UNIVERSITY OF TARTU

Faculty of Social Sciences

School of Economics and Business Administration

Adam Barnett

KEY BUSINESS READINESS CHARACTERISTICS OF TECHNOLOGY STARTUPS

Masters Thesis

Supervisor: Professor Kadri Ukrainski

Tartu 2025

Abstract

This study examines the factors influencing the business readiness of technology startups across five dimensions: Technology, Market, Team and Talent, Business Model, and Funding. Various statistical techniques were applied to dataset derived from the application forms for startups that were successfully to the 2022, 2023 and 2024 cohorts of the Estonian site of the Creative Destruction Lab (CDL) accelerator to explore the question.

The analysis highlights varying levels of maturity amongst the five measures. Technology shows moderate variability and a slight negative skew, indicating most startups have commercially viable tech. Market readiness is generally intermediate, with some startups excelling in industry and competitor analysis. Business Model scores reveal high variability, reflecting a divide in strategic maturity. Most startups demonstrate strong financial backing in Funding, emphasizing its importance. However, Team and Talent scores are the lowest, suggesting startups may undervalue team dynamics or see accelerators as a means to address this gap.

The analysis also reveals key interrelationships between the measures. Strong alignment exists between Technology, Market, and, to a lesser extent, Business Model, for these pre-accelerator startups. The Funding measure appears more independent, indicating its role as an enabler. Team and Talent shows weaker correlations and varied patterns, highlighting its unique, context-dependent role.

On the basis of these results, practical recommendations are provided for startup program managers, founders, and policymakers, including emphasizing targeted support for team development and funding access. Future research suggestions include expanding the dataset to include data from other related sources, and applying additional segmentation.

Keywords: startups, startup ecosystems, technology startups, business readiness, accelerator programs, Creative Destruction Lab

CERCS classification: S190

I have written this Thesis independently. Any ideas or data taken from other authors or other sources have been fully referenced.

Table of contents

1. Introduction

An understanding of the factors that influence the business readiness of technology startups is a highly relevant area of research for numerous reasons. Firstly, insight into the challenges these ventures face will assist lawmakers in developing policies that will support the growth of this important sector of the economy. Additionally, entrepreneurs will gain insight into what practices and strategic decisions might support the creation of successful startup businesses, perhaps even leading to the building of a "unicorn". Alongside this, the many actors in the startup ecosystem including research organisations and universities, support organizations such as accelerators and incubators (Cohen, Fehder, Hochberg, & Murray, 2019), corporations who mentor and financially support startups, funding organizations such as banks, the Alternative Finance sector, innovation clusters, angel investors and Venture Capital (VC) funds, should be expected to benefit from insights into the likelihood of startup being ready to operate as a feasible business (Eisenmann, 2020; Albort-Morant & Oghazi, 2016).

Flowing from this, further relevance of research into the startup business readiness space is also supported by the phenomena of the low survival rate of startups (Adjei, 2021; Swamidass, 2013), and the related issue of addressing the various potential problems with the VC model of decision-making to encourage successful startup development (Gompers, Gornall, Kaplan, & Strebulaev, 2020; Villani, 2023). Given the increasing pace of technological change (Wolff, 2021), the criticality of strategic intelligence for emergent technology investment decision-makers and policy developers has never been more important, with the OECD identifying the robust technological assessment of startups as a core goal (European Commission et al., 2023).

Current research into this area is somewhat fragmentary, focusing, for example, on how specific actors such as universities encourage business readiness via technology transfer (Hasenauer, Gschopf, & Weber, 2016) or similar or associated but distinct measures such as entrepreneur coachability (Bryan, Tilcsik, & Zhu, 2017; Svetek, 2022). In this existing research, there is also a primary focus on *market* readiness (Sreenivasan & Suresh, 2023), such as product market suitability (Schuh, Studerus, & Hämmerle, 2022), with some neglect of other important *business* readiness factors such as team effectiveness, the ability to attract investors and the like.

This study will address this gap by attempting to provide a holistic view of the leading factors that influence the business readiness of technology startups. Both existing literature and empirical analysis will be employed to suggest the key factors influencing technology startup business readiness. The empirical analysis will be predominantly derived from a highly pertinent data source – the application documents of startup companies that have been successfully admitted to the Estonia site of the Creative Destruction Lab (CDL) programme for three successive cohort periods: 2022-23, 2023-24 and 2024-25. CDL is a non-profit programme that enrols science and technology startups with potential massive scale in an objectives-based program; it has 11 sites, located across North America, Europe and Australia (Creative Destruction Lab, 2024). Research derived from this important source would be expected to have potential applicability for both academic researchers and commercial practitioners.

Research questions are formulated as follows:

Q1: What are the leading business readiness characteristics of startups?

Q2: Are there any inter-relationships between these business readiness characteristics?

Regarding the structure of paper, following this introduction, the initial section will conduct a review of existing startup readiness related literature, with the aim of broadly identifying and define the key variables that influence startup business readiness as it stands in the most relevant current research. A proposed definition of startup business readiness, which encompasses five key measures of **Technology**, **Market**, **Team and Talent**, **Business Model** and **Funding**, is derived from this analysis.

The following sections will present the empirical approach. As noted above, the primary source of data is the application documents of startups successfully admitted to the Estonian site of the Creative Destruction Lab (CDL) programme for the 2022-23, 2023-24 and 2024-25 periods. Firstly, an overview of the nature and structure of the data and the methodological approach will be presented. The dataset has been created via assigning a score for each of the five measures identified for each CDL application, using a qualitative, yet structured, technique of assessing the information provided in the application. The dataset will then be analysed using various statistical techniques including descriptive statistics, and more advanced methods, to answer the two research questions. The conclusion and discussion section will highlight the chief findings of the study, examine the limitations, and suggest areas of future research.

2. Literature Review

2.1. Foundational definitions and concepts

Typically founded by one or more entrepreneurs, innovative technology startups focus on high-tech products and services, often employing emerging technology. Startups play a pivotal role in economic growth and job creation, as they frequently introduce market-disrupting innovations that establish entirely new industries (Al-Mubaraki & Busler, 2017). The concept of a "startup" has been defined in various ways within the academic research, reflecting its multifaceted nature (Ehsan, 2021). Influential definitions have been provided by Ries (2011, p. 27), who suggests a startup is a temporary organisation operating in an environment of high uncertainty, with the goal of developing a scalable, repeatable, and sustainable business model, and Blank (2013, p.63), who describes a startup as a temporary organisation formed to seek a consistent and competitive business strategy.

Another important aspect of startups to consider is the divide between those startups that considered conventional versus those that employ "deep technology". Deep technology, or "deep tech", is characterized by its foundation in tangible engineering innovations and scientific advancements, distinguished by their significant potential to drive transformative change (Huynh Evertsen, Rasmussen, & Nenadic, 2022). Unlike conventional technology startups, which often focus on incremental improvements or market-specific applications, deep tech ventures are centred on disruptive innovations that have the potential to redefine industries and reshape markets (Kruachottikul, Dumrongvute, Tea-makorn, Kittikowit, & Amrapala, 2023; De la Tour, Soussan, Harlé, Chevalier, & Duportet, 2017). Deep tech startups typically experience longer cash burn periods compared to more conventional startups, due to the more complex and resource-intensive nature of their development processes, meaning these two types of startups vary in the structure of their life-cycle (Gebru & Awal, 2021).

This leads to a consideration of the work that has been done by researchers in this area of startup life-cycles. Passaro (2016) proposed the following Startup Development Life-cycle Model:

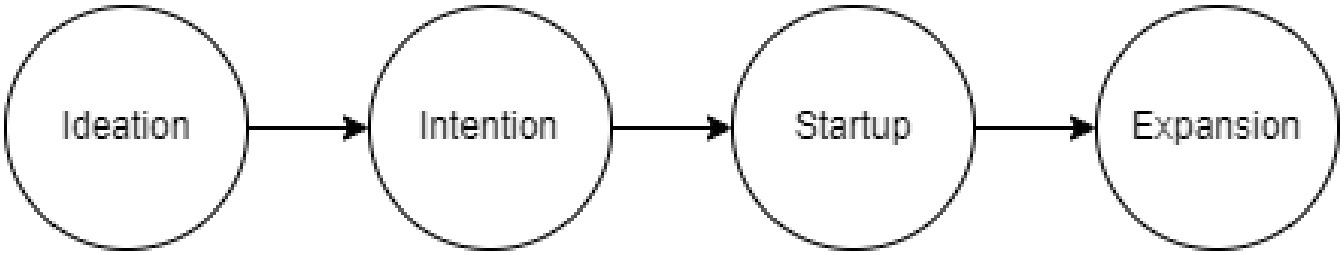

Figure 1. Passaro Startup Development Life-cycle Model
Source: Passaro (2016)

Passaro defines the *Ideation* phase as the stage when the entrepreneur(s) generate ideas for a business concept to solve a customer need or problem. The *Intention* phase is when the founder(s) evaluate the market potential of the business concept; here is where the evaluation of business readiness might be located. The *Startup* phase occurs once the business concept has been launched into the market; during this stage the business readiness level might be said to be evaluated by the response of customers to the product or service. Successful startups are then said to move into the *Expansion* phase, as the undertaking begins to scale.

Schuh, Studerus, and Hämmerle (2022) takes a slightly divergent approach, identifying the following four stages and goals, with a specific focus on deep tech startups:

Table 1
Stages of deep tech startup

#	**Startup Stage**	
1	Early Stage	Experimental or analytical **proof of concept**
2	Research and Development Stage	**Proof of readiness** for **production** and definition of **viable business model**
3	Growth Stage	**Proof of marketability** of **product** through exponential increase in demand
4	Late Stage	**Establishment of product portfolio** on same technological basis

Source: Schuh et al. (2022)

This model suggests that different readiness measures may be more critical depending on the life cycle stage of the startup, with some readiness-related factors acting as loose dependencies on other readiness-related factors.

A slightly more consolidated approach, with a stronger emphasis on external funding, is provided by Salamzadeh and Kawamorita (2015), who identify three phases of the startup life-cycle.

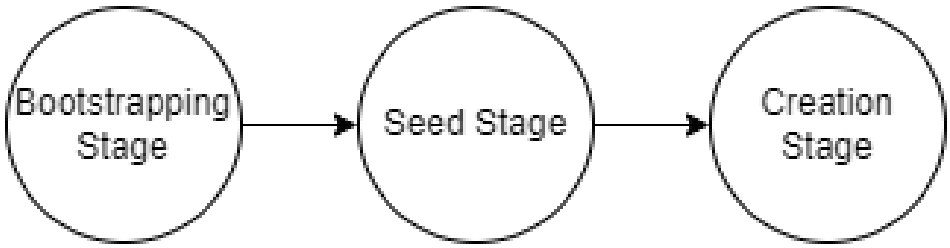

Figure 2. Salamzadeh and Kawamorita Startup Development Life-cycle Model
Source: Salamzadeh and Kawamorita (2015)

The *Bootstrapping Stage* encompasses the activities of the founder(s) into turning ideas into a viable business concept, thus business readiness issues and related risks are initially considered during this first phase in this model. The *Seed Stage* is when initial investment is sought for the startup; often this entails involvement in mentorship programmes, incubators, accelerators and the like, further advancing the business readiness of the startup. Finally, the *Creation Stage* occurs when product or service is launched.

Among the three life-cycle models discussed, the Salamzadeh and Kawamorita model is preferred due to its broader scope and less granular structure. This model provides a generalized framework for understanding the stages of a startup's life cycle, effectively capturing the distinct cash-burn dynamics characteristic of deep-tech startups compared to conventional startups, both of which are represented in the CDL application dataset. Furthermore, the model highlights the significance of pre-launch startups participating in accelerators and other support programs. For these reasons, this model serves as the primary basis for defining startup business readiness, as articulated below.

