Startup ecosystem effect on minimum viable product development in software startups

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Abstract

Context. Software startups develop innovative products through which they scale their business rapidly, and thus, provide value to the economy, including job generation. However, most startups fail within two years of their launch because of a poor problem-solution fit and negligence of the learning process during minimum viable product (MVP) development. An ideal startup ecosystem can assist in MVP development by providing the necessary entrepreneurial education and technical skills to founding team members for identifying problem-solution fit for their product idea, allowing them to find the right product–market fit. However, existing knowledge on the effect of the startup ecosystem elements on the MVP development is limited. **Objective**. The empirical study presented in this article aims to identify the effect of the six ecosystem elements (entrepreneurs, technology, market, support factors, finance, and human capital) on MVP development. **Method**. We conducted a study with 13 software startups and five supporting organizations (accelerators, incubator, co-working space, and investment firm) in the startup ecosystem of the city of Oulu in Finland. Data were collected through semi-structured interviews, observation, and materials. **Results**. The study results showed that internal sources are most common for identifying requirements for the product idea for MVP development. The findings indicate that supporting factors, such as incubators and accelerators, can influence MVP development by providing young founders with the necessary entrepreneurship skills and education needed to create the right product–market fit. **Conclusions**. We conclude from this study of a regional startup ecosystem that the MVP development process is most affected by founding team members' experiences and skill sets and by advanced technologies. Furthermore, a constructive startup ecosystem around software startups can boost up the creation of an effective MVP to test product ideas and find a product-market fit.

Keywords: software startup, startup ecosystem, product idea, minimum viable product, prototype, empirical study

1. Introduction

Software startups are increasingly recognized because of their potential for developing innovative products that can disrupt the existing market and scaling themselves into unicorns (value equal to and over $1 billion), with substantial growth in terms of the number of employees and revenue generation [1, 2]. Some examples of successful software startups known for their popular and innovative products and services are Google, Amazon, eBay, Uber, and Facebook [3].

The core aspect of software startups is their software-intensive product [5]. To find and develop the right product that can help them become established and successful in the market, startups need to validate their minimum viable product (MVP) as quickly as possible until a product–market fit is attained (Figure 2). A product idea and the requirements for it are vital during MVP development (Figure 3). A requirements engineering (RE) process is essential, especially in small software companies [6] and software startups [7], as it enables the quick creation of an MVP in accordance with market needs and customers' and users' requirements for validating the hypothesis and maximizing the market share. In addition, software engineering plays a key role when the MVP is further developed toward a full-fledged software-intensive product that is suitable to and successful in the market [1].

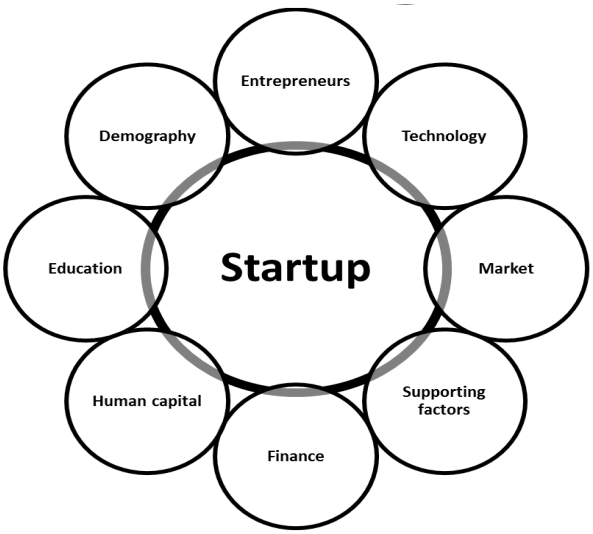

Figure 1: Key elements in a startup ecosystem [4]

Despite their potential, many early-stage startups fail within two years for a variety of reasons, including a lack of a problem–solution fit for their product and a failure to learn from

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mistakes during customer and product development [1, 8]. A suitable ecosystem is needed to nurture a startup from its product conception stage, in which an ideal MVP is created, until the product is mature enough to be launched in the market [9, 4, 10]. The primary objective is providing the necessary support for addressing the challenges in the problem–solution fit and the learning process. In addition, it is important to help the startup through business/product development to become established as a steady, independent organization. The eight important elements in a startup ecosystem, which are *entrepreneurs, technology, market, support factors, finance, human capital, education, and demography* (Figure 1), can directly or indirectly affect a startup [4].

Literature reviews, such as [1, 4, 11], have shown that an empirical analysis of the relationship between the startup ecosystem elements mentioned above and MVP development in software startups has not been conducted previously. Thus, there are important questions about this phenomenon that need to be answered, such as whether MVP development is affected by the startup ecosystem, and if so, how this occurs. To address this gap in the literature and the preceding questions, we design our main exploratory research question [12] for our study as follows:

RQ. How do startup ecosystem elements affect MVP development in software startups?

To answer the main research question, we created a theoretical framework of the phenomenon (Figure 4) based on the background literature in (Section 2) to determine whether the six elements of a startup ecosystem (such as *entrepreneurs, technology, market, support factors, finance, and human capital*) have an effect on MVP development, using the sub-research questions described in Table 2. These research questions are addressed with an empirical study in the startup ecosystem of the city of Oulu in Finland based upon observations and interviews with personnel from 13 software startups and five supporting organizations (Section 3). The Oulu startup ecosystem has several supporting organizations[1] to assist startups in the region and is well know for its startup culture and events (e.g., polar bear pitching[2]). Our study investigates the MVP development process in these software startups and explores the effects of ecosystem elements on MVP development (Section 4). Finally, we answer the main RQ, discuss the implications of the findings and the study's validity (Section 5), and provide some concluding remarks regarding our research (Section 6).

2. Background literature

In this section, key topics related to our study subjects are described in relation to the main research question, which are startups and the startup ecosystem, product development and software engineering, and MVP development in software startups.

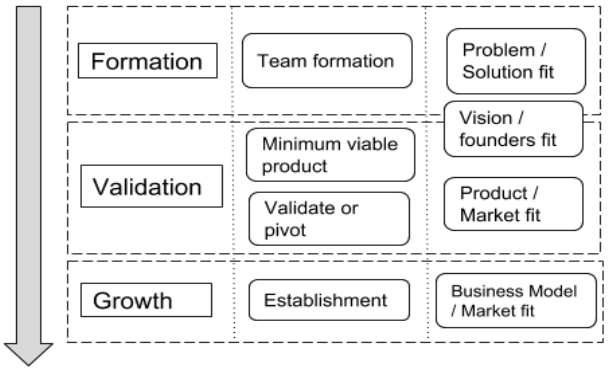

Figure 2: Startup development stages (adapted from startup commons)

2.1. Startups and the startup ecosystem

Blank [13] defined a startup as *a temporary organization in search of a scalable, repeatable, profitable business model,* whereas Ries [14] stated that a startup is *a human institution designed to create a new product or service under conditions of extreme uncertainty.* An example of the startup development stages can be seen in Figure 2, as highlighted in the recognized startup commons[3], which include Formation, Validation, and Growth. In the Formation phase, the vision and team formation are established to identify the problem-solution fit that matches the vision and founder fit. The validation phase includes the development of MVP, which needs to be validated until the product-market fit is established. During the growth phase, more resources (funding and employee) are needed to support full-fledged product development from the MVP. Thus, further investment is needed from investors to support the business expansion and product development that establish and match their business model and market fit.

As mentioned by Paternoster et al. in [1], the word *startup* initially appeared in the SE literature in an article by Carmel [15]. Currently, many researchers[4] refer to startups that develop software-intensive products as software startups. Furthermore, in a recent study by Berg et al. [11], it was shown that there has been an increasing amount of literature on software startups. Crowne [5] described software startups as organizations that have limited experience, work with inadequate resources, and are influenced by several factors, such as investors, customers, competitors, and the use of dynamic product technologies. Similarly, Giardino et al. [16] described software startups as *those organizations focused on the creation of high-tech and innovative products, with little or no operating history, aiming to grow their business in highly scalable markets aggressively.* The authors in [1] provided 15 main themes of software startups, with the main ones being lack of resources, low experience, small teams, rapid evolution, innovation, and a single product. It

[1] `https://www.businessoulu.com/en/frontpage/en/company-networks-2/businessoulu-startup.html`

[2] Polar Bear pitching: `https://polarbearpitching.com/`

[3] http://www.startupcommons.org/startup-development-phases.html

[4] https://softwarestartups.org/about/

was also mentioned in the same article that 60% of startups fail within their first five years. Fully 75% of venture capitalist startups fail for reasons including their high risk-taking nature, lack of problem-solution fit, and failure to learn from mistakes [1, 8].

The word *ecosystem* first appeared in 1935 in an article on vegetation theories [17]. Since then, the word has been used in different fields, such as ecology (e.g., ecosystem ecology, systems ecology) [18], business (e.g., business ecosystem) [19], software (e.g., software ecosystem) [20], and entrepreneurship (e.g., entrepreneurial ecosystem) [21]. Regarding startups, various studies describe the startup ecosystem phenomenon [9, 4, 10]. For example, our earlier study [4] involved a multi-vocal literature review of the topic to identify the existing definitions of a startup ecosystem as well as key ecosystem elements that can nurture a startup as well as to determine the role of these elements in startup product development. After analyzing several definitions of startup ecosystems, we described a startup ecosystem [4] as follows:

A startup ecosystem operates in the environment of a specific region. It involves actors that can act as stakeholders, such as entrepreneurs, investors, and other groups of people who have some self-interest in the ecosystem. They collaborate with supporting organizations, including funding agencies, governments, and educational institutions. Further, they establish organizations to create an infrastructure in which a common network capable of supporting and building startups on a smaller scale is established, increase domestic product development, and create new jobs in the country on a larger scale.

