

4.1.4 Online Banking

Authors in [73] and [53] state that online banking extends banking services like fund transfers, bill payments, and checking account balances from a bank's mobile application. By leveraging mobile applications, customers can carry out banking activities at their convenience without needing to visit a physical branch [3] [53]. The introduction of user-friendly interfaces and enhanced security features has made mobile banking an irreplaceable tool for both urban and rural customers [53].

Internet banking has become popular because of the convenience that comes with it due to the growth in the use of smartphones, which offer round-the-clock access to banking services, including real-time notifications, mobile deposit, and spending insights [53] [69]. Nima et al. [3] says that the adoption of internet banking aligns with regulatory support to promote digital transactions and financial inclusion. For instance, frameworks like Payment Service Directive 2 (PSD2) in the European Union use security protocols, such as strong customer authentication, to prevent fraud [3].

In [53] A.Martina and Dr Sahayaselvi discuss National Electronic Funds Transfer (NEFT) which is an electronic payment system in India that allows customers to transfer money electronically between banks, with transactions typically processed in hourly batches throughout the working day. This system is widely used for planned, non-urgent transfers, such as bill payments and personal remittances [53]. Immediate Payment Service (IMPS), on the other hand, is another example of an inter-bank electronic funds transfer system that facilitates real-time fund transfers 24/7, making it highly suitable for urgent transactions of small-to-medium values [53]. IMPS provides users with instant confirmation, offering both speed and reliability and enhancing the convenience of financial transactions [53]. Together, NEFT and IMPS cater to different needs, with NEFT being suitable for larger or scheduled payments, while IMPS is ideal for immediate, time-sensitive transactions [53].

4.1.5 Card Payments

The use of NFC technology enables contactless payments, where transactions are completed by simply tapping an NFC-enabled card or smartphone on a contactless payment terminal [69]. This type of payment is highly convenient, as it requires minimal interaction between the payer and the point-of-sale terminal, thereby reducing transaction time [69]. Contactless payments also support tokenization, which makes them secure. This technology enhances the speed of payments, making it highly appealing in settings such as retail stores and public transport, where quick customer turnover is crucial. The simplicity and security of NFC payments have led to their widespread adoption, particu-

larly among urban consumers and businesses seeking seamless and efficient payment processes [69] [53].

Credit cards and debit cards are part of the most popular payment tools in the global economy. Credit cards enable consumers to purchase goods and services on credit by using his/her credit card account balance that was extended by the bank and must be repaid, with the added interest, if not paid in full before the statement date [74]. In contrast, debit cards enable consumers to make direct purchases by accessing their bank accounts. These cards normally come with EMV chips – these are important in boosting the security against fraud – besides the magnetic stripe [75]. Consumers are having a good time making payments since the initiation of contactless cards is making payment processes even faster [53].

In [76], authors discuss biometric cards, which represent an innovation in secure, contactless transaction technology, integrating fingerprint sensors directly into EMV cards to enhance convenience and security. These cards use fingerprint verification stored securely within the card chip and no biometric data is transmitted externally, ensuring compliance with GDPR (General Data Protection Regulation) and enhancing privacy [76]. Biometric verification removes regulatory limits on contactless payment amounts, allowing higher-value transactions without PIN input. However, if the biometric sensor fails, the system defaults to alternative methods like PIN entry, ensuring usability in all situations [76].

4.1.6 Offline Digital Payments

While traditional financial transactions have been enhanced by the use of online digital payments, which offer real-time transactions and global connectivity, there is an increasing need for offline solutions to enhance access and reliability of transactions in regions with limited or no internet connectivity. As discussed in [77] and [78], offline digital payments are financial transactions made without an internet connection. Some of these systems integrate technologies such as Bluetooth, NFC, and Dual Network Servers (DNS) to facilitate payments and can operate without an active Internet connection during transactions. For example, DNS allows offline payments through SMS services, ensuring secure transactions even in areas with poor or no internet connectivity. [77] [78] [79]. Hybrid solutions like UPI Lite combine offline transaction capabilities with periodic internet synchronization for settlement, providing an affordable option for low-value transactions in markets like India [78] [79]. Additionally, [79] mentions another example, Pay TM 2019, that allows users to load money onto the card and make payments without an internet connection, provided both parties use compatible cards. Fully offline systems allow direct and instant device-to-device transfers of funds,

which are still in development but hold promise for advancing financial inclusion and reducing risks associated with internet outages [78] [79]. However, these systems face challenges such as mitigating double-spending risks and ensuring robust security and privacy standards [78]. By leveraging innovations such as encrypted voicemail and batch processing, offline payments are poised to democratize digital payments further and strengthen resilience in diverse economic contexts [79].

Table 3 summarizes the primary digital payment methods discussed in the literature and their respective use cases, supported by the number of studies and occurrences in the reviewed materials. Each row provides insights into the relevance and applications of a specific payment method as highlighted in various research studies.

| Payment Method | Use Case | Studies | Occurrences |
|--------------------------|---|---|--------------------|
| Digital Wallets | Used for cashless transactions across business-to-business and supply chain sectors | [3, 6, 7, 52, 53, 54, 56, 55, 73, 77, 80, 81, 82, 83, 84] | 15 |
| Cryptocurrency Payments | Used for e-commerce payments to reduce transaction fees, especially for high-value goods, compared to traditional payment systems | [1, 6, 7, 54, 56, 61, 62, 63, 64, 65, 67, 68, 77, 85] | 14 |
| Mobile Payments | Cashless transactions using mobile applications | [1, 3, 6, 7, 52, 54, 73, 77, 55, 84, 85] | 11 |
| Online Banking | Bank transactions via mobile apps or online. Batch and instant bank transfers | [3, 52, 53, 54, 69, 73, 82, 83, 55, 86] | 10 |
| Payment Cards | Substitution of cash by debit cards in retail and non-retail sectors | [52, 53, 73, 74, 75, 55, 86] | 7 |
| Offline Digital Payments | Financial transactions executed without a continuous internet connection | [77, 78, 79, 87, 88] | 5 |

Table 3. Digital Payment Types Mentioned in Literature

4.2 Key Drivers for Digital Payment Evolution

Digital payments have become an effective financial tool that enhances convenience and efficiency in the conduct of payments in the financial market. The reviewed literature mentions different fundamental and strategic factors that have been endeavored in this revolution that define how and where digital payments have advanced and diversified. These factors are categorized into six areas: technological advancement, regulatory frameworks, customer preferences, financial inclusion, economic drivers, increased trust, and security measures. The following subsections are ordered based on the data found for each category, from most to least.