2.2. The INITS study – Technology and Market readiness

Early research (Adams, Bessant, & Phelps, 2006) proposed quantitative measurement of innovative undertakings. This factorial quantitative approach was subsequently followed by Hasenauer, Gschopf and Weber (2016), in their study of the INITS incubator located in Vienna, Austria. Using data derived from the documents of 57 startup firms, the study presents a number of consolidated measures of startup readiness, some of which have strong relevance for the measurement of startup *business* readiness.

Firstly, the INITS study identifies Technology Readiness Level (TRL), the “degree of a technology to be used safely by the intended and educated users in the envisaged commercial market or non-commercial user environment” (Gschopf & Weber, 2016, p. 1392), as a key component of startup readiness, in line with other research, for example

Héder (2017). The INITS measure identifies ten levels of readiness, starting with "fundamental research" at the earliest level, and culminating in a coherent definition of the business model at the most mature level (the table is reproduced in Appendix A). Although this measure is concerned with the maturity of the startup technological development, the score is ranked according to the level of commercial usability of the technology. An adapted version of the INITS **Technology** readiness measure will be used in current study, due to its relevance to business readiness and commercial emphasis.

The second main measure of readiness as defined by the INITS study is Market Readiness Level (MRL), which is described as measuring "the maturity of a given need in the market considering the potential obstacles" (p. 1392). Interestingly, although the measure is concerned with "market" readiness, the various levels are mainly concerned with activities that take place prior to market launch, culminating at the most advanced level, as with the TRL measure, with a coherent definition of the business model (the table is reproduced in Appendix A). An adapted version of the INITS **Market** readiness measure will be employed in the current study due to the broad orientation towards business readiness via the emphasis on business model maturity in the defined levels of the model.

2.3. The KTH Innovation Readiness tool: Business Model and Funding readiness

The taxonomic-oriented approach used by the INITS study is also employed by the Innovation Readiness Level tool provided by KTH Innovation, the entrepreneurship centre of the KTH Royal Institute of Technology, located in Stockholm, Sweden (KTH Royal Institute of Technology, 2024). The tool, which was developed via the organisation's work with coaching and incubating startups, evaluates startup readiness according to the various measures, with each of these measures assigned a readiness level of 1 to 9 (the table is reproduced in Appendix B). A number of relevant measures related to startup business readiness exist within the KTH measures.

Firstly, the Business Model Readiness Level (BRL), as defined in the KTH study, is concerned with the maturity of the startup business model. The identification of the importance of business model maturity for understanding startup business readiness is in line with other research such as Galper (2001), Magretta (2002), Osterwalder, Pigneur and Tucci (2005), and more recently Krueger and Van Der Beek (2024). Unlike the INITS taxonomy, the KTH study considers the development of the business model as distinct from other measures. It thus provides a higher level of descriptive granularity of that measure than the

INITS study, and thus will be used with some adaptation for the **Business Model** measure in the current study.

The KTH taxonomy also identifies access to funding as a critical measure of startup readiness via the Funding Readiness Level (FRL) measure (KTH Royal Institute of Technology, 2024). Funding as a primary business readiness measure for startups is also supported by the Gebru and Awal (2021) study, which examined a cohort of 143 Swedish startups, and found that the timing of funding significantly impacts startup firm growth. This concords with the work of Sreenivasan and Suresh (2023), who comment on the importance of the "financial resilience" of startups. "Financial resilience" is defined as the ability to "adapt to gradual change and abrupt unforeseen shocks to survive and thrive by enacting appropriate economic policies to decrease budget deficits" (p. 241). The researchers note that multiple funding-related enablers such liquidity planning and financial strategy contribute to the ongoing financial viability of startups in uncertain environments. Earlier studies including Deeds (2001), Swamidass (2013) and Markman, Phan, Balkin and Gianiodis (2005) also support the premise of the criticality of access to funding in various forms for the commercialization of technology originating in universities and elsewhere. The KTH **Funding** readiness measure with some modifications will be employed in the current study.

2.4. Atomico and KTH: Team and Talent readiness

Various aspects of the contribution of team expertise, social networks, access to mentors and related "team and talent" aspects are also prominent in the literature. For example, Swamidass (2013) observes the criticality of the training and mentorship of prospective entrepreneurs for successful startups, alongside other key factors:

"A successful new venture using university technology is, at the minimum, a three-legged stool; it needs three determining factors, intellectual capital, angel/venture capital and a strong management team. Weakness in any one of the three will topple the startup or it may never come into being" (p. 242-243).

Bryan, Tilcsik, & Zhu (2017) extensively explore the concept of "coachability" of startup founders, which is identified as the responsiveness of startup founders to advice and feedback from external sources such as mentors. Interestingly, one of the conclusions of data-based study of 470 applicant firms of the University of Toronto's Creative Destruction Lab (CDL) suggests that lower founder coachability responsiveness does *not* have a statistically significant impact on startup success. However, the study also observes that this lower level

of responsiveness is more prevalent in more mature startup management teams (p. 4-5). Somewhat contrasting research into the impact of mentorship has been provided by Yu (2016), who examined the influence of the participation of startups in accelerator programs. Yu identifies a statistically significant relationship between startup participation in accelerator programs and the time and level of startup closure, suggesting that feedback from external mentors and experts allow for more informed exit decisions by founders (p. 52). Svetek (2022) also comments on this interplay. The mixed evidence in the research suggests a potential trade-off between the importance of mentors and the expertise level of startup management teams. This aligns with the perspective of the current paper, which posits that access to mentors, as an indicator of startup readiness, should be viewed as a *contributing* component of the overall strength of the startup team's business readiness. In other words, mentorship should not be assessed in isolation but rather evaluated in conjunction with other people-oriented factors.

Flowing from this, the aforementioned KTH study identifies Team Readiness Level (TRL) measure (KTH Royal Institute of Technology, 2024) as another key measure of startup readiness. The KTH taxonomy provides a useful level of granularity for the concept of "team", incorporating not only the competency and capability of the internal team and management board, but also external advisers such as mentors. Additionally, the noteworthy European venture capital firm Atomico has developed a metric called STAR (Startup Talent Attraction Rating), which scores startup teams according to their ability to attract and retain key talent (Atomico, 2023, pp. 184–186). These measures will be combined to create a consolidated **Team and Talent** readiness measure for the current study.

2.5. Outcome of literature review

Overall, the literature review does confirm that there is noticeable, but perhaps navigable, gap in the existing startup readiness literature relating to the "business"-oriented readiness measures of startups, in contrast to more clarified metrics of market readiness and product readiness. Firstly, a proposed definition of **technology startup business readiness** follows, integrating and synthesizing the most useful and prominent concepts from the literature:

"Technology startup business readiness comprises those factors, including **technology** commercialization potential, the **market** viability of product or technology, the maturity of the **business model**, the level and structure of the access to **funding**, the clarity of **team and**

talent roles, including key team member retention and attraction strategies and access to mentors, that indicate the level of preparedness for a startup, whether **conventional** or **deep-tech**, to progress through the **bootstrapping**, **seed** and **creation** stages of development."

Each of the five readiness dimension described in the definition above is generally present within the sample of CDL application forms, suggesting they were considered during the CDL selection process. The measures were adapted from the KTH, INITS and Atomico taxonomies for the coding and data analysis as follows:

Technology: The 10-level INITS definitions and scale were used with minor phrasal modification. In particular, to integrate with the overall proposed taxonomy identifying Business Model as an independent, although potentially related measure, the highest level of Technology readiness is articulated as "Mature and functioning business model".

Table 2
Technology Readiness Level: The level of commercial viability of the technology owned and/or developed by the startup.

#	**Description**
1	Fundamental research in social/environmental context
2	Applied research in social/environmental context
3	Research to prove social/environmental feasibility
4	Social environment living lab demonstration
5	Social technology development
6	Whole system field demonstration
7	Compliant prototype
8	Technology acceptance
9	Market/sales certification
10	Mature and functioning business model

Market: The 10-level INITS definitions and scale were used with minor phrasal modification. In particular, to integrate with the overall proposed taxonomy identifying Business Model as an independent, although potentially related measure, the highest level of Market readiness is articulated as "Mature and functioning business model".

Table 3
Market Readiness Level: The level of potential of the potential market for the startup product.

#	**Description**
1	Unsatisfied needs have been identified
2	Identification of potential business opportunities
3	System analysis and social environment impact analysed
4	Market research
5	Target defined
6	Industry analysis with respect to social and environmental impact
7	Competitors analysis and positioning
8	Value proposition defined
9	Product/service defined
10	Mature and functioning business model

Business Model: The KTH definitions and scale were adapted. The KTH description for each level was consolidated to broaden the scope and nuance of the definition. As the KTH measure has a 9-level scale, a lowest ranking level ("No discernible business idea") has been added to ensure consistency with the other measures and ease of analysis.

Table 4
Business Model Readiness Level: The level of maturity and clarity of the business model of the startup.

#	**Description**
1	No discernible business idea.
2	Non-existing or vague and unspecific description of the potential business idea, value proposition or business model.
3	Described the proposed business concept and value proposition in some structured form.
4	Description of a proposed business model in place (e.g. in canvas format).
5	First version of simplified Profit and Loss projections for proposed business model (main costs, main revenue streams) indicate economic viability (based on own assumptions and guesstimates).
6	Received feedback on cost and revenue side of business model (e.g. revenue model, pricing, etc.) from a few potential customers or persons with market knowledge (experts).
7	Complete sustainable business model and financial projections based on feedback from realistic business case displaying economic viability.
8	First sales/revenue on commercial terms demonstrate willingness to pay from significant number of customers.
9	Sales and other metrics from initial business operations (1-3 years) show sustainable business model holds and can meet internal and external expectations on profit and scalability.
10	Sustainable business model is operational and business meets or exceeds internal and external expectations on profit, growth and scalability.

Funding: The KTH definitions and scale were adapted. The KTH description for each level was consolidated to broaden the scope and nuance of the definition. As the KTH measure has a 9-level scale, a lowest ranking level ("No engagement with funding issues.") has been added to ensure consistency with the other measures and ease of analysis.

Table 5
Funding Readiness Level: The ease of access to required capital sources, encompassing also the commitment level of potential or existing funding sources.

#	**Description**
1	No engagement with funding issues.
2	Little insight into different funding options and funding types.
3	Initial activities and costs to verify potential/feasibility if idea is described (e.g. 1-6 months).
4	Awareness of different funding types (own, soft, equity, customer, etc.) and typical pros/cons.
5	Identified relevant long-term funding sources.
6	Decided on funding strategy and funding sources to reach a viable business model - based on pros/cons of the different strategies.
7	3-5 year PnL budget and cash flow for business/project in spreadsheet format that clarifies near and medium term funding needs.
8	Discussions with potential external funding sources around a defined offer (how much money, for what, conditions, valuation, etc.).
9	Concrete discussions (term sheet level) with one or several external funding sources that clearly are interested.
10	Secured funding for at least 6-12 month runway according to current business plan/operational plan – the money is on the bank account or predictable recurring revenue.

Team and Talent: The Startup Talent Attractiveness Rating (STAR) measure created by Atomico was consolidated with the Team measure of KTH, as these measures are broadly inter-related and have a close taxonomic correspondence. The core concepts in the KTH and STAR level definitions were incorporated into a briefer description, to broaden their scope and nuance.