More description on the startup ecosystem elements (Figure 1) and their possible relation with MVP and product development in startups is given in Table 1. Furthermore, other studies, such as [9, 10, 22], have provided information on the definition of startups and elements of a startup ecosystem based on the authors' experiences and observations of the phenomenon.

2.2. Product development and software engineering in software startups

As noted in previous sections, a product is an essential aspect of startups, and several studies investigating different aspects of products have been carried out (see Figure 3). As can be seen in Figure 3, Crowne [5] mentioned four phases of product development: startup, stabilization, growth, and mature. In the startup and stabilization phases, a product idea is refined and validated to create the final product. In the growth and evolution phases, the product development process stabilizes and can be tailored to market requirements. Similarly, in their article, Wang et al. [23] listed the following six product development stages: concept, development, working prototype, a functional product with limited users, a functional product with high growth, and the mature product.

Nguyen-Duc et al. [24] discussed the role of the types of prototypes (throwaway and evolutionary) on the learning of software startup members, resulting in the product in the startups. In a gray literature review by Bajwa et al. [25], the authors discussed the types of pivots (in terms of product, market, etc.) and factors (internal and external) during the conception phase (some are applied after the MVP) of the software startups that later result in the selection of the final product. Product-related pivots were zoom-in, technology, platform, and zoom-out. In another article, Nguyen-Duc et al. [26] proposed a hunter–gatherer cycle conceptual model with the aim of describing the evolution of software startups. During the initial hunting stage, the main emphasis is on the prototyping, which includes product idea development, elicitation of requirements, and development of customers and the market. Once a suitable product idea and prototype are identified, the gathering process happens, which involves commercialization of the prototype. Here, development occurs, where the elicited requirements are specified and the prototype is further developed along with automated testing and system integration and deployment.

With regard to software engineering, once a suitable MVP is identified and validated, software engineering needs to be performed to develop a full-fledged software-intensive product. This will ensure that the product is technologically advanced and its features hold value for the customer and market. A key process area in software engineering is RE, which deals with elicitation, specification, prioritization, and validation of requirements before the start of the software design and construction [27]. Furthermore, these processes need to be managed efficiently, and thus software engineering management and methods are crucial. Recent studies such as by Klotins et al. [28] and Berg et al. [11] discussed on software engineering in software startups.

It has been observed that the RE process is of significant interest in small software companies [6] and software startups because it is central to their software engineering activities [7]. Our previous research [29, 30] on this topic explored the effect of competitor's interaction during the process and identified the following most commonly used techniques during RE processes: internal sources (e.g., for requirements sources); analyses of similar products (e.g., elicitation of requirements); the use of informal notes (e.g., for requirements specification); identifying value for customers, products, and stakeholders (e.g., for requirements prioritization); and internal reviews/prototypes (e.g., for validation of the requirements). Melegati et al. in [31] interviewed representatives of software startups and found that external factors, such as the startup ecosystem, founders, team, and market, affect the RE process. Gralha et al. [32] conducted interviews with personnel in 16 software startups to determine the requirements evolution practices in software startups. Similarly, Rafiq et al. [33] observed that, during requirements elicitation phase interviews, prototyping, analysis of similar and rival products, and team collaboration were the most frequently employed methods in their studied cases.

Software design and construction can overlap during work in an agile context. Here, software architecture and interface components are established, creating a basis for construction to occur. It has been observed that software startups prefer to spend less time on design to reduce development time and shorten the time before the first product release, thereby gaining a competi-

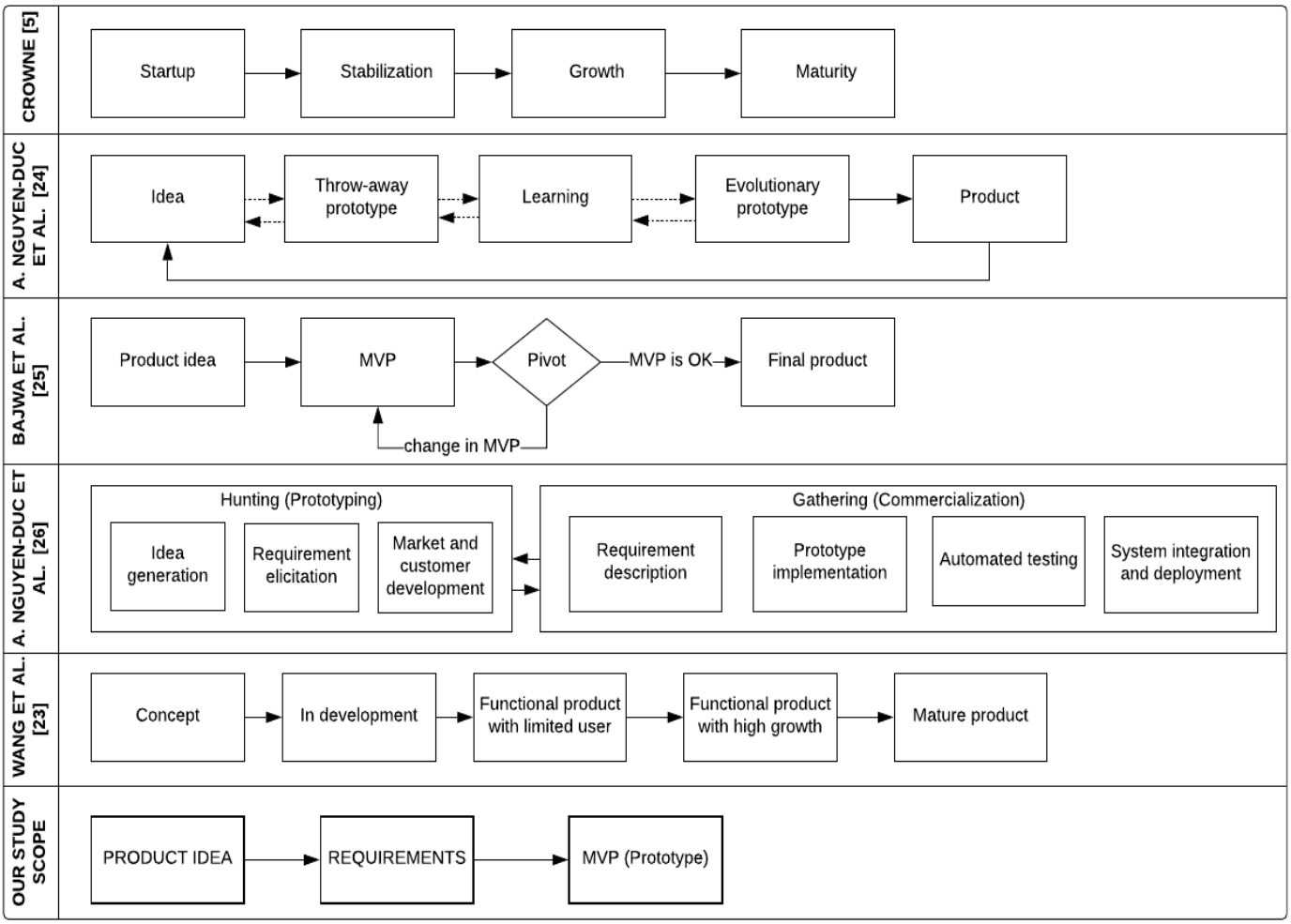

Figure 3: Minimum viable product (MVP) and product development in software startups

tive advantage in the target market. Thus, the primary emphasis is on the use of development technologies, scalability, and third-party components [7, 11]. While are few studies that describe software construction phenomena in detail in software startups [11], authors such as Edison et al. [34] provide information on the use of tools during the construction phase. Furthermore, the authors in [1, 11] found that some literature on software startups emphasizes the use of pair programming and software development standards during the later stages of the software construction phase as software project complexity rises.

2.3. MVP development in software startups

Before spending significant resources on product development, it is crucial for software startups to create an MVP to demonstrate to a customer to validate their hypothesis and test their assumptions. Ries describes an MVP in [14] as

The MVP is that version of the product that enables a full turn of the Build-Measure-Learn loop with a minimum amount of effort and the least amount of development time.

The researchers in [35] explored MVPs and their definitions via systematic mapping research. After a systematic analysis of the 22 definitions, the authors concluded that the most accepted meaning of *minimum* in MVP comprises *minimum features* or *minimum effort*. In a recent study [36], the authors observed that the association between business hypotheses and MVPs in two software startups was non-linear, and the process affected the entrepreneurs learning in terms of hypothesis testing and pivots.

Studies [37, 38, 39] have highlighted that prototypes could be used as MVPs since a prototype needs to be developed with minimum effort to meet the business objectives and can be used by the internal team members for testing the product. The same prototype can also act as an MVP for demonstration to the customer or user to accumulate the validated learning. In their book on interaction design, Preece et al. [40] mentioned that a prototype can range from a paper-based storyboard to a complex piece of software and can be used as a means to discuss the ideas with the stakeholders as well as for team members communication. A prototype can be low or high fidelity and

can be developed from the requirements gathered for the product development and serve as an input source during software design. Considering the limited resources of software startups, particularly in their early stages, mid-level fidelity prototypes seem more feasible for use as MVPs than low or high fidelity prototypes. The bottom of Figure 3 highlights the scope of our current study of MVP development (incorporating the product idea and its requirements), which we extrapolated from the previous literature and our earlier studies [41, 30], as discussed below.