4.2.1 Technological Advancements

Technological advancement has been central in shaping digital payment systems. The use of various technologies has made transactions more efficient, secure, and easier. Key technological factors include:

- **Internet and Mobile Connectivity:** Internet and mobile technology have made the growth of digital payment system as its penetration has risen greatly over the years. The availability of connectivity has allowed users ranging from age 18 to above to use digital financial services [89]. In [90], authors state that the growth of mobile connectivity in China has accelerated the adoption of mobile-based payment solutions like WeChat Pay especially during the Covid-19 pandemic.
- **Blockchain Technology:** Blockchain is the underlying technology for cryptocurrencies such as Bitcoin and Ethereum [77]. It offers payment services that are not centralized and protect consumers' privacy as well as minimize fraud incidences [77] [85]. In [77] and [85] authors state that the distributed ledger technology underlying blockchain allows for real-time verification of transactions without the need for intermediaries, thereby increasing efficiency and lowering transaction costs.

In [91] authors have pointed out that, as is the case with financial institutions, with blockchain, new business models are opened up while others that were previously traditional are eliminated, and the aspects of payment services such as cross-border real-time transactions are enhanced. According to [92], cryptocurrencies leveraging blockchain technology have also been adopted widely in international payments due to their borderless nature and enhanced anonymity. These are financial digital currencies that are connected with other financial systems to encourage cashless societies [92].

Blockchain technology is anticipated to foster the payments industry transformation regarding smart contracts, which enable enhanced automation for contract-based payment execution. As noted by [91], the adoption of blockchain in payment

services has aimed not only at reducing costs but also at offering increased transparency and security thereby promoting the generation of new financial products and services.

- **Artificial Intelligence (AI) and Machine Learning (ML):** AI and ML are at the center of the increasing number of advanced aspects of digital payments. Xu Zhang et al. [93] state that the AI algorithms review consumers' behaviors, identify suspicious activity, and have a security measure against fraudsters. Also, through machine learning, users get details offered that are specific to their spending habits across the online platforms [94]. They are currently being deployed in aspects of mobile wallets and banking applications to enhance the experiences for the users and to safeguard [95].

This aspect was also supported by [94], who stressed that the integration of AI in the digital payment defined above must be efficient and reliable as part of Industry 4.0 that is primarily based on the automation and integrated AI-assisted services in the financial field. In addition, [93] put forward the type of digital payment risk prediction and behavior using machine learning models such as decision trees and logistic regression, which are more comprehensive and produce more detailed consumer trend and fraud predictions.

In [96] and [97], authors discuss another AI-driven framework called Agentic AI. Thus, Agentic AI is an autonomous AI system capable of executing tasks with limited human intervention [96] [97]. In contrast to classical Generative AI (GenAI), which needs particular prompts, Agentic AI systems use advanced reasoning and collaborative networks of agents to solve multi-step problems autonomously [96]. Agentic AI increases productivity by automating repetitive tasks while improving decision-making precision through advanced reasoning, dynamically analyzing market trends, and providing cost-effective financial solutions by autonomously assessing micro-loans in underserved markets [96] [98]. These systems process text, images, and real-time data in various environments using techniques like machine learning, APIs, and multimodal capabilities [97] [99]. [99] mentions that agentic AI can autonomously execute audit processes, such as risk assessment, fraud detection, and journal entry testing, by analyzing historical data, identifying patterns, and accessing external tools to flag suspicious transactions.

- **NFC and Biometrics:** Mobile payment methods such as NFC [89] technology have gained traction for contactless payments, allowing consumers to simply tap their device or card to make a transaction, which reduces the need for physical interaction and enhances convenience. Additionally, biometric authentication methods, including fingerprint recognition, iris scanning, and facial recognition, have been implemented for stronger customer authentication. These technologies

not only make transactions more secure but also improve user experience, supporting higher usage rates, especially in the context of post-COVID-19 contactless payments, which have seen a significant boost in adoption [100]. Similarly, Mugel et al. [62] point out that employing biometric authentication with AI enhances the effectiveness of detection of frauds, thus enhancing the security of transactions and convenience of the process [101] [102].

- **Internet of Things (IoT)** IoT technology plays a role in embedding payment capabilities into connected devices, such as smartwatches and other wearable gadgets. This enables users to make payments directly from their wearable devices, offering convenience and expanding the accessibility of digital payment options. IoT-based payments are becoming increasingly relevant in sectors like transportation, where smart devices enable cashless ticketing and transactions [103]. Nenad Tomic and Violeta Todorovic [104] discuss that IoT is poised to drive significant growth in the payment landscape by creating new use cases such as automated payments in smart homes and vehicles, allowing for payments to be executed seamlessly and in real-time. The integration of microprocessors, sensors, and corresponding software within these devices supports M2M (machine-to-machine) communication, which enables automated payment processing, thus further enhancing efficiency in sectors like retail and transport [104].
- **Cloud Computing** Cloud computing enables payment service providers to deliver scalable, reliable, and cost-effective digital payment solutions [95]. Cloud platforms are used for data storage, processing payment transactions, and running applications, ensuring that payment infrastructure remains secure, fast, and accessible on demand [95]. The adoption of cloud computing has also allowed smaller FinTech firms to enter the market, as they do not need to invest in extensive physical infrastructure, as emphasized by [95].

4.2.2 Regulatory Frameworks

When the environment is properly supported, people will be willing to embrace online payment methods through the use of regulatory measures. Governments and regulatory bodies have taken steps to create policies that promote security and trust in digital transactions:

- **Consumer Protection Regulations:** Laws such as the General Data Protection Regulation (GDPR) in Europe and the Consumer Protection Act, 2019 in countries like India, as well as other consumer protection laws globally, play crucial roles in ensuring data privacy and security [105]. This regulatory framework enhances consumer trust in online payment systems, helping to mitigate risks such as identity theft and fraud. As highlighted in the study, strong consumer protection laws

contribute significantly to boosting user confidence in e-commerce transactions and are seen as essential in encouraging digital payment adoption [105].

- **Standardization and Interoperability:** Organizations have continued to engage themselves in developing frameworks in conjunction with financial service providers towards the enhancement of automation in payment solutions. For example, in Europe, a rule named PSD2 enforces the implementation of open banking that raises competition and integration of services across different tech stacks [106]. The PSD2 has positively impacted the PayTech sector in Europe by creating a new regulatory environment that facilitated the entry of non-bank entities into the payments market, thereby fostering innovation and increasing competition [106].
- **Supportive Government Policies:** Some governments have actively promoted cashless societies by offering incentives such as tax rebates and rewards to encourage the use of electronic payments. For instance, demonetization policies in countries like India, as well as government-backed tax incentives for digitizing payments, have played a significant role in increasing the perceived utility of digital payment methods, thus encouraging adoption. Such policies create network effects that benefit the entire digital payments ecosystem and promote financial inclusion, as highlighted by [107].

4.2.3 Consumer Preferences

Consumers' evolving expectations and behaviors have greatly influenced the adoption of digital payments:

- **Convenience and Speed:** Current consumers expect to complete their payments conveniently and quickly, which digital payment systems provide [86] [84]. With the advancement in technology, digital payment platforms offer time-saving benefits, enabling transactions to be conducted online without the need to visit physical payment centers or carry cash, thus significantly enhancing the convenience and adoption rate of digital finance methods [83] [87]. Customers have shown a strong preference for the ease of use, accessibility, and reduced physical contact offered by these platforms, as highlighted by the study conducted in Zambales, Philippines, which emphasized the importance of customer convenience in driving the acceptance of digital payments [108].
- **Contactless Payments:** The prevalence of the COVID-19 pandemic also affected the evolution of payments gradually as people became worried about their health and thus avoided making contact payments. Mobile payments and the usage of contactless cards also received a boost during this period [89].