Table 6

Team and Talent Readiness Level: The level of clearly defined roles and responsibilities within the startup team, their capacity and competence, and also access to key external mentors and networks, including the ability of the startup to attract and retain key talent.

#	**Description**
1	No team assembled. Little or no access to external mentors and networks.
2	Typically an individual lacking necessary competencies in key areas such as tech, business etc. Minimal access to external mentors and networks.
3	Limited competencies and/or capacity present - typically 1-2 persons. Minimal access to external mentors and networks.
4	One or several individuals that possess some, but not all, of necessary competencies and capacity to start verifying the idea. Some access to external mentors and networks.
5	Aligned team with clarified roles, shared goals and visions, and clear commitment (e.g. time spent). Standard mentor relationships and network.
6	Several, but not all, necessary team competencies are present, typically multiple individuals. Standard mentor relationships and network.
7	All key competencies and capacity necessary for the near term are present, including a clear CEO. Standard mentor relationships and network.
8	Well-functioning team with clear roles, goals, vision, purpose, and culture. Strong mentor relationships and network.
9	Clear leadership and management team with relevant professional experience. Exceptional mentor relationships and network.
10	The management team and organisation is high performing, well-functioning and continuously (cooperation, social environment, etc.). Embedded mentor relationships and network.

3. Analysis of Data

3.1. About Creative Destruction Labs (CDL)

Creative Destruction Labs (CDL) provides programmes for science and technology startups. It was established in Canada in 2012, in association with the Rotman School of Management of the University of Toronto. The original goal of CDL was to promote Canada as a centre for the commercialization of intellectual property created by university research. The mission of the organization has subsequently broadened with a more international focus, with the impressive stated aim of commercializing technology to benefit all humanity. CDL offers a variety of programs for entrepreneurs encompassing practical training, mentorship and access to funding with the aim of maximising the likelihood of these entrepreneurs creating a successful startup. Success is measured through the creation of equity value; participant companies in CDL have generated over $28 Billion in equity. The global focus of CDL has also lead to the establishment of sites throughout the world, including the United States, Australia, France and Estonia (Creative Destruction Lab, 2024). Business analytics firm CB Insights identifies CDL as a top ten startup accelerator internationally, with a count of 578 deals closed during the 2020-22 period (CB Insights Research, 2024).

3.2. Research Design

3.2.1 Approach

An exploratory research methods, via exploratory factor analysis (EFA), has been selected for this study due to the novelty of the data source and the limited availability of pre-existing theoretical frameworks or empirical evidence to guide the analysis. EFA allows for the identification and understanding of the underlying structure of a dataset without imposing predefined assumptions about the number or nature of latent constructs (Yong & Pearce, 2013). This approach is essential when there is insufficient prior knowledge to justify a confirmatory factor analysis (CFA), which requires a well-established theoretical model and predefined hypotheses about factor structure and variable relationships (Fife & Rodgers, 2021).

3.2.2 Data Collection

The primary source of data consists of 60 application documents submitted by startups that were successfully admitted to CDL-Estonia for the 2022-23, 2023-24 and 2024-25 cohorts. It is important to note that the forms were completed and submitted after extensive discussion with the programme selectors. An example structure of the application

document provided by these startups is in Appendix C. Further information about the segmentation split of the startups (venture stage, NAICS sector, country, the year of registration or incorporation and employee size) is provided in Appendix E. Note that due to privacy and non-disclosure requirements, venture-specific data cannot be replicated.

This data source of 60 applications (N=60) was coded across the five identified dimensions derived from our analysis of the existing startup readiness literature above: **Technology**, **Market**, **Business Model**, **Funding** and **Team and Talent**. Each dimension was scored on a 10-point Likert scale (1 = lowest, 10 = highest).

Appendix D describes the coding rules in detail. The section(s) of the application forms noted in the column "Core section(s) in CDL application forms" was consulted primarily to derive the codes for each measure, but if relevant information was outside the core section this was also evaluated. The level of code assigned was according to the broad guidelines described in the "Details in CDL Application" column, via a nuanced and qualitative assessment. For example, if the application form describes a commercialised product launch, the Technology Measure was assigned a score of between the range of 8 and 10, depending on the maturity of the commercialisation; such as when the launch occurred, the sales volume, etc. Those forms where relevant information for the measure was not provided, whether in the core sections or outside them, were generally coded with a lower score for that dimension.

It is important to recognise that there are some limitations for both the initial source of data the derived dataset employed in the analysis. Firstly, it should be noted that all information in the application forms, including quantitative-oriented details such as funding levels, are self-reported, creating the possibility of inaccuracy. Secondly, the application forms are all for startup firms that, as noted above, have been previously pre-selected via discussions with the CDL selectors, and so in some cases relevant information may not have been captured on the form.

3.2.3 Methodology and Data Analysis

To address the first research question (**Q1: What are the key business readiness characteristics of startups?**), a descriptive statistical analysis was conducted, which was subsequently integrated with the five business readiness measures. Descriptive statistics serve to identify underlying patterns and outliers, thereby offering a clearer insight into the characteristics that shape startup business readiness. Additionally, swarm plots for each of the

five dimensions were generated and analyzed to explore the distribution of each individual measure. The approach enables a comprehensive understanding of data distribution, variability and trends of the five startup readiness measures. The Python programming language and associated libraries was used to generate most of the analysis.

To answer the second research question (**Q2: Are there any inter-relationships between these business readiness characteristics?)**, firstly, bivariate analysis was performed via pairwise scatterplots and Pearson's correlation coefficient to measure the strength and direction of the individual interrelationships of the five readiness measures. Then, principal component analysis (PCA) was conducted to explore multivariate interdependencies, to enable a holistic view of the interrelationships by identifying clusters or groupings of related characteristics, providing insights beyond pairwise correlations. The combination of bivariate and mulitvariate techniques allows for a more comprehensive analysis of the interrelationships between the five startup readiness measures, in line with the exploratory nature of the analysis (Fife & Rodgers, 2021). As with **Q1**, The Python programming language and associated libraries was used to generate most of the analysis.

4. Results

Q1: What are the leading business readiness characteristics of startups?

The following presents the results of various methods of descriptive statistical analysis performed on the coded CDL application dataset to answer the question. This analysis focuses on uncovering key patterns and trends within the data, providing a detailed snapshot of these startups, highlighting the leading business readiness factors at this critical stage of development.

Firstly, the following summary statistics were derived from the coded dataset of the five measures:

Table 7
Summary Statistics

	Measures				
	Technology	**Market**	**Business Model**	**Funding**	**Team and Talent**
Lowest Value	2	3	2	1	2
First Quartile	6.75	5	3	9	3
Median	7	7.5	4	9	4
Mean	7.07	6.58	5.32	8.7	3.81
Third Quartile	8	9	8	9	4
Highest Value	9	10	10	10	8
Standard Deviation	1.51	2.05	2.50	1.57	1.61

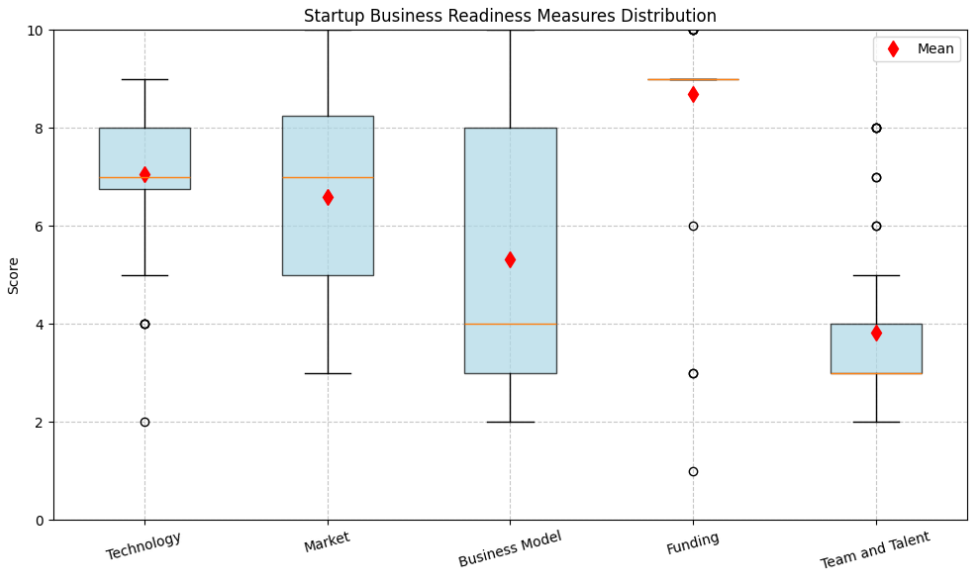

Figure 3. Summary Statistics box plot

The distribution of scores illustrate a noteworthy degree of variability among the measures:

Technology: The consolidated measure demonstrates a relatively symmetric distribution with a median value of 7, indicating a slight negative skew. The interquartile range (IQR = 1.25), calculated as the difference between the first quartile (6.75) and third quartile (8), suggests low variability in technological scores. The mean (7.07) aligns closely with the median, indicating minimal distortion by extreme values. The range spans from a minimum of 2 to a maximum of 9, indicating some lower outliers. The standard deviation of 1.52 indicates a moderate spread.

With some exceptions, the majority of startups in the CDL sample have, as a minimum, a commercially viable prototype product or service. This might suggest that startups, prior to entering accelarators or similar programmes, tend to have technology that is relatively commercialized.

Market: The measure for Market demonstrates a slightly positive skew, with a median value of 7. The interquartile range (IQR = 4) spans from the first quartile (5) to the third quartile (8.25), indicating moderate variability in market assessments. The mean (6.58) is slightly lower than the median, reflecting potential influence from lower outliers. The data range, from a minimum of 3 to a maximum of 10, shows a broad distribution. The standard deviation of 2.05 suggests considerable variability.

The wide data range might suggest that while most startups are perceived as having moderate to high readiness in terms of market conditions, there is some inconsistency in the level of market engagement, possibly reflecting diverse market environments.

Business Model: The consolidated measure shows a slightly positive skew, with a median value of 4. The interquartile range (IQR = 5), calculated between the first quartile (3) and third quartile (8), indicates substantial variability in business model assessments. The mean (5.32) is notably higher than the median, reflecting the influence of higher scores on the distribution. The range spans from a minimum of 2 to a maximum of 10, showing a broad spread. The relatively high standard deviation of 2.5 underscores significant variability in this category.

The significant variability in **Business Model** scores might suggest that a partial impetus for some startups in the sample to enter the accelerator is to refine their strategic

business approach, while the others with more mature business models might have other motivations.

Funding: The measure demonstrates a strong positive skew, with a median value of 9. The zero interquartile range (IQR = 0) reflects a concentration of scores between the first quartile (9) and third quartile (9), suggesting a high level of uniformity among funding outcomes. The mean (8.7) aligns closely with the median, indicating minimal impact from outliers, despite the very wide range of a minimum of 1 to a maximum of 10. The relatively low standard deviation of 1.57 also highlights a consistent performance in funding metrics.

Thus the majority of startups in the dataset are generally well-supported financially *prior* to entering the CDL programme. This strongly supports the premise that concrete access to funding is crucial for startup business readiness.

Team and Talent: The measure for **Team and Talent** shows a slightly negative skew, with a median value of 3. The interquartile range (IQR = 1), spanning from the first quartile (3) to the third quartile (4), indicates low variability in scores. The mean (3.82) is close to the median, suggesting little impact from outliers, despite the broad range extending from a minimum of 2 to a maximum of 8. The standard deviation of 1.61 reflects moderate variability in this measure, indicating some inconsistency in team and talent capabilities.