Product idea. For new product development, the idea usually comes from technology, market requirements, competitors, and user solutions [42]. In software startups, during the startup [5] or concept phase [23] (see Figure 3), to fulfill the product–market fit, various aspects of the product (user experience and its key features) and market (target customers and their unserved needs) must be considered to develop the solution [37]. Bosch et al. [43] proposed an early-stage software startup development model using the lean principle to help practitioners explore several product ideas simultaneously and determine which is worth implementing by validating the problem, solution, and MVP at a small/large scale. Furthermore, the value proposition needs to be considered at the concept stage by analyzing competitors' products to identify similarities and key differences in terms of providing value to the unserved needs of the target customers[37]. In a case study of software startups, Seppanen et al. [41] discovered that founders' competence and software applications affect the idea validation practices.

Requirement gathering. Requirements for the product need to be collected through different methods, such as interviews, focus groups, questionnaires, direct observation, and analyses of similar products [40], and can act as an input source for the product's list of features (see section 2.2 for RE). Some features from the list can be used to develop a prototype and MVP [37]. The authors in [37, 40] highlighted that these collected requirements need to be prioritized in terms of customer value and incorporated during MVP-prototype development to provide a good user experience to the customers. Similarly, the authors in [24, 26] (see Figure 3) noted that requirements elicitation makes it possible to create and validate a throwaway prototype to ensure that the evolutionary prototypes are selected for the commercialization.

MVP. The prototype can be developed using scenarios. For low fidelity prototype development, card-based prototypes from use cases can be used, whereas for high fidelity prototype development, resources such as physical computing and software development kits can be used [40]. The prototype developed from the selected features can act as a candidate for an MVP. The authors in [37, 14, 39] mentioned different types of MVPs (e.g., Explainer video, Mockup MVP, Single feature MVP, Rip off MVP, Wireframes) that can be used to test the value proposition by demonstrating it to the customers to collect their opinions and validate the learning in terms of whether the features actually address the customers' needs. The knowledge accumulated through testing should be incorporated into the value proposition to modify the prototype (MVP) for further testing. After that, the prototype selected for commercialization must be developed further using development methods and tools.

In the next section, we describe our theoretical framework and sub-research questions (to address the main RQ) using the framework highlighted in Figure 1 and 3 to understand the effect of startup ecosystem elements on the MVP development process.

3. Research design and execution

In this section, the theoretical framework and sub-research questions are described. Furthermore, the research process (see Figure 5) is delineated to analyze the framework. In addition, information on the data collection process and data analysis techniques is provided. Finally, details of the analyzed data, which will be used to answer the SQs, are given.

3.1. Theoretical framework and research questions

We developed a framework in which seven components (Ct) were created to explore the effects of the six elements (Ct2–7) of a startup ecosystem on MVP development (Ct1) in software startups. The explanations of the seven components (Ct) of the framework are discussed in Table 1. Some of the guidelines of Sjøberg et al. [49] were considered when creating the framework. For example, in [49], aspects such as constructs, propositions and their explanations, and the scope of a theory need to be clearly presented to develop the theory in SE, while in our framework, for identifying and describing the main actors to study the phenomena, we labeled them as components. Furthermore, six causality-type sub-research questions (SQ) [12], framed with their rationales, are provided (see Table 2) to better account for the phenomena and the interrelationships between components. The designed framework, with its components and sub-research questions, can be seen in Figure 4. To answer the research questions, we conducted an empirical study (discussed in the next section) involving direct observations and interviews with relevant study units.

3.2. Research methodology

The outcome of our research is to create knowledge, with the objective of exploring the topic using a bottom-up rationale, as information about the subject is limited and we want seek in-depth information [50]. In addition, we use interpretivism as the research approach since our aim is to understand what human beings have reflected on subjects such as the startup ecosystem and MVP development; because these phenomena involve human beings, it is important to evaluate human perceptions on the subject [12]. To address our research objective and approach to maintain the research rationale and outcome, we opted to use a qualitative research process to obtain qualitative data for answering the research questions. One benefit of a qualitative research process is that it provides rich textual information about a phenomenon through the study participants [50].

Table 1: Components of the framework

Components	Description
MVP development (Ct1)	Combines a product idea and its requirements to create an MVP to test the business hypothesis with the customers and its feasibility in the given target market [23, 41]. More information on MVP development is given in section 4.2.
Entrepreneurs (Ct2)	Entrepreneurs can be categorized as the opportunity (solution for a problem) or need-based (to seek employment for themselves) and are one of the entities in the startup ecosystem. To start a new venture in a given region, founders need to possess an entrepreneurial mindset and characteristics (entrepreneurial alertness, prior knowledge, and entrepreneurial attitudes like risk-taking) to establish their business in the highly competitive market [4, 32, 44]. These attributes could also enable them to improvise their MVP by proposing radical solutions for unserved customer needs, thereby differentiating their products from those of their competitors.
Technology (Ct3)	Technology is providing new and rapid ways to solve given practical challenges, and so most founders are focusing on developing technology-based products. Thus, technology is influencing the features of the product, which can also effect the MVP. [5, 45] For many early-stage software startups that lack financing, the use of available software technologies (i.e., open source) and software development kits can provide a rich user experience and speed up MVP development in a cost-efficient way, allowing the MVP to be demonstrated to customers quickly. Similarly, software technology, as a part of the MVP, can assist in demonstrating the suitable performance level of the product.
Market (Ct4)	For seeking investment and scaling their business, it is crucial for the founders to understand and analyze the market to determine its influence on their business and product development as well as their product's influence on the market [4, 46]. Moreover, to create an MVP that matches product–market fit, the target market and its characteristics need to be analyzed to identify potential unserved customer needs. Thus, the market can play a role during MVP development.
Supporting factors (Ct5)	Supporting organizations, such as incubators, accelerators, co-working space, mentors, and events, can act in a supporting role to provide inexperienced founders with crucial knowledge for their business and product development. Moreover, an inexperienced founder might find it challenging to identify a problem–solution fit for their product idea and thus have difficulty creating the right MVP. Supporting organizations can help by providing the necessary information and resources for suitable MVP development to help match the product-market fit.
Finance (Ct6)	The acquisition of financing through sources such as bootstrapping, seed or venture capitalist funding, bank loans or government financing programs is a critical part of the startup ecosystem, as it helps startups throughout their development stages [4, 47]. Funding can also affect the MVP development process. For example, because the budgets and resources of startups are limited, bootstrapping funding (that is, founders investing their own money) may encourage the careful development of an MVP. In addition, MVPs need to be developed in such a way so as to attract further funding sources.
Human capital (Ct7)	Due to a lack of experience and the small number of people working on customer and product development in startups, it is crucial for founding team members and hired employees to have different skill sets and talents to gain competitiveness in the target market [4, 32, 48]. During the early stage of the startup, founding team members with the right talents and multiple skills can affect MVP development by assisting in requirements collection through good interview skills as well as in the selection of a suitable MVP to better understand customer needs.

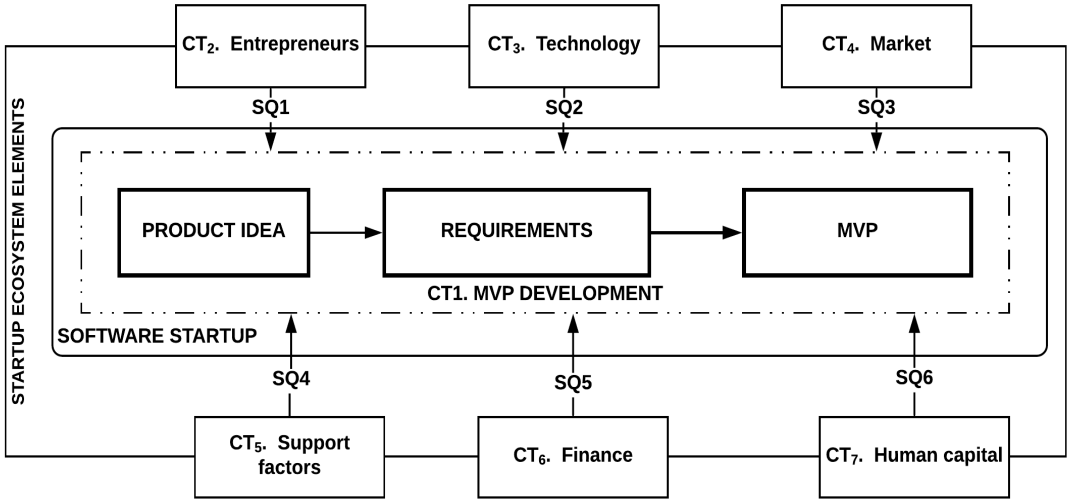

Figure 4: Theoretical framework

Table 2: Sub-research questions to address main RQ

	Sub-research questions	**Rationale**
SQ1	How do the entrepreneurial characteristics of founding team members influence MVP development?	To explore whether entrepreneurs (through their alertness, prior knowledge, and risk-taking ability) can influence MVP development in such a way that business and customer value is achieved in an MVP.
SQ2	How does technology affect MVP development?	To determine the influence of emerging technologies (e.g., the use of open source software) on MVP development in terms of finalizing the key specifications of a product, such as its performance level, features, and user experience, and speeding up the MVP development.
SQ3	What role does the market have in MVP development?	To examine the role of the market in the product features such that the MVP is viable for customer demonstration. The type of market also affects the requirements, which can either be those of the local market or the global market during the early stage of product development.
SQ4	What supporting factors in the startup ecosystem influence MVP development?	To seek whether supporting organizations in startup ecosystem can influence MVP development by helping transform an idea into an MVP by providing support and mentorship (especially when the founding team members are young and do not have much experience).
SQ5	How does funding affect MVP development?	To determine whether financing influences MVP development by forcing the team to develop the MVP within specific time and cost constraints.
SQ6	Do talented members with the required skills in a startup affect MVP development?	To understand whether the talents and skills of founders and team members in startups can influence MVP development.