- **Personalized Financial Services:** With future changes in the amount of data, payment systems can provide certain financial services more satisfying individualistic services like spending profile and relevant products, thus making customers more loyal and satisfied [109].

4.2.4 Financial Inclusion

Digital payment systems have emerged as a tool for enhancing financial inclusion:

- **Access to Underserved Populations:** Mobile wallets enabled by technology transactions such as QR payments and others have allowed people to have access to financial services who are mostly unable to access banking services in the first place. For instance, mobile payment services like M-Pesa in Kenya have empowered the unbanked population to conduct formal financial transactions [110].
- **Micro-Payments and P2P Transfers:** Digital payments enable making small transactions and P2P where payments of relatively small, frequent amounts can be made seamlessly. This has particularly helped to increase the economic activities of the main one-man businesses and persons [89].

4.2.5 Economic Drivers

The economic benefits associated with digital payments also drive their adoption:

- **Cost Reduction:** Digital assets cut expenses by negotiating the utility of tangible assets, paperwork, and cash in operational management for the commercial institutions as well as the commerce firms and customers [109].
- **Market Expansion:** Digital payment is an extension of the market where the business that implements that kind of payment system extends its market in the geographical frontiers. The features presented by digital transactions mean that firms can better extend their services to international customers, which is a great boon to e-commerce sites [109].

4.2.6 Increased Trust and Security Measures

Trust is a crucial component of digital payment adoption, and various measures have been implemented to address security concerns:

- **Enhanced Security Features:** Digital payment applications have adopted the following security measures, encryption of data, two-factor authentication (2FA), and fraud detection software. Such measures have enhanced the security of digital payments and enhanced consumer reliability in embracing the technique [89].

- **Awareness Campaigns:** Campaigns that seek to ensure that consumers have embraced the security of transacting electronically and that have encouraged people to embrace online transactions have also led to high adoption of the technology. The public and other participants have engaged in an awareness campaign to demystify myths and educate users on appropriate or safe practice [89].

Altogether, the existence of those factors significantly contributed to the fast-growing dynamics of digital payments and put them as an essential element of contemporary payment systems. Technological innovations have offered the basic platforms, while legislation and standards have established the mechanisms for security and confidence, people have become more willing to use services that offer comfort, and the efficiency and the inclusiveness of the benefit incentivize take-up across all facets of society.

Table 4 summarizes the drivers behind the evolution of digital payments mentioned in the literature, along with the associated studies.

| Category | Key Factors | Studies | Occurrences |
|-----------------------------------|--|-------------|-------------|
| Technological Advancements | <ul style="list-style-type: none"> • <i>Internet and Mobile Connectivity</i> • <i>Blockchain</i> • <i>AI and ML</i> • <i>NFC and Biometrics</i> • <i>Internet of Things (IoT)</i> • <i>Cloud Computing</i> | [111] [54] | 16 |
| | | [112] [113] | |
| | | [114] [7] | |
| | | [6] [115] | |
| | | [8] [116] | |
| | | [82] [77] | |
| | | [4] [89] | |
| [117] [100] | | | |

Continued on next page

| Category | Key Factors | Studies | Occurrences |
|--------------------------------------|--|--|--------------------|
| Regulatory Frameworks | <ul style="list-style-type: none"> • <i>Consumer Protection Regulations</i> • <i>Standardization and Interoperability</i> • <i>Supportive Government Policies</i> | [106] [107] [107] [115] [118] [73] [116] [87] | 8 |
| Changing Consumer Preferences | <ul style="list-style-type: none"> • <i>Convenience and Speed</i> • <i>Contactless Payments</i> • <i>Personalized Financial Services</i> | [83] [86] [87] [84] [89] [109] | 6 |
| Financial Inclusion | <ul style="list-style-type: none"> • <i>Access to Underserved Populations</i> • <i>Micro-Payments and P2P Transfers</i> | [7] [110] [89] [115] [119] | 5 |
| Economic Drivers | <ul style="list-style-type: none"> • <i>Cost Reduction</i> • <i>Market Expansion</i> | [6] [52] [89] | 3 |

Continued on next page

| Category | Key Factors | Studies | Occurrences |
|---------------------------------------|---|-------------------|-------------|
| Increased Trust and Security Measures | <ul style="list-style-type: none"> • <i>Enhanced Security Features</i> • <i>Awareness Campaigns</i> | [8] [89] [114] | 3 |

Table 4. Key Factors Contributing to Digital Payment Growth

4.3 Evolution of Digital Payments

The future of digital payments is poised to experience significant shifts influenced by emerging technologies, changing consumer behaviors, and regulatory developments. This section explores key aspects of how digital payments might evolve, focusing on innovations, market shifts, and the potential decline of traditional payment methods like cash and cards.

4.3.1 Emergence of Cryptocurrencies and Blockchain Integration

Cryptocurrencies, such as Bitcoin and Ethereum, backed by blockchain technology, are expected to play a prominent role in the future of digital payments [6]. Blockchain's decentralized nature offers secure, transparent, and efficient transactions, reducing the reliance on centralized intermediaries. This trend is seen as facilitating real-time cross-border payments and enhancing privacy, providing an alternative to traditional banking methods [120]. Allowing blockchain to process transactions over a distributed network without a central authority is expected to reduce costs and enhance transaction efficiency [6]. Studies have shown that businesses, such as NASDAQ and Deloitte, have adopted blockchain technology to manage equities, demonstrating its potential in mainstream financial operations [8]. However, their adoption is met with regulatory challenges due to concerns over volatility, speculative investments, and potential impacts on monetary policy [34] [8]. Despite these hurdles, decentralized systems are expected to play a crucial role in the future of payments, particularly in emerging markets where access to traditional banking infrastructure is limited [6].

4.3.2 Technological Advances in IoT and AI

The IoT and AI are expected to be crucial drivers of innovation in the digital payment ecosystem. IoT devices, such as smartwatches and connected cars, will embed payment functionalities, enabling users to pay directly without the need for cash or cards [121]. AI will enhance the user experience by providing personalized payment solutions, predicting consumer spending behaviors, and preventing fraud through improved security measures [121] [122]. Additionally, integrating AI with IoT is a growing trend, which facilitates predictive maintenance and enhances the overall efficiency of IoT devices in smart environments [69].

Shri Ajay et al. [119] mentions that AI models can be designed to analyze large datasets, including social media activity and purchasing patterns, identify anomalies, and detect fraudulent activities with greater accuracy. These systems will leverage digital identity data and personalized consumer insights to create tailored security protocols, making digital payments safer and more reliable [119]. Furthermore, AI-driven fraud prevention will become an integral part of payment ecosystems, helping providers combat emerging threats and maintain consumer trust in an increasingly digital world [119].