This suggests that, at least on the basis of this sample, pre-accelerator startups have less developed team structures, as well as a lower level of engagement with mentors and associated mentor networks. This is in line with other research suggesting that people-based factors are a less important contributor to the business readiness of startups (Adjei, 2021).

Secondly, five swarm plots were generated to explore each of the five dimensions.

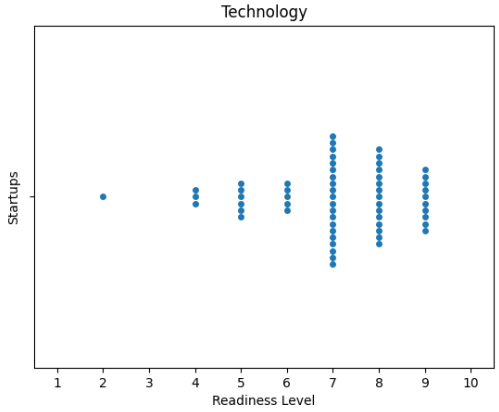

Figure 4. Technology swarm plot

The swarm plot for the **Technology** dimension reveals a relatively concentrated distribution of values, with a few noticeable peaks at scores of 8 and 9. The central tendency appears to be skewed slightly towards higher values. These results could imply that, in general, a higher level of commercialization-orientation of technology is prevalent for pre-accelerator startups.

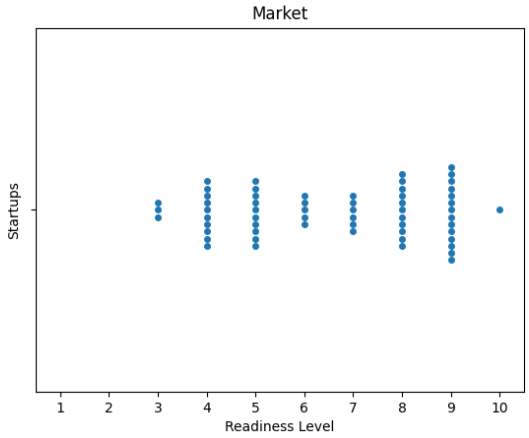

Figure 5. Market swarm plot

The swarm plot for the **Market** dimension demonstrates a wider distribution of values, with significant clustering at the higher end of the scale (around 8 and 9). However, there is a noticeable spread towards the lower values (scores of 3 and 4). The higher frequency of values at 9 indicates that most, but not all, of the startups in the dataset have a moderate-to-high level of market engagement.

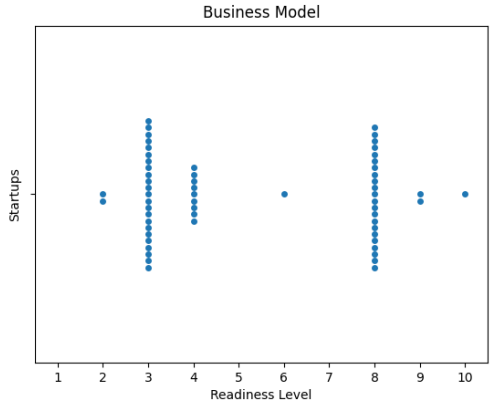

Figure 6. Business Model swarm plot

The **Business Model** swarm plot shows a more varied distribution, with values ranging significantly from 1 to 10. This wide spread is indicative of differing levels of strategic engagement. A majority of points are clustered around the lower end (scores of 3 and 4), suggesting that many startups may be in the early stages of refining their business model. The smaller cluster at 8 and 10 might suggest that there are startups with mature business models who are entering CDL for other reasons.

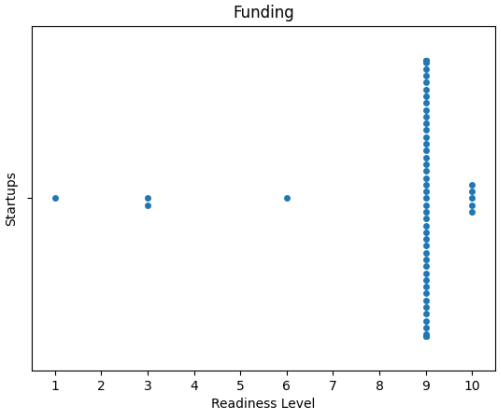

Figure 7. Funding swarm plot

The swarm plot for the **Funding** measure reveals a generally high concentration of values clustered around 9, with a few outliers. The central tendency towards higher funding scores does seem to reflect the importance of investment capital in driving startups to successfully achieve accelerator entry. However, the presence of outliers with lower scores

might indicate a minority are entering CDL to improve their engagement with potential funding sources.

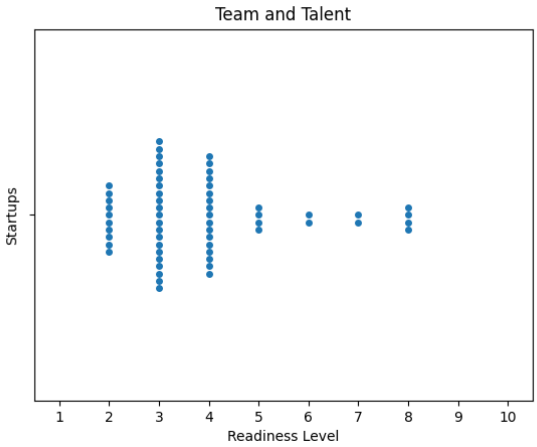

Figure 8. Team and Talent swarm plot

Team and Talent swarm plot shows a distribution that is relatively skewed towards lower values, with many entities scoring between 2 and 4, with a few outliers on the higher end. This does seem to suggest that pre-accelerator startups have less focus on "people" measures prior to seeking entry, as per prior analysis.

The analysis of startup business readiness across the five dimensions of **Technology**, **Market**, **Team and Talent**, **Business Model**, and **Funding** reveals a degree of diversity amongst these measures prior to their entry to the accelerator. The **Technology** dimension, with moderate variability and a slight negative skew, suggests that most pre-accelerator startups have technology with at least a minimum level of commercial viability. The **Market** readiness scores within the sample indicate a generally intermediate level of engagement with issues such as industry and competitor analysis, with a few of the startups displaying a far stronger participation. The high variability in the **Business Model** readiness score suggests an interesting divide between the levels of strategic maturity of the startups in the sample. The results for the **Funding** measure demonstrate that most of the startups in the sample possess substantial financial support, underscoring the criticality of this factor. The **Team and Talent** consolidated score is noteworthy for having the lowest averages of all the dimensions, suggesting a lower emphasis placed on team structure and mentor engagement for these startups. This may suggest that many startups enter accelerators with the aim of enhancing

their readiness in the “people” areas, or alternatively, they may not perceive such factors as critical to their success.

Q2: Are there any inter-relationships between these business readiness characteristics?

The following presents the results of the statistical and visual/graphical techniques used to explore the inter-relationships between the five defined business readiness characteristics in the dataset. A large number of interesting relationships were highlighted by the analysis.

Preliminary bivariate scatterplot analysis was conducted on pairwise combinations of the five business readiness variables. The scatterplots revealed several notable patterns.

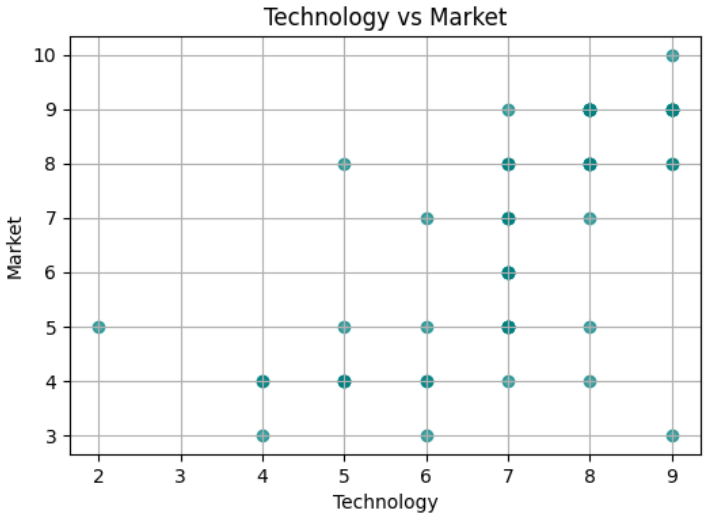

Figure 9. Technology versus Market measures scatterplot

The scatterplot shows a positive correlation between **Technology** and **Market** scores. Higher **Technology** scores tend to align with higher **Market** scores, suggesting that technological advancements are often associated with stronger market potential. However, some variability exists, particularly for mid-range values.

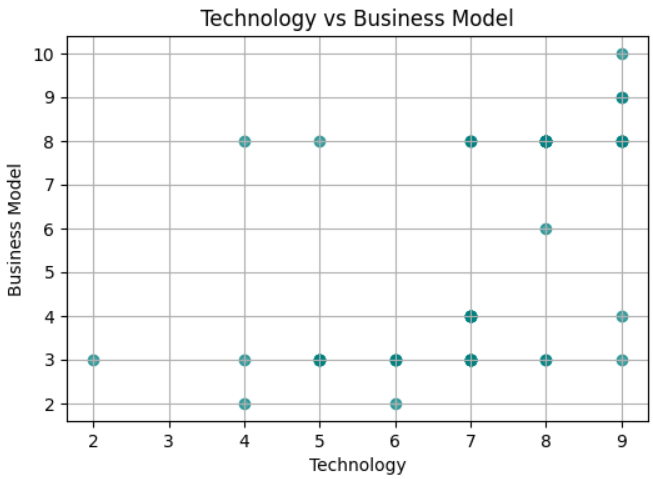

Figure 10. Technology versus Business Model measures scatterplot

This scatterplot reveals no strong correlation between **Technology** and **Business Model** scores. While some high **Technology** scores correspond to robust **Business Models**, there is significant dispersion, indicating that technological strength does not necessarily predict business model maturity for startups in the sample.

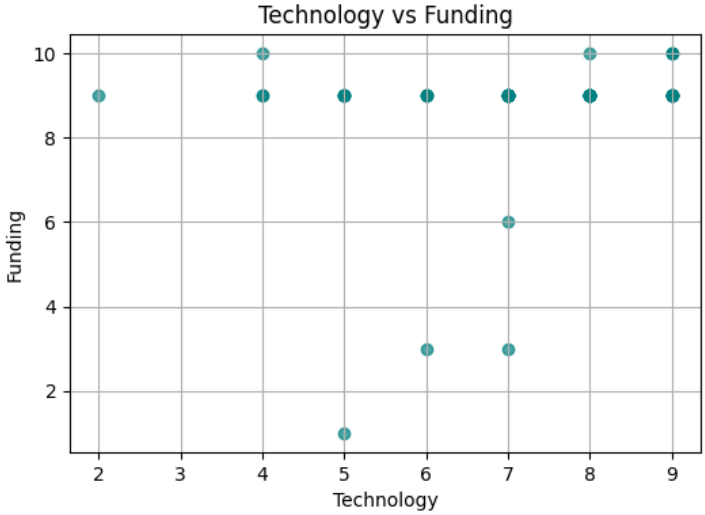

Figure 11. Technology versus Funding scatterplot

The **Technology** and **Funding** scatterplot exhibits a positive trend. Higher **Technology** scores are associated with greater levels of **Funding**, possibly indicating that startup firms with stronger technological foundations are more likely to secure higher financial support, or alternatively higher funding leads to the development of more commercially-oriented technology.