Table 3: Sample of thematic coding data analysis

Raw data	*- We have been working for three years, and before that I had a couple other start-ups already.* *- We incorporated early this year, so we are a very young startup. We started the process in January and got our business registration in March, and we also started the actual operation in March, so it has been only about three or four months of active operations now.*
Precode	Study unit age
Focus area	The contextual information of the study units and the interviewees
Raw data	*- I am the founder of the company, or one of the key founders, and I'm the CEO of the company… I'm involved in everything, so sales and marketing and product development. We are a very small team, only four people, so we need to be involved in everything. And, of course, managing the company and finance, and so forth, so everything.* *- So my role in our company is to be kind of the main software developer for our product. We have two software developers in our company, and we share the responsibility for creating the product.*
Precode	Interviewee role
Focus area	The contextual information of the study unit and the interviewees
Raw data	*- I developed the product idea many years ago; I was thinking that you can do more with a smartphone. Basically, back then, we had the mobile phone, and it had different types of interfaces.* *- The idea developed because we've been trying to sell the IoT [Internet of Things] platform to many of Finland's top companies, (–) companies. Then, we realized that everybody wants it, wants something, but they don't know what to do with it. So, then we came up with an idea, then we understood that IoT is too broad a solution, so we have to narrow it down to a concrete product that people can use immediately.*
Precode	Product idea
Focus area	MVP development

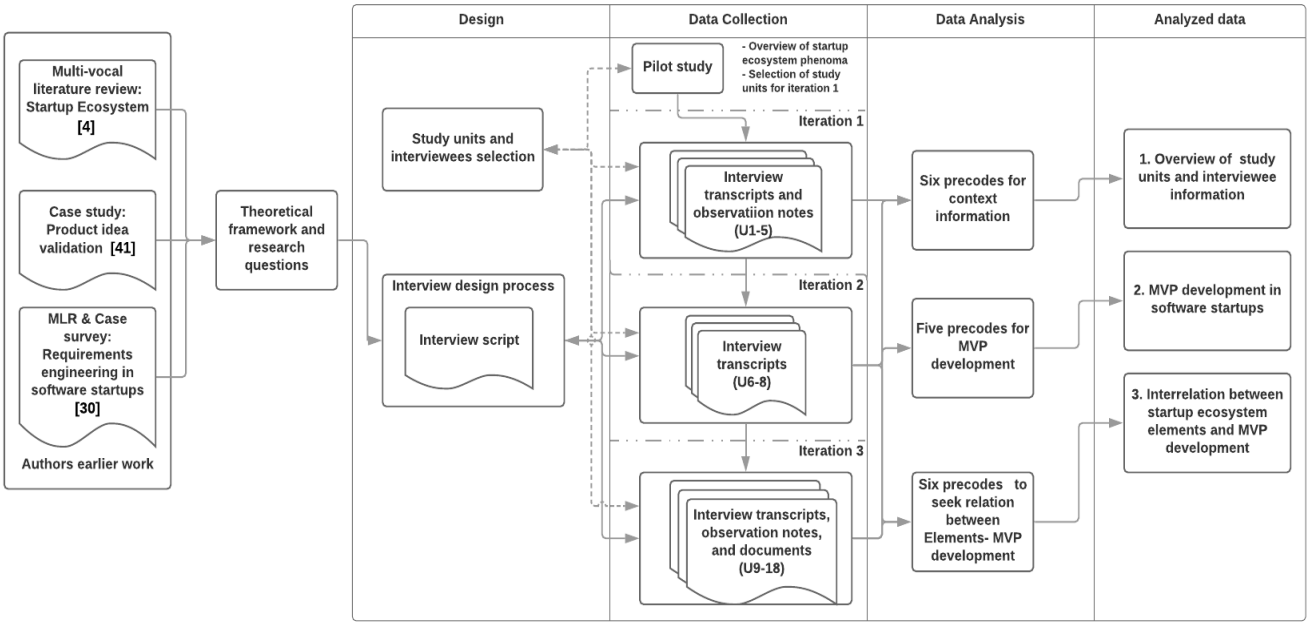

Figure 5: Research process

As we were interested in studying a startup ecosystem with the goal of understanding the influence of its elements on MVP development, we selected a regional startup ecosystem to study the phenomena. Previous studies, such as [4, 10, 22], have stated that the startup ecosystem is a regional phenomenon; therefore, selecting a region to explore the startup ecosystem phenomenon was suitable and appropriate for our purpose. We selected the startup ecosystem in Oulu, Finland. This region has a population of around two hundred thousand people and is known as an information and communications technology (ICT) hub due to the presence of large software companies, such as Nokia Corporation and F-secure Corporation, many small and medium-sized enterprises (SMEs), and higher education institutions, including the University of Oulu (UoO)[5] and Oulu University of Applied Science (OUAS)[6]. These educational institutes are aiming to develop a startup culture and entrepreneurship mindset among their students. Currently, Oulu has an active evolving startup ecosystem and has established several supporting organizations, with the goal to create hundreds of new companies each year by nurturing new startups and established companies looking for global exposure. Supporting organizations can be incubators[7] [8] [9], accelerators[10] [11], co-working spaces[12], or funding agencies (e.g., investment firms [13] providing funding services for organizations a maximum of five years old and venture capital firms[14] investing in early-stage startups). Currently, there are more than a hundred startups in the Oulu region focusing on local/global markets and creating products that are targeted to different business domains. The availability of the technical talents and support of the large companies in the given region assist in the creation of many software startups.

In our study, different units of the startup ecosystem, such as accelerators, venture capitalists, co-working spaces, and software startups, were explored and examined. The software startup was selected as the study unit based on its characteristics, such as a lack of resources, a small team with limited experience, innovation, and the presence of one product, as mentioned in [1]. Table 4 shows the team size, interviewees' experience, and types of products developed. The aspect we investigated in the study unit to answer the SQs in Table 2 was the role of different ecosystem elements in MVP development. The study protocol included information on the study plan, field technique, and interview questions to ensure that the empirical study design and execution were systematic and rigorous.

[5]University of Oulu: https://www.oulu.fi/university/innovations-and-entrepreneurship

[6]Oulu University of Applied Science:https://www.oamk.fi/en/studies-and-applying/masters-degree/education-entrepreneurship/

[7]Oamk labs: https:/oamklabs.fi

[8]Business kitchen- https://www.businesskitchen.fi/

[9]Kielo growth - https://kielo.com/kielo-in-english/

[10]Avanto - https://www.oulu.fi/forstudents/entrepreneurship/avanto-accelerator

[11]Neshtholma - https://nestholma.com/collaboration-programs/oulu-startup-accelerator/

[12]Njetwork Inn - https://www.njetworking.com/en/njetwork-inn-home-company/

[13]Business Finland https://www.businessfinland.fi/en/for-finnish-customers/services/funding/startup/in-brief/

[14]Butterfly ventures - https://butterfly.vc/about-us/

3.3. Data collection procedure

To analyze the study units in the Oulu startup ecosystem, we used a variety of data collection techniques, including observations, interviews, and documents [51]. The data were collected incrementally in three iterations and were limited to the Oulu region. For example, data would only be collected in the third iteration when the initial data from the second iteration were analyzed. This was done to maintain a precise chain of evidence and seek data saturation. Direct observations were made, and documents were collected in instances where supporting organizations collaborated with software startups. For instance, study unit U02 (see Table 4) organized startup events (i.e., pitching event and startup weekend) in which the first author of this paper participated as an observer and made notes. Similarly, study unit U18 conducted a three-month intensive workshop for early-stage startups in which the first author participated and collected documents. The interviewees were selected through convenience and snowball sampling (finding participating study units in the startup events and personal references) [52]. They were chosen based on their experiences in startups and the roles that their organization played in the Oulu startup ecosystem.

The interviews were semi-structured, and both open- and closed-ended questions were used in the interview script, making it possible for the researchers to collect information on both general and specific aspects of the phenomenon. The interview questions covered three mains areas, which were as follows: (1) the contextual information of the study units and the interviewees, (2) the MVP development process (the interview script questions were framed in such a way that the interviewee could reflect on aspects of the product idea, RE, and MVP), and (3) the role of ecosystem elements in MVP development. For example, for the third area, questions such as *How does the market influence your company and product development?* and *How does the market affect your product idea and MVP development?* were used to identify the role of the market in MVP development and to seek answers to SQ3. The interview script containing the questions for the three areas was refined and updated during the three iterations, and the refined interview script can be found online [15].