According to [98], Agentic AI is expected to transform financial services by enabling autonomous and adaptive solutions that surpass the capabilities of traditional Generative AI. As an example, AI-powered trading agents will autonomously monitor markets, adjust strategies, and manage risks in real-time, alongside enhanced compliance and fraud detection mechanisms that refine risk assessments and identify anomalies dynamically [98]. Additionally, the paper also states that Agentic AI can autonomously evaluate micro-loans for small businesses, like farmers, by using local data to assess risk without the need for direct human intervention [98].

In addition to these technological advancements, [79] mentions some emerging innovations like encrypted sound waves and batch processing with mesh technology as critical enablers of offline payment systems. Encrypted sound waves use inaudible frequencies to encode information and offer a new way to securely transmit transaction data, even in regions with limited connectivity [79]. This approach enables secure offline payments without relying on internet infrastructure [79]. Similarly, batch processing with mesh technology facilitates transactions in areas with poor network availability by collectively storing and processing payment data when connectivity is available [79].

4.3.3 Digital Currencies (CBDC)

One of the anticipated changes in digital payments is the adoption of Central Bank Digital Currencies (CBDCs). CBDC is a form of digital currency linked to a nation's official currency unit and directly managed by its central bank [67]. This ensures that central banks control both the issuance and regulation of the digital currency [67]. In [121], authors highlight that smart contracts embedded within CBDCs can automate complex transactions, such as tax deductions at the point of sale or the conditional release of escrow payments. Additionally, CBDCs have the potential to enhance financial inclusion by providing secure and cost-effective digital financial services to unbanked and underbanked populations, enabling greater participation in the financial system [7]. As an example of a CBDC, [123] highlights Europe's focus on the conception and implementation of the *Digital Euro*, which aims to facilitate cross-border payments and support machine-to-machine payments by adopting advanced payment formats like ISO 20022. [7] mentions another example of CBDC which is called *Digital Yuan* and it's linked to China's monetary. The authors state that the Digital Yuan aims to function both as a genuine CBDC and a payment system [7]. As more nations adopt CBDCs, interoperability between different currencies will become a focal point, requiring collaboration between governments and international organizations [121].

4.3.4 Consumer Behavior Shifts

Consumer preferences are evolving towards faster, more secure, and more convenient payment solutions. As a result, traditional payment methods like cash and cards are

expected to decline in favor of digital alternatives [124]. Consumers also prioritize personalized services and seamless integration with various platforms, reflecting their growing expectations for adaptability and user-friendly experiences in financial transactions [121] [124]. These shifts are paving the way for innovative digital finance solutions, promoting flexible and accessible payment systems [124].

4.3.5 Regulatory Influence and Government Initiatives

Governments will continue to play a significant role in shaping the future of digital payments. Regulatory measures and government initiatives will help create a secure and inclusive digital financial ecosystem. These efforts are particularly geared toward promoting financial inclusion, increasing transparency, and reducing dependency on cash transactions [125] [126]. Governments are likely to promote cashless transactions to combat issues like black money and improve tax collection [126]. However, different regulatory environments will affect the speed of digital payment adoption across different regions [126].

As mentioned in [60] and [58], Wero, a European digital payment wallet, has been launched only in Germany, France, and Belgium across Europe. Thus [58] states that EPI aims to become a unified European digital payment wallet in 3-4 years by integrating all transaction scenarios while improving user control over finances securely and in compliance with European regulations. Wero plans expansion in 2025 to include subscription management, payments at small retailers, and online merchants [58]. According to [58], Wero will be able to handle POS payments at major retailers by 2026. Additionally, according to [58], value-added services like Buy Now-Pay Later (BNPL), merchant loyalty programs, and shared spending tools will also be integrated, which will help to reduce costs and foster innovation.

In addition, significant steps are being taken to address connectivity issues in digital payments. Publications like [78] and [79] discuss the development of truly offline solutions. These systems allow transactions without any internet connection by using locally stored funds or digital bearer instruments for instant in-person settlement [78] [79]. This innovation holds the promise to increase system resilience in regions with intermittent internet access while also expanding the reach of digital payments to underserved communities.

Table 5 illustrates the mostly mentioned possible future trends in digital payments, along with associated studies.

| Key Area | Future Trends and Use Cases | Studies | Occurrences |
|--|---|------------------------|-------------|
| Emergence of Cryptocurrencies and Blockchain | Increased role of cryptocurrencies in cross-border and secure payments. | [6] [34] [6] [8] [120] | 5 |
| Technological Advances in IoT and AI | Integration of IoT and AI for wearable and connected payments. | [122] [69] [119] [121] | 4 |
| Digital Currencies | Rise of the Central Bank Digital Currencies. | [123] [7] [121] [67] | 4 |
| Consumer Behavior Shifts | Shift towards contactless, personalized, and secure payment methods. | [124] [121] | 2 |
| Regulatory Influence and Government Policies | Promotion of cashless transactions, enhanced regulation for security. | [126] [125] | 2 |

Table 5. Future Trends and Use Cases in Digital Payment Systems

4.4 Values for stakeholders

Digital payment systems provide distinct advantages for different stakeholders, including consumers, businesses, financial institutions, and governments. This section explores the benefits and insights gathered from the literature.

4.4.1 Value for Consumers

The adoption of digital payments provides numerous benefits for consumers, which include convenience, security, and increased accessibility.

- **Convenience:** Digital payments, such as mobile payments and online banking, allow consumers to transact from anywhere at any time, significantly enhancing the ease of conducting transactions. Authors in [90] and [127] state that mobile wallets such as WeChat Pay and Go-Pay enable consumers to make transactions anytime and anywhere, reducing the need for cash or physical banking. Lee and Kang highlight that mobile payment systems enhance convenience through the

use of features like QR codes and NFC for quick, seamless transactions significantly enhancing consumer satisfaction [124]. They emphasize the importance of convenience as a significant driver in consumer purchase decisions, particularly among millennial consumers, who value the ability to make payments quickly and without hassle [124] [128].

- **Security:** Security is a crucial factor influencing consumer adoption of digital payments. Studies show that modern digital payment systems employ advanced encryption and biometric technologies to secure transactions, reducing the risk of fraud [124]. Ballaji et al. mentions that digital payment methods such as biometric-enabled payment cards and mobile wallets with fingerprint or facial recognition technology enhance transaction security by reducing the risks of unauthorized access [3]. Additionally, Pandey's empirical survey reveals that one of the key reasons for the growing adoption of digital payments is the perception of enhanced security compared to traditional cash transactions, which has been particularly critical during the COVID-19 pandemic [129].
- **Accessibility:** Digital payment methods also help in promoting financial inclusion by enabling consumers without traditional banking access to participate in financial activities. This aspect is particularly beneficial in developing regions, where mobile payment systems often replace cash as the main form of value transfer. [124] further state that the penetration of internet services among the millennial population has played a major role in increasing accessibility to digital payments, helping more individuals integrate into the formal financial system [128]. Leo and Antoine discuss a mobile-based money transfer service in Kenya called M-PESA, which fosters financial inclusion by allowing unbanked populations in rural and underserved areas to access formal financial systems [130].