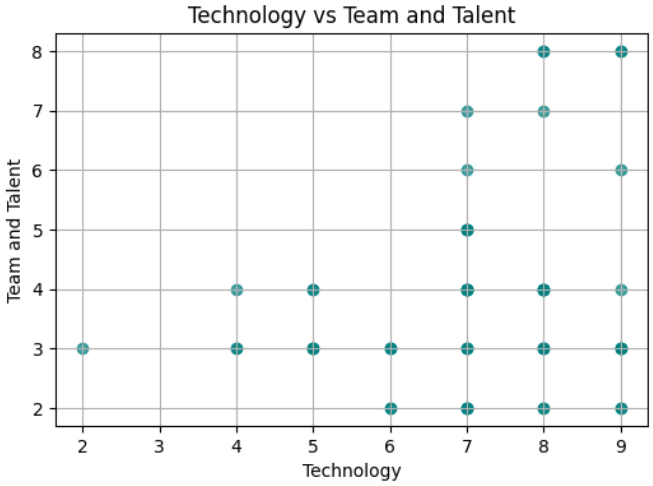

Figure 12. Technology versus Team and Talent scatterplot

The relationship between **Technology** and **Team and Talent** measures appears weak. While a few high **Technology** scores coincide with moderate **Team and Talent** scores, the scatterplot displays considerable variation, suggesting that team strength is not consistently aligned with technological performance.

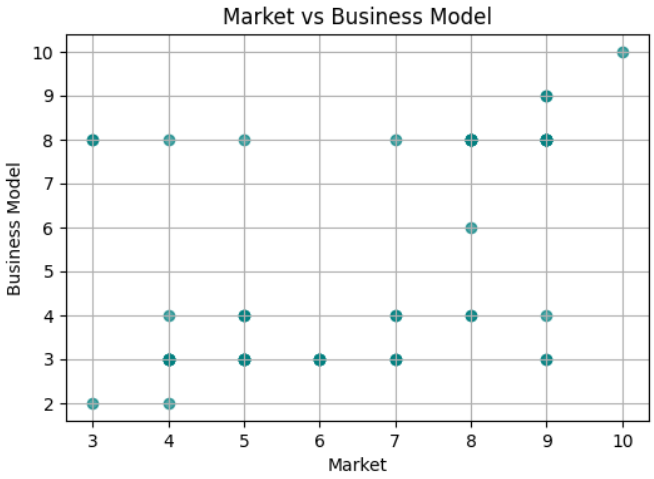

Figure 13. Market versus Business Model scatterplot

A moderate positive correlation can be observed between the **Market** and **Business Model** scores. Higher **Market** scores tend to correspond with stronger **Business Models** in the dataset, which may reflect that startups with more mature business models are better positioned for market engagement.

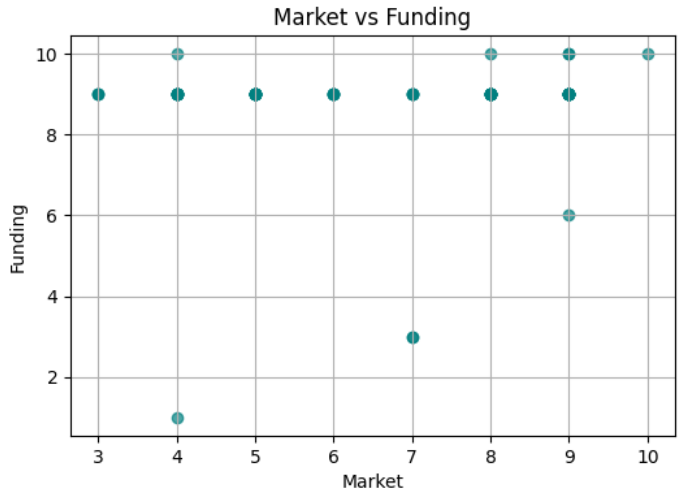

Figure 14. Market versus Funding scatterplot

The scatterplot suggests a strong positive relationship between **Market** and **Funding** scores. Startups in the dataset that have higher **Market** scores are typically well-funded, reinforcing the notion that market potential attracts financial investment.

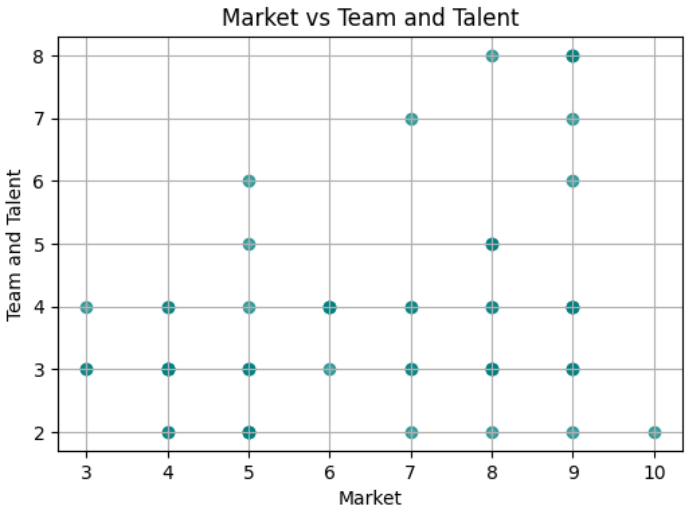

Figure 15. Market versus Team and Talent scatterplot

This scatterplot indicates no strong correlation between **Market** and **Team and Talent** scores, suggesting these factors are independent of each other for pre-accelerator startups.

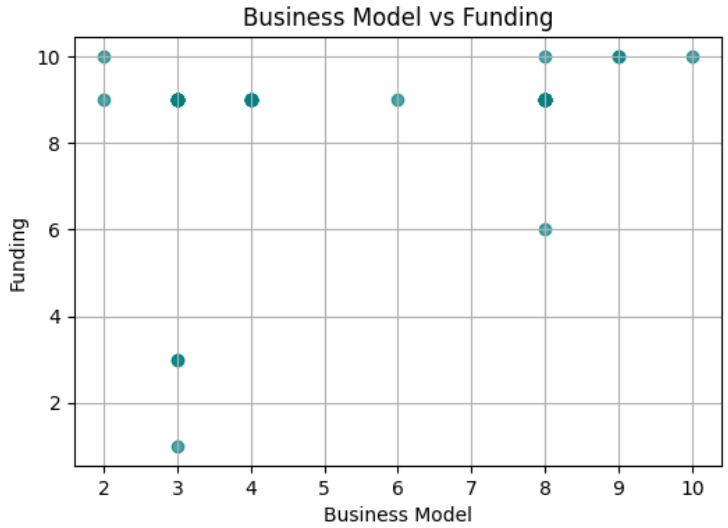

Figure 16. Business Model versus Funding scatterplot

A clear positive relationship exists between **Business Model** and **Funding** scores. Those startups in the dataset with more mature business models generally have strong access to funding, perhaps suggesting that investors prioritize firms with well-defined and scalable business frameworks.

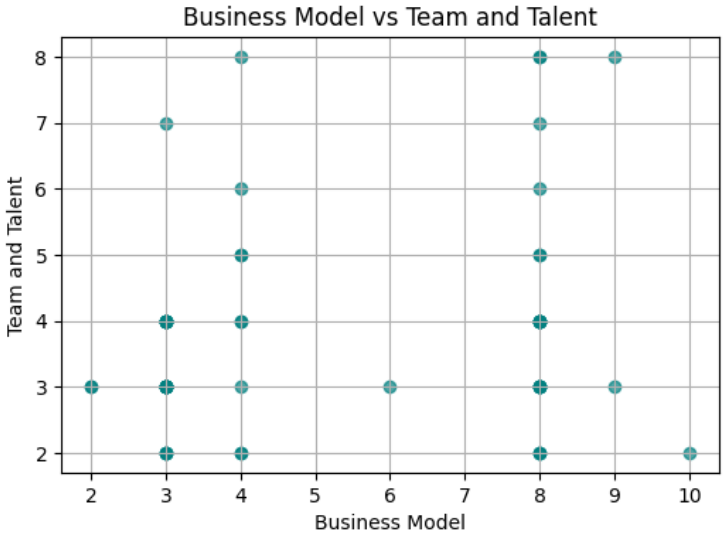

Figure 17. Business Model versus Team and Talent scatterplot

The scatterplot shows a weak correlation between **Business Model** and **Team and Talent**. Despite some outliers, the overall spread suggests that team strength does not seem to consistently drive business model maturity for pre-accelerator startups.

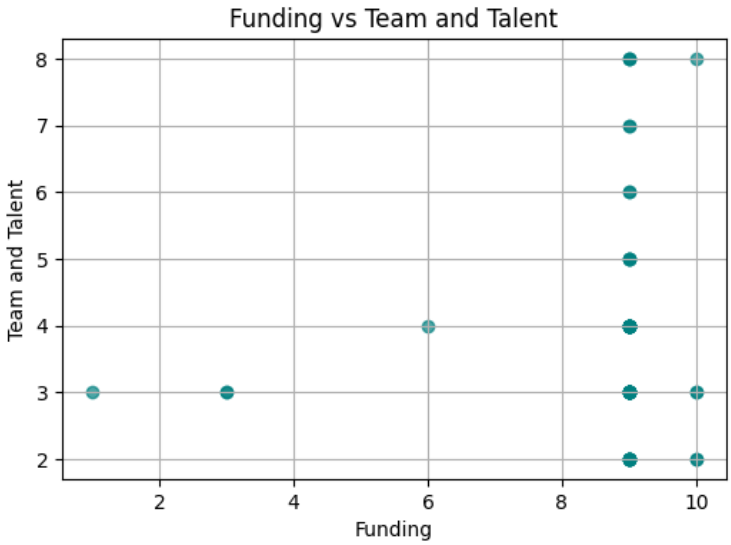

Figure 18. Funding versus Team and Talent scatterplot

The **Funding** versus **Team and Talent** scatterplot reveals limited correlation. With some exceptions, the overall dispersion suggests that funding levels are influenced by other factors beyond team quality for startups in the sample.

A consistent theme in the scatterplot analysis is the strong positive correlation between **Technology** and **Market**, suggesting that advancements in technology often align with market engagement for startups. Similarly, **Funding** exhibits relatively stable correlations with the other measures, particularly with **Market** and **Business Model**, underscoring the importance of this measure in contributing to overall startup business readiness. In contrast, **Team and Talent** tends to show weaker and more varied associations, indicating its role as a more independent or heterogeneous factor. The visual dispersion in several plots suggests that certain attributes, such as **Business Model**, may operate under context-specific influences.

Secondly, a correlation analysis using Pearson's correlation coefficient was conducted on the dataset.