A pilot study unit was selected for the interview to test the interview scripts. During the interview sessions, notes were made to examine the specific factors. In the first iteration, interviews were conducted with five study units (two software startups and three supporting organizations (U01–05)) in the startup ecosystem to gain an overview of the studied phenomenon in general and the interviewees' views on the roles of certain elements in product and MVP development. In the second iteration, after gaining conceptual knowledge of the studied phenomenon, the next three interviews were conducted with representatives from three software startups (U06–08) about MVP and product development and the ecosystem's role in it. In the third iteration, the remaining 10 interviews were conducted with eight representatives of software startups and two from supporting organizations (U09–18), with the same objectives as during the second iteration. While analyzing the data obtained during the third iteration, the authors came to the conclusion that no new information was emerging. Thus data saturation had occurred, and no further interviews were needed. The first author of the paper conducted all the interviews, and he has several years' experience in conducting research interviews. One interview was done through Skype, and the rest were performed face to face. The shortest interview (I15) was around 20 minutes, while the longest (I01) was 90 minutes. The rest of the interviews were between 40 and 60 minutes, recorded in audio format, and later transcribed by a professional company. The interview transcripts were sent to the interviewees so that they could check the data; seven participants responded and approved the transcription text.

3.4. Data analysis and interpretation procedure

The interview transcripts and materials were imported into the qualitative data analysis tool NVivo. We used a qualitative analysis method to analyze the data to maintain a clear chain of evidence [53]. Coding was done using a deductive approach to examine and arrange the data in a systematic manner [54]. For this deductive approach, precodes were created to extract information, such as contextual information on the study units and the interviewees (six precodes), the MVP development process (five precodes), and the role of ecosystem elements in MVP development (six precodes). An example of this can be seen in Table 3, and a detailed description can be accessed online[16]. The contextual information was later transferred to an Excel sheet for statistical analysis in terms of frequency.

The *effect* of the elements (as shown in Figure 7) was analyzed based on the responses given by the interviewees. For example, when asking I14 about the effect of the market, he responded *It affects but not so much that you could imagine because we are using Google cloud...* and thus considered it to be in the *somewhat effect* category. Similarly, when I15 was asked about effect of technology, he said it was *very important in our start-up... We are doing the wearables and IoT (latest) things so, the technology matters...*, indicating that technology affected the MVP development process. Moreover, *no effect* could be seen in supporting factors for I01 because for his startup he did not need assistance from supporting organizations during MVP development, as they developed it based on their own capability. Finally, *no answer* was recorded when the interviewee did not express any of his views in response to the question.

3.5. Analyzed data

In Table 4, we provide the background information on the interviewees and their relationship to the study units using the data extracted through the six precodes (study unit's age, domain, product, and size; and interviewee's experience in startups and job role in the study unit) for the contextual information of the study units and the interviewees. The extracted data

[15] `https://tinyurl.com/ycvh6t8q`

[16] Data analysis: https://tinyurl.com/y9gwk8jp

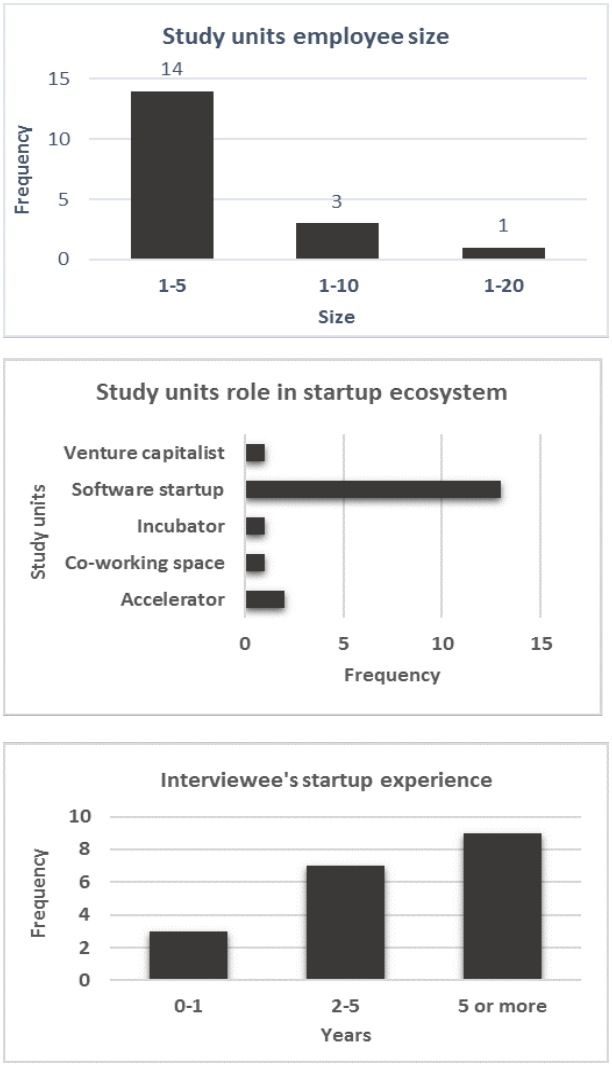

Figure 6: Statistical information of the study units and interviewees

in these six precodes are also discussed in section 4.1. An identity code was assigned to distinguish each study unit and interviewee during the interpretation of the results, and thus, to maintain the chain of evidence. Similarly, five precodes (product idea, elicitation method, requirements documentation, prioritization of requirements, MVP) containing information regarding the MVP development and the results obtained are described in section 4.2. The results of the data analysis of the effects of the ecosystem elements on MVP development using six precodes (entrepreneurs, technology, market, support factors, finance, and human capital) are discussed separately in section 4.3.

4. Results

4.1. Description of study units and interviewees

Study unit description. The units we studied in the Oulu startup ecosystem were 13 software startups and five supporting organizations. Information regarding the study units can be found in Table 4 and Figure 6. Out of 13 software startups, 11 had less than five employees, while the other two had 5–20 employees. Each software startup is characterized into one of two categories: university spin-off (USo) or solo entrepreneurs (SoE). USos are startups that originated from academic research, whereas SoE startups are independently created by entrepreneurs. Furthermore, most of the software startups were less than three years old. This signifies that the software startups were usually in the early phases, where they were aiming to stabilize their business and product development. In addition, six software startups were focusing on creating products to be used either on desktops (or laptops) or mobiles, while the other five were aiming their products to Web use.

Apart from the software startups,two study units were accelerators, and their primary objective was to provide support and mentorship to early-stage software startups and students at the university level. The other two study units were an incubator and co-working space. The incubator was creating an environment for the startups in their preconception stage, aiming to transform the mindset of the people living in the region towards entrepreneurship. The objective was to create a channel where people could meet and discuss the idea and to help them to develop and provide business contacts through which they could further develop their idea with the help of two accelerator organizations. The co-working space organization was providing affordable prices for early-stage founding team members in terms of technical infrastructure and workspaces in which they could establish their startups and develop their companies with a focus on customer and product development. Finally, the investment firm was investing funds in early-stage startups with the potential to scale and good founding team members.

Interviewee description. In the software startups, most of the interviewees were founders and worked in the role of chief executive officer (CEO), chief technical officer (CTO), software developer, or product owner. Furthermore, these interviewees had more than a year of experience with the startups. Concerning the supporting organizations, most of the interviewees had key roles in their organizations and were acting as mentors, event managers, investors, and business developers. Thus, they were working closely with startups in the region.

Based on the characteristics of the Oulu startup ecosystem, study units, and experience of the interviewees in startups within the study units, we can say that the empirical data gathered from the studied phenomena are suitable for answering the research questions (Table 2) to analyze the effect of startup ecosystem elements on MVP development.

4.2. The MVP development procedure

We discuss MVP development in three stages, which were observed in the studied software startups.

Product Idea. In the context of software startups, a product idea typically originates from founders and is influenced by the founders and team members based on their previous and current involvement in the work environment. For example, if the

Table 4: Study units and interviewee details

Unit ID (U)	Unit description	Employee size	Business domain	Product type	Age (years)	Interviewee ID (I)	Startup experience (years)	Interviewee role
U01	Software startup (SoE)	1-5	Marine	Desktop	8	I01	7	Founder/SW developer
U02	Accelerator	1-10	-	-	-	I02	2	Business developer/ Mentor
U03	Software startup (USo)	1-4	Healthcare	Mobile	1	I03a	1	Founder/CEO
						I03b	1	Founder/CTO
U04	Co-working space	1-5	-	-	5	I04	5	Event manager
U05	Venture capitalist	1-5	-	-	6	I05	6	Investor/partner
U06	Software startup (SoE)	1-5	Software	Desktop	4	I06	4	Founder/CEO
U07	Software startup (SoE)	1-5	Software	Web+Mobile	3	I07	3	Founder/CEO
U08	Software startup (SoE)	1-5	Games	Mobile	3	I08	3	CEO
U09	Software startup (SoE)	1-5	Ecommerce	Web+Mobile	3	I09	6	Founder/SW developer
U10	Software startup (SoE)	1-20	Software	Web+Desktop	3	I10	3	Founder/Product owner
U11	Software startup (USo)	1-5	Education	Mobile	1	I11	1	Founder/CEO
U12	Software startup (USo)	1-5	Software	Mobile	2	I12	7	Founder/ SW developer
U13	Incubator	1-5	-	-	7	I13	7	Mentor
U14	Software startup (SoE)	1-5	Location services	Mobile	2	I14	2	Founder/CEO
U15	Software startup (SoE)	1-10	Software	Desktop	6	I15	6	Founder/CEO
U16	Software startup (SoE)	1-5	Cybersecurity	Web+Desktop	1	I16	10	Founder/CEO
U17	Software startup (USo)	1-5	Games	Web+Desktop	2	I17	2	Founder/ SW developer
U18	Accelerator	1-10	-	-	2	I18	5	Business developer/ Mentor

founder has experience and competence, the product idea context will be unique, and it has the potential to address the product–market fit. In software startups (U09 and U10), the product idea originated from the founders based on their competence and experiences in their previous companies' context and work, and they were quick to recognize the product–market fit. Similarly, the product idea in spinoff startups, such as U03, U11–12, and U17, was developed by Ph.D. and master's students based on their theses and university contexts.