4.4.2 Value for Businesses

Businesses gain significantly from adopting digital payment systems, primarily through cost savings, improved customer engagement, and enhanced transaction efficiency.

- **Cost Savings:** Digital payments help reduce the need for cash handling, which is labor-intensive and costly. The reduction in cash management infrastructure such as cash registers and security systems helps businesses save on operational costs. [127] notes that platforms like Go-Pay allow businesses, especially small and medium enterprises, to operate without the physical requirements of cash handling, ultimately reducing operational expenses. Lee and Kang also mention that mobile payment also helps businesses to reduce cash handling costs [124].

- **Enhanced Customer Engagement:** Digital payment systems provide businesses with the opportunity to engage more deeply with customers through loyalty programs and personalized offers. [124] describe how integrating digital payments with customer loyalty systems helps businesses target consumers with promotions that enhance customer engagement and loyalty. This integration helps improve customer engagement by providing a seamless experience, as loyalty rewards can be automatically applied during transactions. As noted by Lee and Kang [124], combining mobile payment systems with loyalty programs enhances operational efficiency for businesses by streamlining payment and reward redemption processes, improving the relationship between businesses and their customers.
- **Transaction Efficiency:** Digital payments significantly streamline payment processes, leading to reduced transaction times and greater efficiency. [90] highlight that the adoption of mobile payment systems like WeChat has led to smoother, faster transactions, especially for businesses dealing with high transaction volumes. Authors also state that these kinds of mobile payment platforms operate continuously, enabling businesses to transact outside traditional banking hours [90]. This flexibility is crucial for e-commerce and international trade, where time-zone differences often disrupt transactions processed through conventional systems [124] [90].

4.4.3 Value for Financial Institutions

For financial institutions, digital payment systems represent an avenue for increased profitability and innovation.

- **Profitability:** The use of digital payments allows for the minimization of operating expenses relating to the conveyance of traditional payments including checks and cash. Transaction fees applying to such digital payments also constitute an additional source of revenue. [131] argues that digital financial services play a crucial role in attaining banking stability in emerging economies by capitalizing on payment penetration and presenting more efficient subcategories to conventional banking.
- **Innovation Opportunities:** The use of digital payments is helping financial institutions expand the offering of new financial services and products. For instance, applications enabling mobile banking linked with payment systems provide targeted financial services that enhance clients' loyalty. [131] also note that the financial sector is deploying technological trends such as AI to gain insights on consumers, an essential factor in service delivery. Furthermore, digital financial services enhance the ability to offer tailored products such as micro-credit and

insurance, thereby expanding the reach of financial services and fostering inclusion, particularly for underserved populations [132].

4.4.4 Value for Governments

The digital payment system is also advantageous to governments in the aspects of financial inclusion, taxation, and policy on money.

- **Financial Inclusion:** Governments view digital payments as a tool for enhancing financial inclusion. By promoting digital financial services, governments can ensure that previously unbanked populations gain access to financial systems, thereby supporting economic growth and poverty alleviation. Leora Klapper and Dorothe Singer [133] point out that developing inclusive digital payment systems helps facilitate financial access, especially for underserved populations in developing countries. Additionally, in [79], authors mention that offline digital payment solutions like UPI Lite and Pay TM 2019, enable financial inclusion in remote or underserved areas with unreliable or inaccessible internet connectivity, which democratizes digital payment technology and ensures that it is not limited to urban centers.
- **Taxation and Transparency:** Digital payments make it easier for governments to track financial transactions, thereby increasing transparency and reducing tax evasion. Authors in [134] highlight that shifting government-to-person (G2P) payments to digital forms not only ensures efficiency but also minimizes fraud, thereby reducing leakages often found in cash-based systems.
- **Monetary Policy:** Digital payments also assist governments in monitoring and implementing monetary policy more effectively. By encouraging cashless transactions, governments can maintain better control over the money supply and reduce the circulation of counterfeit currency, contributing to more stable economic governance [133].

Table 6 highlights the discussed values in the literature that digital payment systems offer to different stakeholders, each of whom plays a role in driving the adoption and integration of these systems into everyday financial transactions.

| Stakeholder | Key Benefits | Studies | Occurrences |
|------------------------|--|---------------------|--------------------|
| Consumers | Convenience, security, accessibility | [124], [128], [129] | 3 |
| Businesses | Cost savings, enhanced customer engagement, transaction efficiency | [127], [124], [90] | 3 |
| Financial Institutions | Profitability, innovation opportunities | [131], [132] | 2 |
| Governments | Financial inclusion, taxation transparency, monetary policy efficiency | [133], [134] | 2 |

Table 6. Key Benefits for Stakeholders in Digital Payment Systems

4.5 Challenges

The adoption and integration of digital payment solutions present several challenges that stakeholders must navigate to ensure a smooth transition and widespread acceptance. The reviewed literature classifies these challenges into the following categories:

4.5.1 Technological Barriers

Another significant problem is the integration of multiple digital payment technologies. The payment technologies being adopted now include mobile wallets, NFC payments, blockchain, etc., and all these are incompatible, leading to ecosystem fragmentation [118] [135]. [136] describe how this fragmentation means that users must download and operate several apps or platforms, which results in wasted time and poor customer experience. Furthermore, due to the absence of the same solutions in every technology of payment systems, the pattern leads to annoyance and irregularity that is not accepted widely, as realized by [137].

4.5.2 Infrastructure Limitations

Thus, the adoption of digital payments can only go smoothly when the infrastructure is also orderly. As noted earlier, they point out that in areas where Internet connection is slow or unavailable, the use of digital payments is highly restricted. Due to slow and unreliable internet connectivity, transactions either fail or take longer, hence discouraging

consumers and businesses from using online payment systems [3]. According to [3] [137], weak infrastructure impedes the pace of digitization, especially in rural regions. Also, [136] noted that the lack of infrastructure including smart gadgets hampers the adoption of digital solutions, thus explaining why a number of consumers have not embraced the innovations.

4.5.3 Lack of Interoperability

Due to the lack of unified payment schemes different payment service providers do not or cannot interact with one another. For this reason, consumers struggle when they want to make payments from one platform to another. In a related note, [136] explains how interoperability challenges influence the simplicity of using digital payment services and stifle advancement based on the range of services that can be offered by interconnecting the solutions. Hence, enhanced communication between the payment players is necessary to foster the creation of integrated payment solutions [118] [135].

4.5.4 Trust and Consumer Awareness

In the current and future electronic payments, trust is an essential tool for success. Suspicions of data misuse and generally low awareness regarding digital payments act as a sore discouragement to its adoption. As [136] indicate that it can not be reiterated enough how important reliability, disclosure, and consumer literacy with regard to the topic are. A lack of awareness and insufficient understanding of what digital financial services constitute is an important challenge to their adoption in developing regions [135] [52].