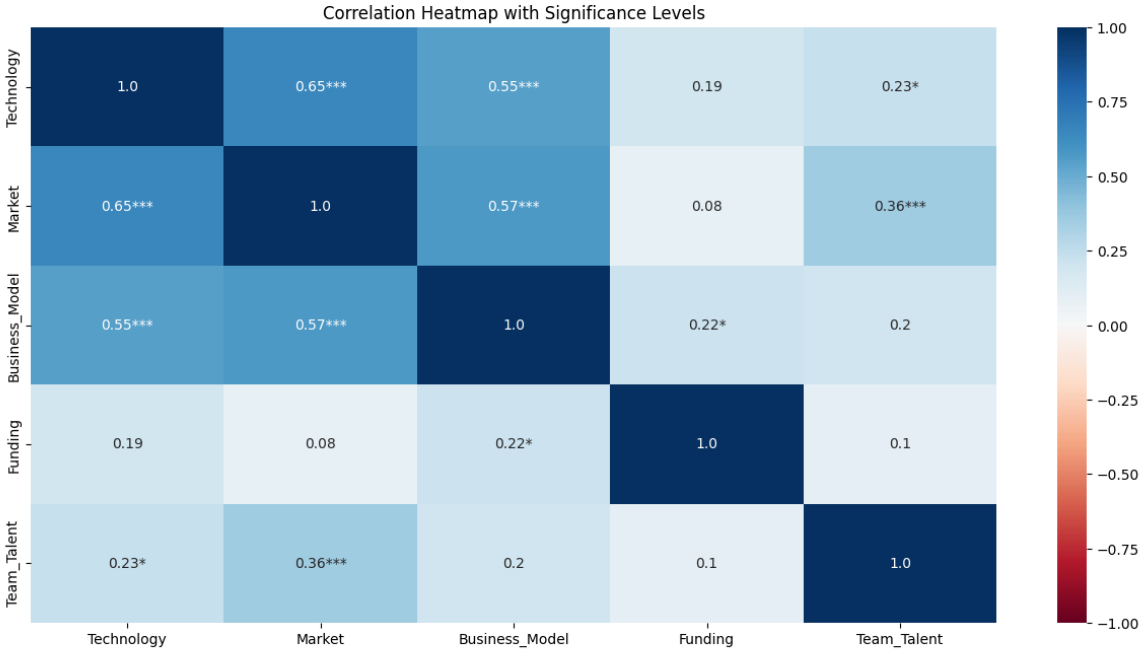

Figure 19. Heatmap of Pearson Correlation Analysis (PCA)

The correlation analysis revealed several significant relationships between the business readiness characteristics. Strong positive correlations ($r > 0.6$) were observed between **Technology** and **Market** scores, as well as between **Technology** and **Team and Talent** scores. **Market** and **Team and Talent** measures also demonstrated a substantial correlation.

Moderate positive correlations ($0.3 < r < 0.6$) were found between **Business Model** scores and both **Technology** and **Market** scores. Notably, **Funding** scores showed weak or slightly negative correlations with all other variables ($-0.2 < r < 0.2$), with the strongest correlation being with **Team and Talent**.

For the sample size (N=60), correlations exceeding $|r| = 0.214$ are statistically significant at the $\alpha = 0.10$ level (two-tailed). The higher α-level was chosen due to the exploratory and nuanced nature of the data and analysis, as well as the small-to-medium sample size. The correlation data suggests that the relationships between the **Technology**, **Market**, and **Team and Talent** dimensions represent meaningful patterns rather than random variation.

Thirdly, principal component analysis (PCA) was performed on the dataset. The results were as follows:

Table 8
Loading Matrix

	PC1	PC2	PC3	PC4	PC5
Technology	0.841750	-0.032993	-0.223875	-0.391466	-0.322416
Market	0.862103	-0.245564	-0.078736	-0.131792	0.435727
Business Model	0.799885	0.060920	-0.277284	0.534495	-0.104165
Funding	0.324736	0.928789	0.192405	-0.065761	0.086624
Team and Talent	0.494386	-0.224251	0.840719	0.074749	-0.099229

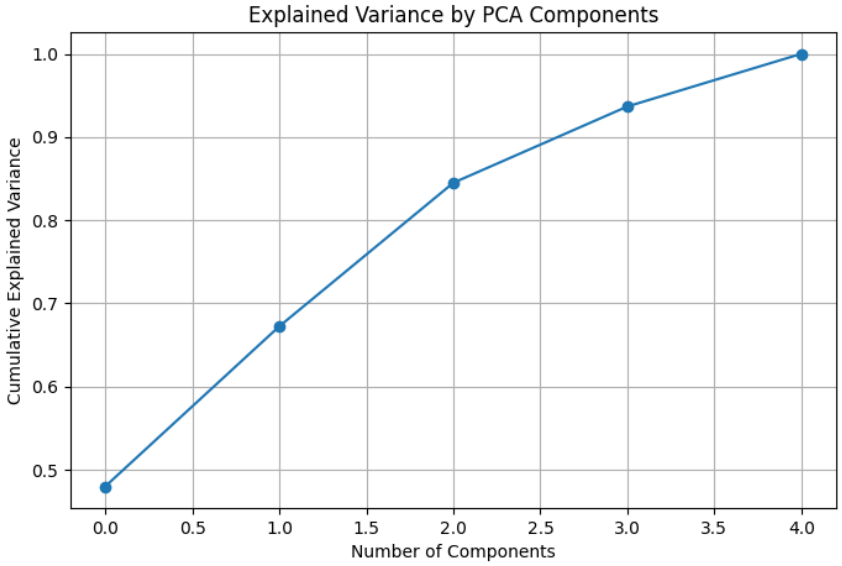

Figure 20. Explained variance plot

The explained variance analysis indicates that the first principal component (PC1) accounts for 48% of the total variance, signifying its critical role in capturing key dimensions of startup business readiness. The loading matrix reveals that PC1 is most strongly influenced by **Technology**, **Market**, and **Business Model**, suggesting these measures are strongly interrelated and develop in tandem. The addition of the second principal component (PC2) increases the cumulative explained variance to 67.2% and is primarily driven by **Funding**, reflecting the importance and independence of this factor. The inclusion of the third principal component (PC3) raises the cumulative explained variance to 84.5%, with **Team and Talent** being the dominant variable, perhaps indicating that this also operates independently of the others. The remaining components, PC4 and PC5, contribute less explanatory power, however further investigation may be warranted.

The statistical analyses—the scatterplots, Pearson's correlation, and the principal component analysis (PCA)—provide complementary insights into the interrelationships among the five business readiness dimensions. Across all methods, a consistent theme emerges regarding the strong alignment of **Technology** and **Market**, and to a lesser extent **Business Model**, suggesting their mutual inter-relationship. **Funding**, however, generally seems to operate more independently, as demonstrated by its stable but moderate correlations in the scatterplots and its dominant loading on the second principal component of the PCA analysis. This independence might suggest that financial resources often act as an enabling factor for technology startups, but are less interdependent on other measures. **Team and Talent** consistently exhibits weaker correlations and varied scatterplot patterns, emphasizing its unique and potentially context-dependent role within the dataset. Together, these findings highlight the mutli-faceted relationship between the five startup business readiness measures, which have significant implications for prioritizing resources and strategies for both founders and other ecosystem participants.

5. Conclusion and Discussion

Arguably, the leading contribution of this study is the clarification and validation of the five measures of startup business readiness (**Technology**, **Market**, **Business Model**, **Funding** and **Team and Talent**); it is hoped that this taxonomy may be useful for subsequent quantitative and qualitative research into this area. Almost as important is the finding that there is likely a complex and overlapping interrelationship between the dimensions in the proposed taxonomy, suggesting that startup business readiness evaluation must have an awareness of factorial nuances and inter-dependencies.

Arguably, this study's primary limitation is the potential bias stemming from the relatively small to medium sample size and the exclusive reliance on data from a single startup accelerator program in one national setting. Future research could address these limitations by incorporating data from additional CDL offices, earlier cohorts, and startups that were seriously considered but ultimately not admitted to the CDL programme. Comparative analyses with data from other startup support organizations could further enrich the findings. Additionally, future studies might examine the success trajectories of startups with different business readiness levels following completion of the CDL programme. Another promising extension of this area of research could involve analyzing a segmented dataset based on the factors outlined in Appendix D (e.g., Venture Stage, NAICS Sector,

Country, Year of Registration/Incorporation, and Number of Employees) and integrating additional documentary sources into the dataset, such as pitch decks and interviews with founders and selectors.

Despite these caveats, it is hoped that this study offers several practical applications for all stakeholders within the startup ecosystem. For startup programme managers and selectors, the identified readiness dimensions can serve as a framework for refining selection criteria, enabling a more targeted admission process that prioritizes startups with well-defined business models, robust funding access, and market readiness. This framework also highlights key areas, such as team and talent development, where startup programmes might provide more intensive support to enhance a startup's operational capacity post-admission. For founders, understanding these readiness dimensions offers a roadmap to optimize their ventures before seeking startup accelerator or incubator entry, particularly by focusing on attracting strategic talent and securing sustainable funding sources. Additionally, these insights are valuable for policymakers and educators who support entrepreneurship, as they emphasize the need for resources and training that cultivate core readiness factors, ultimately bolstering the broader innovation ecosystem.

References

1. Adams, R., Bessant, J., & Phelps, R. (2006). Innovation management measurement: A review. *International Journal of Management Reviews, 8*(1), 21–47. https://doi.org/10.1111/j.1468-2370.2006.00119.x

2. Adjei, E. K. (2021). Surviving start-ups: The importance of entrepreneurial capital. *Regional Studies, Regional Science, 8*(1), 239–258. https://doi.org/10.1080/21681376.2021.1927813

3. Albort-Morant, G., & Oghazi, P. (2016). How useful are incubators for new entrepreneurs? *Journal of Business Research, 69*(6), 2125–2129. https://doi.org/10.1016/j.jbusres.2015.12.019

4. Al-Mubaraki, H., & Busler, M. (2017). Challenges and opportunities of innovation and incubators as a tool for knowledge-based economy. *Journal of Innovation and Entrepreneurship, 6,* Article 7.

5. Adjei, E. K. (2021). Surviving start-ups: The importance of entrepreneurial capital. *Regional Studies, Regional Science, 8*(1), 239–258.

6. Anthropic. (2024). *Claude* [Large language model]. https://www.anthropic.com/

7. Atomico. (2023). *State of European tech 2023*. Atomico.

8. Blank, S. (2013). Why the lean start-up changes everything. *Harvard Business Review, 91*(5), 63–72.

9. Bryan, K. A., Tilcsik, A., & Zhu, B. (2017). Which entrepreneurs are coachable and why? *American Economic Review, 107*(5), 312–316. https://doi.org/10.1257/aer.p20171010

10. CB Insights Research. (2024). The most active startup accelerators and where they're investing. Retrieved December 2, 2024, from https://www.cbinsights.com/research/report/most-active-startup-accelerators/

11. Cohen, S., Fehder, D. C., Hochberg, Y. V., & Murray, F. (2019). The design of startup accelerators. *Research Policy, 48*(7), 1781–1797.

12. Creative Destruction Lab. (2024). Creative Destruction Lab. Retrieved October 5, 2024, from https://creativedestructionlab.com/

13. De la Tour, A., Soussan, P., Harlé, N., Chevalier, R., & Duportet, X. (2017). *From tech to deep tech*. Boston Consulting Group.

14. Deeds, D. L. (2001). The role of R&D intensity, technical development and absorptive capacity in creating entrepreneurial wealth in high technology start-ups. *Journal of Engineering and Technology Management, 18*(1), 29–47. https://doi.org/10.1016/S0923-4748(00)00032-1

15. Ehsan, Z.-A. (2021). Defining a startup: A critical analysis. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3823361

16. Eisenmann, T. (2020). *Determinants of early-stage startup performance: Survey results* (Working Paper No. 21-057). Harvard Business School.

17. European Commission. Directorate General for Research and Innovation., Deloitte Consulting., & Advisory BV/SRL. (2023). *European startup scoreboard: Feasibility study.* LU: Publications Office. https://data.europa.eu/doi/10.2777/254834

18. Fife, D. A., & Rodgers, J. L. (2021). Understanding the exploratory/confirmatory data analysis continuum: Moving beyond the "replication crisis." *American Psychologist*. Advance online publication.

19. Galper, J. (2001). Three business models for the stock exchange industry. *The Journal of Investing, 10*(1), 70–78. https://doi.org/10.3905/joi.2001.319454

20. Gebru, E. K., & Awal, A. L. M. A. (2021). The impact of venture capital on the deep tech startups' growth: An empirical analysis on startups leaving university incubators (Master's thesis, KTH Royal Institute of Technology, Stockholm, Sweden). https://www.diva-portal.org/smash/get/diva2:1588563/FULLTEXT01.pdf

21. Gompers, P., Gornall, W., Kaplan, S. N., & Strebulaev, I. A. (2020). How do venture capitalists make decisions? *Journal of Financial Economics, 135*(1), 169–190.