Requirements gathering for MVP development. In our study, the sources for the requirements varied among the software startups study units. For example, internal sources were used in U01, U09–10, and U15, in which the founders' and team members' competency was the source of the requirements. Similarly, in U02, U12, and U17, the founders' postgraduate theses served as the source for the requirements. In terms of the elicitation method, a brainstorming session was used in U09–10 and U16; the members of the startup, including management, provided a high level of requirements, which the technical team used to create a new level of features needed for the prototype development, and they discussed these in a brainstorming session. Customer interviews/surveys (U11–12, U15, and U17) and prototyping (U10) were the other elicitation methods used.

In some software startups, documentation was done using a text document as an informal note. For example, in U09–12 and U16, the requirements were obtained from the text document. They were then refined and added to an Excel sheet, Wiki page, Microsoft Word document, or Google Drive document. In a few of these units, different feature layers were also created to organize the requirements (U09). The members could add their requirements to improve the product further (U10), and there was also a possibility of tracing who added what (U12, U16). In U17, the requirements were documented in a bachelor's thesis. In the document, prioritization was carried out based on the value for the customer/product/company/shareholders (U09–12, U15–17). The cost and effort required for implementation were given priority, for example, in U11. In U10, a marketing team prioritized the requirements given by customers as well as the delivery time. In U14, the founder served as the product manager and could prioritize the requirements in different categories based on the requirements for the prototype, first pilot version, or first release.

MVP. In the analyzed study units, the MVP was created to validate the customer and user needs (U09, U16–17), examine the feasibility of further development based on the availability of cost and time (U17), and expand the product scope from the local to global market (U16). In U11, a prototype was created based on prioritized requirements. In U12, the features of the MVP were reduced three times based on the customer feedback and market requirements. A similar result was observed in U10, which trimmed its broad solution by creating an MVP to validate it with the customers.

4.3. Ecosystem elements' effect on MVP development

In this section, we discuss the answers to each of the SQs mentioned in Table 2. Furthermore, Figure 7 provides a matrix displaying information on the elements' effects on MVP development, as identified during data analysis. Similarly, Figure 8 shows the effects of the elements in terms of frequency.

4.3.1. Entrepreneur

The third set of data analyses examined the effects of entrepreneurs on MVP development. Figure 7 presents the breakdown of entrepreneurs' effects according to the interviewees. For example, interviewees (I04, I10, I12–16) expressed that it had a clear effect while others (I01, I09, I11, I17–18) thought that it had some effect on the MVP development. A possible explanation for these differences may be the interviewees' role in the studied units. For example, I10, I12, and I14–16 were acting

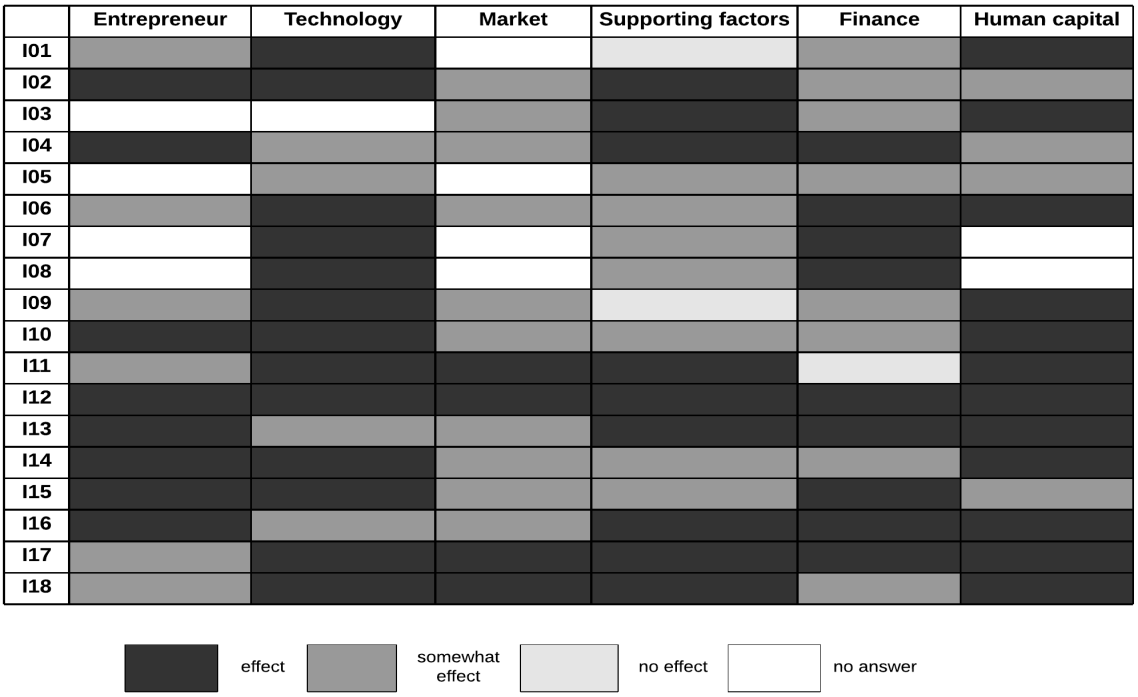

Figure 7: Matrix displaying the levels of elements' effects on MVP development, as identified in interviews with study unit participants

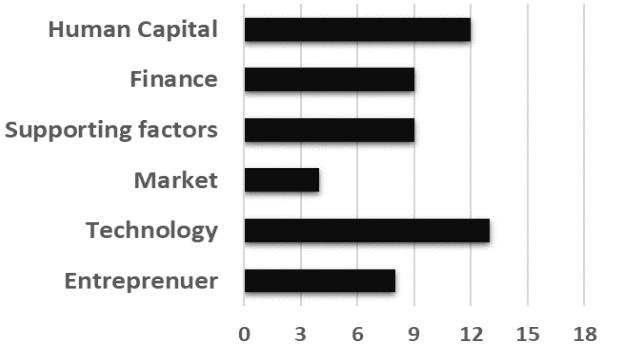

Figure 8: Elements' effect (in frequency) on MVP development

as the founders and CEOs, and therefore they were leading their software startups. This required entrepreneurial characteristics, such as alertness and prior risk-taking, which were reflected in their views on the subject. In contrast, I01, I09, and I17 were also founders, but they were mainly acting as software developers. Therefore, their main focus was on software development, and they may have lacked entrepreneurial characteristics, which may have resulted in different viewpoints.

Entrepreneurs with no or little competence encounter challenges in determining what types of product ideas and related requirements are valuable to create their MVP for achieving a product–market fit, especially when acting as internal sources, and later, when prioritizing the requirements for the MVP. These entrepreneurs are often new graduates who have just established their first startup and are exemplified in U3, U12, and U17. The primary challenge they face is developing requirements for MVPs that give value to their business (U12, U17) and include the customer perspective (U3). Similarly, a highly competent entrepreneur knows which product ideas and MVPs would be appropriate to validate with the customers to address a given problem and provide customer value. This type of scenario was observed in U9–10 and U14–16, in which the MVP development was more rigorous than that in the spin-off startups started from university (U3, U11-12, and U17). Another example was seen in U1, where the founder launched several startups before U1, and this helped create the requirements that made the product idea and its prototype valuable to the customer. Respondents (I10, I11, and I13) mentioned that risk-taking is a critical aspect of entrepreneurship, and it influences MVP development by creating bold, innovative features. It is essential that the founders of a startup should have an entrepreneur skill set, such as practical experience and an innovative mindset. As interviewee I16 put it,

Part of the entrepreneurship mindset is that you are not afraid of trying new things, and I think it is also reflected in our product in the sense that you may be taking leaps with the product that you wouldn't do in an enterprise or the enterprise wouldn't sign off on radical product ideas that easily. But in a startup, you can also experiment with the product ideas much more freely. - I16

Conclusion. The first SQ in Table 2 sought to determine the influence of the entrepreneurial characteristics of founding team members on MVP development. Overall, the above results indicate that founding team members' competence in terms of entrepreneurial characteristics had a significant effect on MVP. Moreover, previous experiences in startup creation can improve the entrepreneurial characteristics of founders, which could positively affect the MVP.

Furthermore, most of the software startups were opportunity based (e.g., U03, U16, U17), with the founder seeing an opportunity to address a problem. However, it was also observed that some software startups were need based, where the founders were looking for employment (U01, U10, U12, U15) and thus motivated to develop the ideal MVP and product to establish their startups, which could be a reason that they were remained in operation for at least three years.

Related literature. Seppänen et al. [41] stated that entrepreneurs' influence is based on their level of competence (no/little competence or high competence) when acting as founders during the product idea validation. Thorpe et al. [39] indicated that entrepreneurs operating as founders could use an MVP as a tool to communicate with investors and software developers for sharing the knowledge to transform MVPs into full-fledged products; this was observed in U06–07 and U16. Furthermore, the authors in [44] also pointed out that entrepreneurial alertness, prior knowledge, and entrepreneurial attitudes (including risk-taking) are some traits of an entrepreneur that are needed to identify opportunities for the product idea in the market.