4.5.5 Legal and Regulatory Issues

There are legal and regulatory challenges to the adoption of digital payment systems in countries. When there are no harmonized rules either at a global or regional level, there occur challenges in international business transactions [3] [112]. [136] note that the absence of legal guidelines with respect to such emerging technologies as cryptocurrencies and DPS creates some other problems for applying them to regular financial infrastructures. Global compliance with different legal entities and financial authorities is a major challenge that affects both the deployment and growth of the digital payments sector [136] [138].

4.5.6 Cost Concerns

Another barrier is the transaction cost involved in digital payments. High transaction fees, especially in cross-border payments, discourage businesses and customers from using digital payment methods. [136] state that the cost of managing a decentralized system,

such as blockchain for digital payments, can be significant due to energy consumption and the need for constant validation by network nodes. Cost reduction is essential for making these solutions attractive to a wider audience [135].

4.5.7 Cybersecurity Concerns

As people turn to digital means of payments the chances of being scammed or hacked also go up. Normally, threats include things like loss of data through theft, stealing of identity, and unauthorized access to information and data. According to [137] having better security measures is necessary to address these dangers and enhance customer confidence. Similarly, [139] also stated that continued difficulty in establishing a safe online payment system is also well-known within the context of new technologies.

4.5.8 Cultural and Behavioral Resistance

In many regions, people still prefer cash over digital methods due to the tangible nature of cash transactions. [89] argue that cultural factors and resistance to change hinder the adoption of digital payments, particularly among older populations who may be less tech-savvy and have concerns about the reliability of digital systems.

Table 7 illustrates mostly mentioned challenges associated with adopting and integrating digital payments.

| Challenge | Description | Studies | Occurrences |
|------------------------------------|---|-------------------------|--------------------|
| Technological Barriers | Fragmentation across different payment technologies lead to inefficiencies. | [118] [135] [136] [137] | 4 |
| Infrastructure Limitations | Poor internet connectivity, and limited access to smart devices hinder adoption. | [3] [137] [136] | 3 |
| Lack of Interoperability | Payment platforms do not effectively communicate, limiting seamless experiences. | [118] [136] [135] | 3 |
| Trust and Consumer Awareness | Lack of awareness and fear of data misuse deter consumers from adoption. | [52] [136] [135] | 3 |
| Legal and Regulatory Issues | Varying regulations and lack of clarity for technologies like blockchain. | [3] [112] [136] | 3 |
| Cost Concerns | High transaction fees, especially for cross-border payments, are discouraging. | [136] [135] | 2 |
| Cybersecurity Concerns | Increased risks of data breaches, fraud, and unauthorized access pose threats. | [137] [139] | 2 |
| Cultural and Behavioral Resistance | Preference for cash and resistance to change, especially among older populations. | [89] | 1 |

Table 7. Key Challenges in Digital Payment Systems Adoption

5 Structured Overview

This section outlines the structured overview developed based on the findings of the systematic literature review of 93 publications. This overview aims to synthesize the SLR findings in a structured and accessible manner, providing an understanding of current and emerging types, driving factors, benefits, challenges, enabling technologies, and future trends of digital payment systems. The overview can be used by students, researchers, and industry practitioners to explore the landscape of digital payments and identify key trends and limitations.

| Category | DP Type | Evolution | Description | Use Case | Value | Stakeholder | Driver | Technology | Change | Challenge | Reference |
|------------|-----------|-------------|---------------|--|---|---|--|--|--|---|-----------|
| Category 1 | DP Type 1 | Evolution 1 | Description 1 | <ul style="list-style-type: none"> • Use Case 1 • Use Case 1 • Use Case n | <ul style="list-style-type: none"> • Value 1 • Value 2 • Value n | <ul style="list-style-type: none"> • Stakeholder 1 • Stakeholder 2 • Stakeholder n | <ul style="list-style-type: none"> • Driver 1 • Driver 2 • Driver n | <ul style="list-style-type: none"> • Tech 1 • Tech 2 • Tech n | <ul style="list-style-type: none"> • Change 1 • Change 2 • Change n | <ul style="list-style-type: none"> • Challenge 1 • Challenge 2 • Challenge n | [Ref] |
| | DP Type 2 | Evolution 2 | Description 2 | <ul style="list-style-type: none"> • Use Case 1 • Use Case 2 • Use Case n | <ul style="list-style-type: none"> • Value 1 • Value 2 • Value n | <ul style="list-style-type: none"> • Stakeholder 1 • Stakeholder 2 • Stakeholder n | <ul style="list-style-type: none"> • Driver 1 • Driver 2 • Driver n | <ul style="list-style-type: none"> • Tech 1 • Tech 2 • Tech n | <ul style="list-style-type: none"> • Change 1 • Change 2 • Change n | <ul style="list-style-type: none"> • Challenge 1 • Challenge 2 • Challenge n | [Ref] |

Table 8. Sample dynamics of structured overview table

The sample dynamics of structured overview table is illustrated in Table 8, due to sizing issues the full version of table is available on shared link ³.

The overview table contains twelve columns and is read from left to right while each column highlights a different aspect of digital payment evolution, providing insights into the methods, drivers, and challenges that have shaped the transformation of this domain.

First, it categorizes the payment types under the "category" column like wallet-based, device-based, crypto-based, etc. Next, the "methods" column indicates the type of digital payment method examined in the literature, such as digital wallets, mobile payments, and cryptocurrency payments addressed in RQ1. Following this, the "definition" column describes each method briefly. The "evolution" column illustrates how certain payments might evolve over time, considering advancements such as blockchain integration, AI-driven tools, and regulatory improvements. This is further elaborated in the "description" and "use-cases" columns, which explain the particular evolution in more detail, alongside specific real-world examples to demonstrate its applicability. This part of the overview corresponds to RQ3. The "value" and "stakeholder" columns discuss how different stakeholders, such as consumers, businesses, and governments, will benefit from the evolution of the mentioned payment method. The value includes cost reduction, enhanced security, borderless transactions, and financial inclusion. These two fields correspond to RQ4. The next is the "change" column, which highlights the major shifts or changes that specific evolutions might bring to the digital payment ecosystem. Meanwhile, the "drivers" column addressing RQ2 expresses the factors that have fueled the evolution, ranging from technological advancements and economic demands to supportive regulatory policies. In addition to the driver column, there is also the technology field, which mentions the technologies driving or enabling the evolution. Finally, the "Challenges" column points out the barriers preventing the adoption of the mentioned evolution, such as privacy concerns, scalability issues, and digital literacy gaps. By identifying these limitations, this section answers to RQ5. Additionally, to ensure traceability and provide the relevant sources supporting each entry are listed in the "references" column.