22. Hasenauer, R., Gschopf, A., & Weber, C. (2016). Technology readiness, market readiness and the triple bottom line: An empirical analysis of innovating startups in an incubator. In *2016 Portland International Conference on Management of Engineering and Technology (PICMET)* (pp. 1387–1428). Honolulu, HI, USA: IEEE. https://doi.org/10.1109/PICMET.2016.7806523

23. Héder, M. (2017). From NASA to EU: The evolution of the TRL scale in public sector innovation. *The Innovation Journal, 22*, 1–23.

24. Huynh Evertsen, P., Rasmussen, E., & Nenadic, O. (2022). Commercializing circular economy innovations: A taxonomy of academic spin-offs. *Technological Forecasting and Social Change, 185,* Article 122102. https://doi.org/10.1016/j.techfore.2022.122102

25. Joint Research Centre, Basso, A., Baltar, E., & Andonova, E. (2018). *Startup innovation ecosystems in Southern Europe.* European Commission, Brussels. JRC113872.

26. Kruachottikul, P., Dumrongvute, P., Tea-makorn, P., Kittikowit, S., & Amrapala, A. (2023). New product development process and case studies for deep-tech academic research to commercialization. *Journal of Innovation and Entrepreneurship*, *12*(1), 48.

27. Krueger, C. C., & Van Der Beek, K. (2024). New and emerging business models for online news: A survey of 10 European countries. In *17th Bled eCommerce Conference.* Retrieved February 8, 2024, from https://core.ac.uk/display/24683825

28. KTH Royal Institute of Technology, KTH Innovation Readiness LevelTM. (2024). *KTH Innovation Readiness LevelTM.* Retrieved January 22, 2024, from https://kthinnovationreadinesslevel.com/

29. Magretta, J. (2002). Why business models matter. *Harvard Business Review.* https://hbr.org/2002/05/why-business-models-matter

30. Markman, G. D., Phan, P. H., Balkin, D. B., & Gianiodis, P. T. (2005). Entrepreneurship and university-based technology transfer. *Journal of Business Venturing, 20*(2), 241–263. https://doi.org/10.1016/j.jbusvent.2003.12.003

31. Mistral. (2024). *Mistral models* [Large language model]. https://mistral.ai/Mistral.

32. Nickens, N. M. (2018). Measures of Variability. In *The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation* (pp. 1041–1042). SAGE Publications, Inc.

33. OpenAI. (2024). *ChatGPT* (Version GPT-4) [Large language model]. https://chat.openai.com/

34. Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the Association for Information Systems, 16.*

35. Passaro, R. (2016). The stages of the entrepreneurial process: A comparison between Italian and French firms. In *The life cycle of entrepreneurial ventures* (pp. 339–363). Cham: Springer.

36. Ries, E. (2011). *The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses.* New York: Crown Business.

37. Salamzadeh, A., & Kawamorita, H. (2015). Startup companies: Life cycle and challenges. https://doi.org/10.13140/RG.2.1.3624.8167

38. Schuh, G., Studerus, B., & Hämmerle, C. (2022). Development of a life cycle model for deep tech startups. https://doi.org/10.15488/11730

39. Sreenivasan, A., & Suresh, M. (2023). Readiness of financial resilience in start-ups. *Journal of Safety Science and Resilience*, *4*(3), 241–252.

40. Svetek, M. (2022). The role of entrepreneurs' perceived competence and cooperativeness in early-stage financing. Entrepreneurship Theory and Practice.

41. Swamidass, P. M. (2013). University startups as a commercialization alternative: Lessons from three contrasting case studies. *The Journal of Technology Transfer, 38*(6), 788–808. https://doi.org/10.1007/s10961-012-9267-6

42. Villani, C. (2023). How do venture capital funds select deep tech startups?

43. Wolff, J. (2021). How Is Technology Changing the World, and How Should the World Change Technology? *Global Perspectives*, 2(1), 27353. https://doi.org/10.1525/gp.2021.27353

44. Yong, A. G., & Pearce, S. (2013). A Beginner's Guide to Factor Analysis: Focusing on Exploratory Factor Analysis. *Tutorials in Quantitative Methods for Psychology*, 9(2), 79–94. https://doi.org/10.20982/tqmp.09.2.p079

45. Yu, S. (2016). How do accelerators impact the performance of high-technology ventures? *SSRN Scholarly Paper.* Rochester, NY. https://doi.org/10.2139/ssrn.2503510

Appendices

APPENDIX A. INITS Study Measures

Table 9

INITS study Technological Readiness Level (TRL)

#	**Description**
1	Fundamental research in social/environmental context
2	Applied research in social/environmental context
3	Research to prove social/environmental feasibility
4	Social environment living lab demonstration
5	Social technology development
6	Whole system field demonstration
7	Socially and environmentally compliant prototype
8	Socially and environmentally technology acceptance
9	Market/sales certification
10	Business model defined coherently

Note: Edited slightly for clarity.

Source: Hasenauer, Gschopf, & Weber (2016, p. 1394)

Table 10

INITS study Market Readiness Level (TRL)

#	**Description**
1	Unsatisfied needs have been identified
2	Identification of potential social business opportunities
3	System analysis and social environment impact analysed
4	Market research
5	Target defined
6	Industry analysis with respect to social and environmental impact
7	Competitors analysis and positioning
8	Value proposition defined
9	Product/service defined
10	Business model defined coherently

Note: Edited slightly for clarity.

Source: Hasenauer, Gschopf, & Weber (2016, p. 1394)

Table 11
INITS study Innovation Readiness Level (TRL)

#	**Description**	
1	Basic principles observed and reported	Concepts
2	Technology concept and/or application formulated	
3	Analytical and experimental critical function and/or characteristic proof-of-concept	
4	Component and/or breadboard validation in laboratory environment	Components
5	Component and/or breadboard validation in relevant environment	
6	System/subsystem or prototype demonstration in a relevant environment	
7	System prototype demonstration	Completion
8	Actual system completed through test and demonstration	
9	Actual system proven through successful operation	

Note: Edited slightly for clarity.
Source: Hasenauer, Gschopf, & Weber (2016, p. 1411)

APPENDIX B. KTH Study Measures

Table 12
KTH Readiness Levels

Type	**Description**
Customer (CRL)	Level of engagement with customers and markets.
Technology (TRL)	Product/service/method/system/technology/solution etc. The "thing", or tangible realisation of the idea, to be developed.
Business Model (BRL)	The sustainability and maturity of the business model, encompassing the potential profitability and positive social contribution over time.
Intellectual Property Rights (IPRL)	Level of intellectual property protection via Patents, trademarks, design rights, copyright, database rights, trade secrets, digital registrations (domain names, account names, etc.), company name, etc.
Team (TRL)	Level of competency and capacity of company team.
Funding (FRL)	Level of secured funding.

Note: Edited slightly for clarity.
Source: KTH Royal Institute of Technology (2024)

Table 13
KTH Business Model Readiness Level (BRL)

#	**Description**
9	Sustainable business model is operational and business meets or exceeds internal and external expectations on profit, growth, scalability, and environmental and social impact. Credible systems and metrics in use to track economic, environmental, social performance. Historic data on economic, environmental, and social performance proves viable business which is profitable and sustainable over time.
8	Sales and other metrics from initial business operations (1-3 years) show sustainable business model holds and can meet internal and external expectations on profit, scalability, and environmental and social impact. Sales channels and supply chain (aligned with sustainability expectations) are in place and operational. Business model is set but is fine-tuned to improve revenue/cost and leverage sustainability.
7	First sales/revenue on commercial terms demonstrate willingness to pay from significant number of customers. Complete financial projections validated by first sales/revenue and data. Agreements in place with key suppliers, partners, channel partners etc. (aligned with sustainability expectations) to execute your business model.
6	Complete sustainable business model (cost side and revenue side), including key measures to increase positive and decrease negative environmental and social contribution, is tested in one/a few realistic business scenarios (test sale, pre-order, pilot, tender, etc.). Complete financial projections based on feedback from realistic business case show economic viability.
5	Received feedback on revenue side of business model (e.g. revenue model, pricing, etc.) from a few potential customers or persons with market knowledge (experts). Received feedback on cost side of business model (e.g. production, supply chain, etc.) from a few external partners/suppliers/experts. Key measures to increase positive and decrease negative environmental and social contribution specified in business model. Updated P&L projection based on market feedback indicates economic viability. Target market description (such as target segment(s) and competitive analysis) updated based on market feedback.
4	First version of simplified Profit and Loss projections for proposed business model (main costs, main revenue streams) indicate economic viability (based on own assumptions and guesstimates). Initial assessment of positive vs negative contribution indicates environmental and social sustainability, based on own assumptions and guesstimates.
3	Description of a proposed business model in place (e.g. in canvas format). Description of relevant factors in the business model causing positive and negative contribution to environment and society. Defined target market(s) and estimates of market size. Defined competition and identified relevant input from competitive landscape on business model (competitors' positioning, business models, prices, etc.).
2	Described the proposed business concept and value proposition in some structured form. Brief familiarity with market size, segments, and competitive landscape (listed some competitors/alternatives) – typically derived from secondary sources.
1	Non-existing or vague and unspecific description of the potential business idea, value proposition or business model. Little insight into the market and its potential/size-hypothesising on possible applications. Little knowledge or insight into competition and alternative solutions.

Note: Edited slightly for clarity.
Source: KTH Royal Institute of Technology (2024)

Table 14
KTH Team Readiness Level (TRL)

#	**Description**
9	The organisation is high performing and well-functioning (cooperation, social environment, etc.). All levels of the organisation actively engaged in continuous learning and development. Organisational culture, structure, processes etc. are continuously improved and developed. Incentives/rewards are aligned to motivate the whole organisation to reach goals and perform well. The management team is maintained, developed and performs over time.
8	There is a clear leadership and management team with relevant professional experience. Competent and diverse board, and relevant advisers in place and professionally used. HR policies/processes/responsible in place to assure good HR practices and team diversity. Necessary recruitment according to longer term plan are ongoing to ascertain relevant competencies, capacity, and diversity in the organisation. All levels of the organisation are properly trained and motivated.
7	Well-functioning team with clear roles. Goals, vision, purpose, and culture are clearly articulated and documented to support team and organisational development. Plan in place for how to build necessary organisation and grow the team over longer term (~2 yrs). Processes/systems and plan for continuous learning and staff development implemented. Board and advisers operational and supporting business and organizational development.
6	Complementary and diverse founding team in place, capable of starting to build a business. All key competencies and capacity necessary for the near term are present, including a clear CEO. Committed team where everyone feels responsibility and accountability. Started recruitment of advisers and/or board members, keeping in mind board diversity. Awareness of risks to team performance (conflicts, burn-out/mental health, politics, etc.).
5	An initial founding team working together and all spending significant time. The founding team jointly having main needed competencies and capacity to start building this startup. Aligned team with clarified roles, shared goals and visions, and clear commitment (e.g. time spent). The team has agreed on their respective shares (signed agreement). Ownership is balanced and incentivising, and reflects historical and future commitment and contribution. Activities to get additional competencies and capacity in progress, keeping in mind team diversity. Initial systems/processes/tools in place to share knowledge and information within the team.
4	Team (or individual) has a clear idea of how to take the idea to market (startup, IP deal, etc.). At least one champion (driver and committed to take the idea forward) is present. Several, but not all, necessary competencies are present, typically multiple individuals. A plan is in place and initiated to find necessary additional competencies and capacity (described e.g. in a requirement profile), keeping in mind team diversity. The team has started discussions on roles, commitment, ownership, etc. going forward.
3	One or several individuals that possess some, but not all, of necessary competencies and capacity to start verifying the idea. Needs and gaps in competencies, capacity, and team diversity are identified. Initial plan is defined for how to find needed prioritized competencies (near-term, <1 year).
2	Limited competencies and/or capacity present - typically 1-2 persons. First idea of which additional persons/competencies that could be needed to verify/develop idea. First idea of overall goal for the project
1	Typically an individual lacking necessary competencies in key areas such as tech, business etc. Little insight into needed/necessary competencies and other needed resources (e.g. partners, service providers etc.) to verify and develop the idea.