4.3.2. Technology

Most interviewees responding (see Figure 7) to this item felt that technology has a significant effect on MVP development. One possible explanation could be that because software startups aim at developing software-intensive products, the role of the latest technology becomes essential during MVP and product development to maintain competitiveness in the market (I07). Furthermore, advancements in technology and incorporating technological solutions for the given problem can affect an MVP by making the solutions viable for the longer term and helping to avoid technical debt from the beginning (I16, I17). For example, in U01, U06–08, U14, and U16, the products were focused on the Web, desktop, and mobile platforms, and they needed to infuse technology into the requirements to make the MVPs feasible for the desired technology and scalability. The selection of the right technology can speed up MVP development and market launch. As interviewee I10 put it,

Choosing the right technology helps you to get your minimal viable product off the ground fast. Choosing a fancy technology may not help you to bootstrap your idea fast. - I10

The selection of the technology also depends on the previous work experience of the founding team members in large companies (U01, U07–10, U14–16). For example, I07 mentioned that, before starting the startup, they worked in a large company, and somehow, the technology used in the previous work influenced the selection of the current technology. Similarly, I08 pointed out that large software companies in the region provide necessary technical talent through employment, and this talent is affected by the technology in use by large software companies, which in turn, affects the selection of the technology during the prototype design.

The role of technology can be assessed during the identification of requirements through the analysis of similar and rival products. Furthermore, I12 pointed out that investors prefer technology-based startups, so technology needs to be considered during MVP development to attract potential investors in the future. The use of open source technology also played a role in the MVP development in software startups (e.g., 10 and U17) in speeding up the development. As interviewee I17 stated,

Big companies like Google and Facebook, they are releasing their, for example, technology or software frameworks free, so that you don't have to build everything from scratch. They are quite powerful tools that enable us to do things that were not possible even two years ago. ...Now I'm using those tools. And they are helping me a lot, so that, in that sense, I think this technological progress has been quite important for us. -I17

Conclusion. The second research question in Table 2 aimed to assess the technology effect on MVP development. The results discussed above indicate that technology advancement can enhance the user experience of an MVP. Similarly, the selection of the right technologies by founders can increase the innovativeness of the MVP, and its quick launch and use of open source software can also assist in speeding up of the prototype development. Previous experience in large software companies can also influence the selection of suitable technology, which can affect the prototype design.

Related literature. Crowne [5] also stressed that startups need to use emerging technologies to make innovative products, and they affect MVP development in terms of the essential specifications of the product, such as its performance levels and features [45, 55]. Furthermore, with the selection of the latest development technology tools that are recognized and supported by the software community, software startups can incorporate new features and improve the speed of their first release to market [7, 16]. Advanced innovative technological products that are new to the market can lead the team members to pursue the creation of requirements that focus more on technology than on customer and user needs [7, 56]. As finance and human capital resources are limited in startups, the authors in [39, 57] emphasize that the use of open source technology can speed up the prototyping design because it is freely available to everyone. This was also observed in our software startups' study units.

4.3.3. Market

For software startups, it is essential to analyze the market and paying customers and to evaluate their MVP with new cus-

tomers and promote the first version of the product in the market (I01, I17). However, from Figure 7, we can observe that only a few interviewees (I11, I12, I17, and I18) expressed that the market influences the development; three represented early-stage software startups, while the rest were acting as supporting organizations. The others revealed that the market affects MVP development in some way. One possible explanation could be that due to the limited market size of the region, many software startups collect the requirements from and test their MVPs targets with easy-to-reach local customers and users and avoid analyzing the market beforehand. Another possible reason could be related to the early stages of the startups and their lack of knowledge regarding how to examine the market fit for the product idea.

In the analyses, some respondents mentioned that the market and customers influence MVP requirements, such U12 and U16–18. In U01 and U07, customers affected the requirements and acted as requirement sources. In addition, after having these discussions with the customers, it is crucial to refine the collected ideas and seek patterns. This makes it possible to recognize patterns and essential features for the broadest possible variety of target customers and market (I16). Similarly, in U08 and U09, the sources of the requirements for the prototype were similar products in the market. To find the market fit, discussion with and gathering feedback from the customer can provide some direction, which may affect the creation of a viable MVP (I08, I16). I10 mentioned that, in his organization, the founders had previous experience in a large company and used the same types of techniques to analyze the market and identify potential customers' underserved needs and integrate the information obtained in the requirements for prototype development.

Conclusion. Overall, with regard to the third SQ, we did not find any strong indication that the market affects MVP development. One possible explanation could be the limited market size of the region. Consequently, during MVP development, several software startups were focused on collecting the perspectives of reachable potential customers in the region for validation of the ideas.

Related literature. In the literature [11, 33], it has been noted that many software startups are market driven, where the customers and users are unknown, and thus requirements are identified and elicited by the founders' assumptions, market analyses, and product value. Klotins et al. [7] highlighted that the market also stresses the startup's need to create an attractive first version of a product to satisfy the customer and maintain competitiveness in the market. Studies [58, 59] have also pointed out that markets can act as significant sources of requirements for startups; customers from sensitive market sectors (e.g., defense and finance) expect the use of standardized processes during the development process, and thus the type of target market also influence the requirements.

4.3.4. Supporting factors

Interviewees like I02-04, I11-13, and I16-18, who belonged to either early-stage software startups or supporting organizations, indicated that supporting organizations had affected their MVP development. During the early stages of startups, if the founders are recent graduates, they may lack practical experience and thus need support from incubators, accelerators, and mentors to improve their product ideas, prototypes, and business-related activities. Interviewees I03, I06, and I07 mentioned that even if a product idea was not scalable at the initial stage, coaches and mentors helped the founders by providing business, technical, and customer discovery support for their product ideas.

For early-stage software startups like U03, U11, and U17, supporting organizations, such as incubators and accelerators (U02 and U13), provided them with confidence and necessary knowledge regarding the business and prototype development to help further develop their product idea and build the MVP on it. For one software startup (U10), the accelerator (U18) also provided potential contacts that could help develop the prototype, as it was not possible for the startup to do everything independently (I10). Accelerators and incubators also offered workshops to young founders that helped them shape and validate their MVPs by pointing out potential customers and other sources of requirements (U17–18). As interviewee I02 from accelerator U02 described it,

In our program, we urge them to build a totally simple prototype, just to explain the basic functions of the product. We encourage them to develop a prototype right now; afterwards, the only thing we're doing is linking them with the players so that they could actually push it further if they want to. -I02

An example of this scenario was seen in U11, which obtained support from accelerators (U02 and U18). In addition, U14 received mentorship from incubator U13 during product idea development. Similarly, software startups such as U03 and u17 received support from incubators and help in accelerating their development process from the accelerators' intensive programs. I12 mentioned that one incubator in the region provided a co-working space to U12 and other startups, where they could discuss product ideas with one another for information sharing and further shaping the process of MVP development. Furthermore, during the pitching of ideas in a startup event, the judges of the competition provided feedback on the product idea of U12, which resulted in an improved MVP.

However, one interesting observation was that the founders with experience and competence usually avoided supporting organizations, such as incubators and accelerators; however, they did consider assistance from funding agencies to secure investments for the software startups. This was observed in study units such as U01 and U06–10.

Conclusion. Our overall conclusion (to answer the fourth SQ) is that supporting factors, such as incubators, accelerations, co-working spaces, events, and mentors in the startup ecosystem, can affect MVP development in most software startups in which the founders are young and inexperienced in terms of business and product development. Incubators provide long-term programs for building an entrepreneurship mindset among the individuals in the region. This may affect the product ideas

on which startups can be formed. Accelerators provide-short term intensive programs that can accelerate the product idea and prototype development process among the program participants. By participating in co-working spaces, founders can have discussions with other founders about their ideas and prototypes and receive feedback that could result in improved MVPs. Mentors can provide valuable guidance during the programs to improve the prototype development and identification of potential customers to validate the MVPs. During the pitching event, feedback can be received from experts and judges to improve the product ideas in terms of value to customers and the market.

Related literature. Articles such as [4, 60, 61] emphasized that support organizations could be incubators, accelerators, co-working spaces, and events that support early-stage startups lacking expertise and experience in business and product development.

4.3.5. Finance

Several interviewees (I06-08, I12, I15-17) expressed that finance played a role during MVP development. One possible explanation could be that, initially, funding in the form of bootstrapping can provide startup companies with a basic level of salary, and the founders can start working as full-time employees and focus on developing a prototype and first version of the product quickly. As I02 and I16 put it,

When you have the idea and you wanna do something with the idea, you at least need some funding or some financial, things that mean you can actually develop a prototype, develop your first draft of a product or service or software, which you basically need for the time you invest or to buy the additional skills if you don't have them yourself. Funding is important. -I02

I think if you want to quickly develop a first version of the product that you can market test with, then you'll need funding so that your team can focus on one thing entirely and get the first version out quickly. - I16

I12 and I15 stated that, in their software startups (U12 and U15), it was necessary to develop an MVP within a strict period because of the limited amount of seed funding they received. This may provide constructive pressure on the team members to create the product idea and its requirements to efficiently generate the MVP. As interviewee I13 described it,

I would like to see that none of the startups get too much money, in the first phase, but there would be, 5,000, 10,000 max, euros available to provide the minimum viable product, to provide the first initial prototype of that product. And then they go to the customer and select and collect the feedback on how this applies to your problems. -I13

A venture capitalist firm (U05) invested in U06 and U07 with capital funding to expand their prototypes into products through research and development. Funding can also help provide the resources to improve the validation of the product requirements. I16 mentioned that investors influenced requirements by acting as the requirement source; they invested in U16 through seed funding in the concept stage of product development.