³<https://docs.google.com/spreadsheets/d/>

5.1 Practical Applicability

To use the overview effectively, start by pinpointing the exact focus area related to the future of digital payments. Each row in the structured overview table corresponds to a unique aspect, such as payment methods, while the columns add further layers of detail, including evolution drivers, enabling technologies, relevant stakeholders, and potential challenges or opportunities. By methodically reading across the rows, users can track the logical relationships between emerging trends and their future implications.

For instance, suppose a researcher aims to identify the most promising payment technologies for enhancing cross-border transactions in the next decades. They would first find the relevant row associated with “Cryptocurrency Payments.” As they review the columns, they note that blockchain technology plays a central role in enabling decentralized and secure cross-border payments. The driver’s column may point out the necessity for lower transaction costs and quicker processing times, while the stakeholder’s section could highlight the main involved parties, such as businesses, legal entities, tech companies, and banks. The technology column would point to specific technologies or protocols that support this innovation, such as DLT, cryptographic hashing, and consensus algorithms (e.g. PoW and PoS). The challenges column might list issues like regulatory uncertainty and price volatility that need to be resolved before broader acceptance can happen. From this information, the researcher could conclude that cryptocurrencies have significant future potential for cross-border payments, contingent upon the evolution of regulatory frameworks to support their use.

In another scenario, a technology strategist could apply the overview table to assess emerging solutions for contactless and AI-driven payments. By looking at rows related to “Technological Innovations” or “Future Trends,” they would uncover links between Artificial Intelligence, IoT, and biometric technologies that improve security, personalization, and user convenience. This understanding would help the strategist predict market demand for AI-enabled fraud detection and IoT-based payment systems, positioning their organization to succeed in these innovative areas.

Overall, the structured overview serves as a guide outlining the future direction of digital payments. It highlights emerging technologies, shifting consumer behaviors, and industry-wide prospects while also addressing potential adoption barriers. By systematically exploring the rows and columns, users can gain insights that are customized to their specific goals. Whether the aim is to explore new markets, tackle financial inclusion, or create next-generation payment solutions, the overview provides a structured and evidence-based strategy for shaping the future of digital payments.

6 Discussion

This section discusses the results of the research by answering research questions and stating the possible limitations.

The first research question is *"What are the current types of digital payments?"*. The study explored several digital payment methods mostly mentioned, including digital wallets, crypto payments, mobile payments, online banking, and card payments [6]. The studies show that among these methods, digital wallets like Google Pay and Apple Pay are becoming more and more important due to their convenience and integration with mobile devices, enabling quick and secure payments [6] [56]. These wallets reduce the need for physical cards by securely connecting bank accounts or credit cards to mobile devices [56]. Digital wallets can be classified as open, semi-closed, or closed based on the issuer and the scope of their use [54].

Additionally, in order to reduce the dependency on non-European payment providers like Visa and Mastercard, EPI focuses on launching a new pan-European digital wallet [57]. The wallet is named Wero, which recently launched in France, Belgium, and Germany, enabling P2P payments and instant transactions across European markets [60] [58]. In contrast to digital wallets, cryptocurrency payments offer a decentralized alternative, utilizing blockchain technology to enable secure and borderless transactions with lower fees. However, their adoption is limited by issues of volatility and regulatory challenges [61]. Unlike cryptocurrencies, CBDCs are centrally controlled and represent a major development, with projects like China's e-CNY and Europe's Digital Euro by merging the advantages of blockchain technology with the stability of being government-backed [64] [7].

Mobile payments using technologies such as NFC and QR codes are particularly important in emerging markets, where limited access to banking infrastructure limits financial inclusion [6]. These payments offer affordable, contactless solutions, even in remote locations [6] [69]. Meanwhile, card payments, especially contactless cards with NFC integration, remain common in industrialized regions due to their speed and increased security via tokenization [69].

Additionally, biometric cards enable higher-value transactions without PIN input, offering enhanced convenience and security through fingerprint verification, which is securely stored within the card's chip [76]. Finally, due to advancements in authentication technologies like encryption protocols and biometrics, online banking continues to play an essential role in daily financial transactions [53].

The second research question is *"What are the key drivers behind the evolution of digital payments?"*. The findings highlight key factors behind the evolution of digital payments, mainly under six categories: technological advancement, regulatory frameworks, financial inclusion, changing consumer preferences, economic drivers, and increased trust

and security measures. Innovations like AI, blockchain, and IoT have impacted digital payment systems by improving efficacy, personalization, and security [77] [91] [93]. The blockchain ensures transparent and cross-border payments, while AI-driven algorithms provide fraud detection, behavioral analysis, and customized financial suggestions [77] [85]. Additionally, IoT embeds payment capabilities into connected devices, enabling seamless and automated transactions in daily life like smartwatches, connected vehicles, and smart home systems that support IoT-enabled payments for services like subscription renewals and automated purchases [104] [103].

Regulatory actions have also stimulated the adoption of digital payments. The PSD2 in Europe promotes open banking, boosting competition by enabling non-bank entities to offer payment services [106]. Similarly, the Wero wallet and the EPI address the need for regionally specialized, interoperable solutions that lessen dependency on non-European payment providers [57] [58]. These initiatives are a reflection of the increased focus on technological standardization and regional financial sovereignty.

Furthermore, financial inclusion is one of the key factors, especially in regions where mobile payments facilitate access to financial services for unbanked populations. For example, studies like [110] showed how digital solutions like M-Pesa in Kenya can empower underserved communities. Additionally, there has been a shift in consumer preferences towards faster, more secure, and user-friendly payment systems [83] [87]. This trend has accelerated the adoption of digital wallets and contactless technologies, particularly in response to the COVID-19 pandemic [89].

From an economic standpoint, studies show that digital payments foster market expansion and cost reductions [109]. Businesses benefit from reduced dependence on cash, lower transaction costs, and more efficient financial operations [109]. The use of digital payments, which allow companies to reach a global audience, has led to a significant increase, especially in e-commerce [109].

Finally, integrating enhanced security measures like encryption, 2FA, and fraud detection systems has played a role in building consumer trust, another key factor behind digital payments evolution [89]. These security measures tackle ongoing issues regarding data protection and transaction security of digital payment solutions [89]. On the other side, awareness campaigns aim to educate consumers on digital payment security, which increases consumer confidence and accelerates adoption [89].

The next research is "*How might digital payments evolve?*". The results of this question revealed that digital payments will be shaped by blockchain technology, AI-driven solutions, IoT-based payments, changes in consumer behavior, and government initiatives in the following years [8] [121] [119] [98] [67] [125] [124] [126].

Cryptocurrencies are becoming more popular for cross-border payments as they provide real-time settlements and lower transaction costs [6] [120]. Decentralized systems are expected to emerge in markets with limited access to traditional banking [6].

However, volatility and regularity issues remain major barriers to widespread use [34] [8].

According to studies like [121], technological advances in IoT, AI, and blockchain will continue to drive trends. IoT devices like smartwatches and cars will facilitate seamless, automated transactions [121]. On the other hand, AI models will be used to create tailored security protocols that will make digital payments safer and more reliable [119]. Additionally, Agentic AI is anticipated to impact financial services by enabling autonomous and adaptive solutions surpassing the skills of GenAI [98].