Note: Edited slightly for clarity.
Source: KTH Royal Institute of Technology (2024)

Table 15
KTH Funding Readiness Level (FRL)

#	**Description**
9	Secured funding for at least 6-12 month runway according to current business plan/operational plan – the money is on the bank account or predictable recurring revenue. Fully implemented financial monitoring and bookkeeping system for continuous control of current financial status, and good forecast/foresight of future funding needs.
8	Concrete discussions (term sheet level) with one or several external funding sources that clearly are interested. All necessary supporting material for external funding in place (financials, business plan, etc.). Correctly established legal entity with ownership structure suitable for the planned funding source (not fragmented or significant parts held by inactive/non-contributing persons). All key legal, IPR, financial, and operational documentation and agreements collected and available for external review (due diligence).
7	Discussions with potential external funding sources around a defined offer (how much money, for what, conditions, valuation, etc.). Pitch for funding is complete, tried, and tested, and a business plan (or equivalent) with financial projections, milestone plan etc. is in place. Basic accounting systems and documentation in place for financial follow-up.
6	Updated/improved pitch for funding has been tested on relevant audience. 3-5 year PnL budget and cash flow for business/project in spreadsheet format that clarifies near and medium term funding needs.
5	Pitch for funding (e.g. investor pitch format) elaborated and tested on relevant audience. Initial PnL budget & cash flow for coming 12 months in spreadsheet format. Decided on funding strategy and funding sources to reach a viable business model - based on pros/cons of the different strategies. Insight into requirements and consequences of external funding (in particular equity funding) on business model, control, and ownership.
4	Elaborated plan to verify commercial potential of the idea is in place (e.g. 3-12 months, including hypotheses to verify, goals, activities, timeline, funding need). Identified relevant funding sources. Secured sufficient funding to implement substantial part of the verification plan.
3	Secured sufficient funding for initial verification/feasibility activities (e.g. 1-6 months). Awareness of different funding types (own, soft, equity, customer, etc.) and typical pros/cons.
2	Initial activities and costs to verify potential/feasibility if idea is described (e.g. 1-6 months). There is a basic plan with funding options for the initial milestones (e.g. 1-6 months).
1	Little or no insight into relevant activities and costs to verify potential/feasibility of the idea. Little insight into different funding options and funding types.

Note: Edited slightly for clarity.
Source: KTH Royal Institute of Technology (2024)

APPENDIX C. Structure of CDL-Estonia Application Form

The main sections of the CDL-Estonia are as follows:

1. Primary Contact Person’s Information
2. Venture Overview
3. Venture Specifics
4. Technology Overview
5. Team Information
6. Site/Stream Preferences & Additional Information

APPENDIX D. Coding Rules for CDL Application Dataset

The table below describes the coding rules for the creation of the dataset. To create this table, a high-level collective examination of the forms was undertaken to identify the most relevant section or sections in each form for each of the derived measures for the taxonomy described in Tables 2-4 above. It was decided to consolidate the 10 levels in each taxonomy into three groupings (1-3, 4-7, 8-10) due to the qualitative nature of the analysis, to allow for some flexibility and nuance. Key milestones within the consolidated levels, such as "reference to existing prototype" for Technology readiness, were then identified to suggest a level of detail indicator for information within the application for each of the three consolidated levels.

Table 16

Technology and Market Startup Business Readiness measures with CDL application mapping rules

Type of Readiness	**Core section(s)**	**#**	**Details in CDL Application**
Technology	• Technology Overview	1-3	Minimal or no discussion of commercialisation of technology.
		4-7	Reference to existing prototype or similar but no market launch.
		8-10	Product or service based on the technology
Market	• Venture Overview • Venture Specifics	1-3	Cursory description of potential market for technology.
		4-7	Moderately detailed analysis of industry and competitors.
		8-10	In-depth consideration of how product or service addresses market gaps and needs.

Table 17

Business Readiness measures with CDL application mapping rules

Type of Readiness	**Core section(s)**	**#**	**Details in CDL Application**
Business Model	• Venture Overview • Venture Specifics	1-3	Business model unclear from information provided.
		4-7	Discussion of potential revenue and costs in Venture Specifics.
		8-10	Startup already operating in the market, reasonable to high level of detail of ongoing revenue and costs.
Funding	• Venture Specifics (especially those questions relating to funding)	1-3	Minimal or no funding sources able to be identified.
		4-7	Some funding commitments, including details about amount and type of funding. More detailed discussion of specifics generally scored more highly.
		8-10	Extensive discussion of funding, including specific amounts and details about fund structure (equity, debt, etc.). Higher dollar amounts relative to other startups were generally scored more highly.
Team and Talent	• Primary Contact Person's Information • Team Information	1-3	Limited details about team members (contact details, education, etc.). Limited or no discussion about recruitment or retention strategy and mentor relationships.
		4-7	Moderate level of detail of team members, perhaps including LinkedIn of key members including CEO, details about how team members met, etc. General reference to retention and/or recruitment strategy and/or mentor relationships.
		8-10	High level of detail about all senior team members including CEO, including LinkedIn, work history, educational background, team interrelationships. Detailed consideration of HR and People including retention, recruitment and mentor engagement.

APPENDIX E. CDL Application Dataset Segmentation

Table 18
Count by Cohort

Cohort	Count
2022-23	18
2023-24	22
2024-25	20

Table 19
Count by Venture Stage

Venture Stage	Count
Concept	1
Validation	15
Prototype	9
Early Revenue	29
Profitable	6

Table 20
Count by NAICS Sector

NAICS Code	NAICS Description	Count
11	Agriculture, Forestry, Fishing, and Hunting	1
23	Construction	1
31-33	Manufacturing	4
48	Transportation and Warehousing	1
51	Information	10
52	Finance and Insurance	2
54	Professional, Scientific and Technical Services	26
61	Educational Services	1
62	Health Care and Social Assistance	5
81	Other Service (except Public Administration)	1
99	Unclassified	8

Table 21
Count by Country

Country	Count
Canada	3
Denmark	2
Estonia	24
Finland	5
Germany	4
Hungary	1
Latvia	1
Luxembourg	1
Netherlands	1
Norway	2
Poland	3
Portugal	1
Romania	1
Sweden	7
USA	1
Ukraine	3

Table 22
Count by Year of Registration/Incorporation

Year of Registration / Incorporation	Count
Prior to 2016	2
2016	5
2017	0
2018	8
2019	5
2020	15
2021	11
2022	5
2023	5
2024	1
Not provided	3

Table 23
Count by Number of employees

Number of employees	**Count**
1-5	26
6-10	15
11-15	9
16-20	4
21 or more	6

Resümee

TEHNOLOOGIA IDUFIRMADE ÄRIVALMIDUSE PÕHITUNNUSED

Adam Barnett

See magistritöö uurib tegureid, mis mõjutavad tehnoloogia idufirmade ärivalmidust viies põhivaldkonnas: tehnoloogia, turg, meeskond ja talent, ärimudel ning rahastus. Analüüsi läbiviimiseks kasutati Creative Destruction Lab (CDL) kiirendi Eesti haru idufirmade andmeid, mille analüüsi tulemused näitavad erinevaid ärivalmiduse tasemeid nendes valdkondades.

Tehnoloogia valmisolek valimi idufirmades näitab mõõdukat varieeruvust. Enamik idufirmasid pakub elujõulisi ja potentsiaalseid lahendusi, mis näitavad tehnoloogilist arengut ja valmisolekut turule sisenemiseks. Samas esineb mõnedel juhtudel veel arenguvajadusi, mis vajavad tähelepanu enne laiemat praktikas rakendamist. Turuväljakutsete osas peegeldab valimi idufirmade turuvalmidus keskmist taset (ehk on keskmiselt madalam tehnoloogia valmidusastmest). Kuigi osad idufirmad on loonud tugevaid sidemeid oma sihtturgudega, vajavad teised oluliselt suuremat klientide kaasamist, et mõista täielikult nendevajadusi ja turutingimusi.

Ärimudeli mõõde osas ilmneb olulist varieeruvust idufirmade vahel. Paljudel idufirmadel puudub selge ja toimiv ärimudel, mis võimaldaks skaleerimist ja pikaajalist kasumlikkust. Rahastuse valdkonnas on siiski valmi idufirmade skaalal kõrgemad tulemused; enamik idufirmasid on suutnud kindlustada tugeva algrahastuse, mis aitab neil oma projekte edasi arendada. Suurimad probleemid valimi idufirmades ilmnevad meeskonna ja talentide valdkonnas, kus madalamad skoorid viitavad organisatsioonilistele ja mentorluse puudujääkidele enne kiirendisse sisenemist.

Analüüs toob esile ka olulisi omavahelisi seoseid, mis on tugevaimad tehnoloogia, turuvalmiduse ja ärimudeli näitajate vahel ning mis määravad olulisel määral idufirma edukuse. Nende kolme elemendi sünergia on kriitilise tähtsusega, et tagada idufirma püsivus ja areng.

Uuringu praktilised soovitused on suunatud idufirmasit kiirendavate programmide juhtidele, asutajatele ja poliitikakujundajatele. Soovituste kohaselt tuleks pakkuda eelkõige

sihipärast tuge meeskonna arendamiseks, sealhulgas juhtimiskoolitusi ja mentorlusprogramme. Samuti on oluline parandada juurdepääsu rahastusele, pakkudes rohkem ressursse algfaasis olevatele idufirmadele.

Tuleviku uurimisteemadeks soovitatakse andmekogumi laiendamist, kaasates andmeid teistest riikidest ja kiirenditest, et saavutada mitmekülgsem ja täpsem pilt. Lisaks võiksid tulevased uuringud keskenduda täiendavale segmenteerimisele, mis võimaldaks täpsemalt analüüsida erinevate tegurite mõju idufirmade arengule.

Non-exclusive licence to reproduce thesis and make thesis public

I, Adam Barnett, herewith grant the University of Tartu a free permit (non-exclusive licence) to reproduce, for the purpose of preservation, including for adding to the DSpace digital archives until the expiry of the term of copyright, my thesis

KEY BUSINESS READINESS CHARACTERISTICS OF TECHNOLOGY STARTUPS

supervised by

Professor Kadri Ukrainski

2. I grant the University of Tartu a permit to make the work specified in point 1 available to the public via the web environment of the University of Tartu, including via the DSpace digital archives, under the Creative Commons licence CC BY NC ND 4.0, which allows, by giving appropriate credit to the author, to reproduce, distribute the work and communicate it to the public, and prohibits the creation of derivative works and any commercial use of the work until the expiry of the term of copyright.

3. I am aware of the fact that the author retains the rights specified in points 1 and 2.

4. I certify that granting the non-exclusive licence does not infringe other persons' intellectual property rights or rights arising from the personal data protection legislation.

Adam Barnett

16/1/2025