In most recent studies, authors predict the adoption of CBDCs as one of the anticipated changes in digital payments [67] [121]. In contrast to cryptocurrencies, these currencies will be centralized by being managed by its central bank and will be linked to the country's official currency [67]. CBDCs are expected to play a role in the digital payments landscape by integrating advanced features such as smart contracts, which will enable automated and conditional transactions like tax deduction and escrow payments [121]. These currencies have the potential to enhance financial inclusion by providing secure and cost-effective digital financial services in underserved regions [7].

Consumer preferences are also changing toward faster, more secure, and contactless payments. [124] predicts that traditional payment methods like cash and card payments will decline as digital payment alternatives. Finally, the future of digital payments will continue to be influenced by regulations. The programs like PSD2 in Europe and open banking regulations promote competition that enables third-party companies to offer innovative solutions [106]. Studies show that governments are supporting cashless economies through incentives and policies that encourage the development of digital payment infrastructure [107] [126]

The research question, "*What is the value of digital payments for different stakeholders?*" aimed to explore the values of digital payment solutions for different stakeholders. The study identified and categorized these values across four key stakeholder groups: consumers, businesses, financial institutions, and governments.

The findings show that digital payment solutions provide benefits to diverse stakeholder groups. For consumers, digital payments offer convenience by enabling payments anytime and anywhere via mobile wallets or online banking, accessibility by promoting financial inclusion in underserved regions with tools like mobile payment services, and security by integrating advanced technologies like encryption and biometric authentication to reduce fraud risks [90] [127] [124] [128] [129] [128] [130].

Based on studies, digital payments benefit businesses by reducing operational costs, improving customer engagement through loyalty programs, and simplifying transactions that improve efficiency and flexibility [127] [124] [90].

Financial institutions use digital payments to increase profitability through transaction fees and reduced operational costs [131]. Digital payments also allow financial

institutions to launch innovative financial services and products [131].

On the other hand, governments gain enhanced transparency and efficiency in taxation, enhanced financial inclusion initiatives, and improved authority over monetary policy through digital payments [133] [134].

The final research question "*What are the challenges of adopting and integrating digital payment solutions?*", explores the challenges that hinder their widespread adoption and integration. The findings highlight eight key limitations: infrastructure limitations, technological barriers, security concerns, lack of interoperability, trust and consumer awareness, regularity issues, cost concerns, and cultural resistance.

According to studies, the adoption of digital payment is restricted by infrastructure limitations such as slow or unreliable internet connection and the lack of smart devices, particularly in rural and underserved regions [3] [137] [136]. Technological barriers like payment systems fragmentation and incompatibility among platforms cause inefficiencies and poor user experience [118] [135] [136] [137]. Security concerns such as data theft, stealing of identity, and unauthorized access continue to keep threatening consumer confidence while the lack of interoperability among different payment service providers complicates transactions and hinders possible innovations [137] [136]. Furthermore, studies also highlight trust and consumer awareness as another barrier to the adoption of digital payments, driven by low understanding and skepticism about data security [136] [135] [52]. Additionally, legal and regularity issues, including the absence of harmonized rules for emerging technologies, can cause significant hurdles to international transactions and compliance [3] [112] [136] [138]. High transaction costs discourage consumers from using digital payment methods, especially for cross-border payments [136] [135]. Finally, cultural and behavioral resistance, especially among older and less tech-savvy populations, continues to hinder the widespread adoption of these systems [89].

6.1 Limitation

In this section, we explore the limitations and threats to the validity of this study. According to Zhou et al. [140], the key threats to validity in SLR studies include restricted time span, bias in study selection, and data extraction bias.

The restricted time span restricts researchers from identifying other relevant studies that may fall outside this period. In this study, digital payments represent a rapidly evolving field where new technologies, regulations, and trends are introduced frequently. This means that studies published after the data collection period could not be included, potentially limiting the completeness of the results and missing emerging innovations. We have mitigated it by documenting the time frame of our search and ensuring comprehensive coverage of major databases to include the most relevant and up-to-date studies within the defined period.

The bias in study selection can arise from the subjective interpretation of inclusion and exclusion criteria during the study selection process. Given the diversity and ambiguity in terminology within the digital payments domain, there is a risk that relevant studies might have been inadvertently excluded or misinterpreted. We reduced this risk by clearly defining the inclusion and exclusion criteria before initiating the review process and adhering strictly to those criteria throughout the selection stage.

The data extraction bias poses a risk, particularly when the included studies discuss emerging technologies or evolving trends inconsistently defined across the literature. During the extraction process, this demanded some subjective interpretation. To minimize this, we developed a structured data extraction form in an Excel sheet to ensure consistency and completeness across all studies.

7 Conclusion

This thesis provides a comprehensive review of the current landscape of digital payments and possible future trends. The study aimed to address five primary research questions including the types of digital payment methods in use, the key drivers behind their evolution, the challenges hindering their adoption, the potential trajectories of their development, and the value these systems offer to different stakeholders. To achieve these objectives, the study employed SLR methodology to gather and analyze relevant academic and gray literature on digital payments. This structured approach ensured that the review was thorough, unbiased, and reflective of the field's research state.

The findings revealed that digital payments have evolved significantly due to technological advances such as blockchain, artificial intelligence, and the Internet of Things, alongside regulatory frameworks like PSD2 and supportive government policies. These developments have facilitated the adoption of payment systems like mobile payments, digital wallets, and cryptocurrencies, while CBDCs are emerging as a future cornerstone of financial ecosystems. Key drivers such as convenience, security, financial inclusion, and economic efficiency have fueled the rapid evolution of digital payments. However, challenges like cybersecurity risks, interoperability issues, regulatory uncertainty, and social resistance remain significant barriers to widespread adoption.

The study also highlights the benefits that digital payments provide to different stakeholders. Consumers benefit from convenience and speed, businesses gain operational efficiency and market expansion opportunities, financial institutions see improved profitability and service innovation, and governments achieve greater financial inclusion and transparency.

To support these insights, the thesis includes detailed analyses of various digital payment types and the trends shaping their adoption. This study also offers a structured overview table derived from the study's results, which serves as a table to summarize and categorize the insights. This table consolidates findings on digital payment methods, possible evolutions, their drivers, challenges, and stakeholder values, presenting them in an accessible format. By organizing the results systematically, the structured table not only reflects the core findings of the research but also provides a practical tool for policymakers, businesses, and researchers to assess current trends and identify areas for improvement or innovation.

During this study, several areas requiring further research were identified. Future studies should focus on monitoring emerging technologies like Agentic AI and IoT in payment ecosystems, examining the socio-economic implications of transitioning to cashless societies, exploring regional disparities in adoption, particularly in developing countries, and assessing the long-term impacts of digital payments on financial stability, consumer trust, and regulatory frameworks. As digital payments continue to evolve, understanding these aspects will be critical for navigating the challenges and opportunities in this dynamic field.

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