Conclusion. An optimum level of funding can provide positive stress for the founding team members to build the MVP efficiently and within the allotted time. Seed funding in the form of bootstrapping can motivate founders to develop idea prototypes to make a positive impression on the customers. Venture capital firms and investors can invest in startups that have MVPs with rich user experiences and the potential to scale, which may force startups to design prototypes in such a way to attract investment attention. Investors who have invested in startups can also provide their perspectives on improving the prototype to increase their return on investment.

Related literature. Startups need different kinds of funding (i.e., seed funding at the concept stage and venture capital funding at the mature stage) during the various phases of product development. Seed funding can affect MVP development significantly, especially during the early stages of startups [4, 47]. Furthermore, studies [7, 62, 63] have shown that finance-related aspects, such as crowd-funding success and crowd-funding websites, can serve as the indirect requirement sources for the product idea and MVP validation.

4.3.6. Human capital

Other than technology, human capital turned out to be the most important aspect (Figure7) affecting MVP development. If founders and team members have the required capabilities for creating product requirements and prototypes, there is a good chance that their MVP will address customer and user needs and provide a good user experience when it is launched for demonstration. Furthermore, people with different types of skills can help to develop the prototype efficiently [I07]. For example, in the case of U01, the founder and members had the relevant human capital and talent (because of their long experience in working for large companies and creating a few startups previously) to develop the product requirements and act as requirement sources. Respondent I07 mentioned that an excellent technical team is essential for product development. I10 stated that, in U10, each member (either on the technical or marketing team) had responsibilities for developing the requirements for the prototypes, and thus all the members were useful by serving as internal sources for the requirements. Overall, many software startup units emphasized that human capital and talent played a significant role in their MVP development. As interviewees I14 and I16 mentioned,

I think it's really important that people.. have different kind of skills and different kind of mindset. It's not good if all the people are the same, all have a technical background, and so on. It's better that you have mixed background from school and life in general, that you get different kinds of examples. -I14

We had people who knew how to run a startup business, how to run a security business, and how to run an international business, so it's really the experience and knowledge of the people that was the key driver in how we shaped up our both product and business plan. - I16

Conclusion. Human capital is the second most crucial aspect in a startup ecosystem that can affect the MVP, and multi-talented team members can provide necessary business and technical knowledge during the development related to the product–market fit. Talented members can assist in MVP development by gathering requirements through effective customer interviews and surveys and systematically analyzing qualitative and quantitative data to offer meaningful input during the development. Further, hiring individuals with previous companies could affect the MVPs and prototypes, especially during the design stage. Finally, having a team with different backgrounds (e.g., business and technical experience) can enrich the prototype features in various ways.

Related literature. In the literature [41, 32, 58], it has been stated that the competence of founders and team members determines requirement priorities and idea validation practices, and it sets the direction of the startups and their product development. Importantly, the authors in [7, 11, 64] argued that capturing the requirements from the customer requires good interview skills to identify the real customer needs, and thus talented individuals with such skills can affect MVP development.

5. Discussion

In this section, we discuss the implications of the results of our study along with the validity of the research.

5.1. Answer to the main RQ

In our study, we learned how six different elements in a startup ecosystem affect MVP development (see Table 5) in software startups. From the analyses, it was found that in most software startups, the product idea commonly originates from the founder. Most elements in the startup ecosystem, such as the entrepreneur, support factors, and human capital, can initially affect the product idea by providing mentorship to enhance the founders' and team members' entrepreneurial skills and talents (business and technical aspects), who can then, in turn, generate rich user-experience MVPs (prototypes). Similarly, the market can influence customer interviews (through customer discovery) and market research to elicit the requirements and facilitate the development of MVPs. Finance can play a role here, as startups need to consider the implementation costs during MVP development. Furthermore, entrepreneurs can estimate the real value of the requirements in terms of enhancing the business value of the product features.

Table 5: Elements' effects on MVP development

	MVP development
Entrepreneur	Entrepreneurs' attributes, such as entrepreneurial attentiveness, competence, and risk-taking ability, affect MVP development by making a product more business and customer oriented.
Technology	Emerging technology and the use of open source software affects MVP development, as it ensures a satisfactory performance level and contemporary features with improved MVP development time.
Market	The type of target market (local/global) and/or the type of market sector (sensitive/not sensitive) can influence MVP development, as the prototype may be shaped according to its market fit. A local market with a limited size may prompt the founding team members to consider local customers' and users' perspectives during the development and validation of their MVP. Later, the modified MVP can be shaped to fit the global market.
Supporting factors	Supporting factors, such as incubators and accelerators, can help inexperienced founders advance their MVP development through their programs. Receiving assistance from mentors and participation in startup events can provide valuable guidance and feedback on MVPs and their development.
Finance	Founding team members with enough funding can work full-time to conduct MVP development efficiently, allowing them to launch the product at the right time in the market. Furthermore, an appealing MVP needs to be designed and developed to attract investors' attention for further investment.
Human capital	Talented members with the necessary skills and diverse backgrounds can provide quality requirements, assist in better design and development of MVPs, and, later, test MVPs accurately with customers.

5.2. Results implications

A product idea is an important piece of information during the product development stage, and it is essential for achieving product success. To understand MVP development and the RE process, startup founders and team members need to analyze the product idea. In this process, the business and technical aspects of the product idea should be considered along with the influence of startup ecosystems on the idea.

Implications for practice. The data found and analyzed in this study were from actual cases of software startups and supporting organizations in the startup ecosystem. Practitioners can use our results in the following ways:

- Experienced/inexperienced founders and team members can gain the understanding that ecosystem elements may directly or indirectly affect their MVP development;
- Our study presents the way in which requirements are created from the product idea and how they are influenced by different elements of a startup ecosystem. This will give insights to practitioners when they start looking for a product idea, and later, when they create an MVP for it; and
- Our study has discussed the role of the entrepreneur, market, and technology in the creation of the product idea and the requirement development process. Therefore, startup team members can be guided in acquiring entrepreneurial skills so that they can develop scalable product ideas. Similarly, inexperienced founders can understand the role of supporting factors in helping them with product ideas.

Implications for research. We conducted an empirical study in which units were analyzed to understand the role of startup ecosystem elements in MVP development. Our findings have the following implications for researchers:

- Researchers should perform an in-depth evaluation of the propositions discussed in Table 5 with explanatory and descriptive objectives using research methods, such as experiments and surveys, to determine the cause-and-effect relationships between variables in the hypothesis;
- Human capital and supporting factors play a role by providing required business and technical skills to the process, and this is evident in the difference between experienced and novice team members in startups. Researchers can explore how inexperienced members could obtain the necessary skills and education to make MVP development more effective; and
- The results imply the need to closely examine whether product idea validation is the same as requirements validation in software startups. In some situations, they appear similar, but researchers need to thoroughly examine various scenarios to bring greater clarity to this topic.

5.3. Validity discussion

In this section, we discuss the validity of our study based on the criteria put forward in [53, 65].

Construct validity. This deals with whether the constructs created in a study reflect the research objectives and RQs. In our study, the components were developed based on the existing literature (see section 3.1). Similarly, interview questions were created in such a way as to obtain answers to the SQs. It is also important to validate whether the theoretical framework and SQs we developed were properly reflected during the data collection. In our study, observations and interviews were conducted to collect data and obtain multiple sources of evidence for the SQs. In addition, there may be a threat related to the interviewees' subjective opinions. To address this issue, we ensured that, during the analyses, multiple subjects were considered and that our findings were based on these. We also used semi-structured interviews to ensure that we could ask in-depth questions. There was also the possibility that the interviewees were unfamiliar with the role of ecosystem elements in MVP development in their context. To address this concern, we ensured that, before discussing this topic, we first asked the interviewees about their opinions regarding their product development, how MVP development processes were performed in their context, and their opinions on the elements of startup ecosystems and the role of these elements in their company. Only then did we ask them about their ideas regarding the relationship between ecosystem elements and MVP development.

Internal validity. This deals with whether the causal relationship that exists between two variables is not affected by an external variable. However, a causal relationship is often the focus in an explanatory study. In our study, internal validity depended on how the SQs were evaluated based on the evidence found. Two issues may affect this process, which are interviewee bias about the study topic and incorrect answers about their actual work process in the study units. To address this bias, we made sure that the interviews were recorded and transcribed by a professional company and then sent back to the interviewees for confirmation. Regarding incorrect answers on their work process in the different study units, most of the interview participants were eager to participate in the research to gain the knowledge from the research outcome. For the other study units, at the start of the interviews, we mentioned that the participant's name and company identity would remain anonymous.

External validity. This deals with whether the results of a study are applicable and generalizable to contexts outside the studied case. We acknowledge that the answers to the SQs in the present study are limited to a specific region, based on one interview in each unit, and thus may not apply to startup ecosystems in general, which is a threat. Nevertheless, the Oulu startup ecosystem is well known as an ICT hub. Indeed, it is famous for its software and startup companies, comprising talented individuals in the field of technology. A detailed description of this ecosystem is also provided in section 3.2, which highlights

its key stakeholders. Furthermore, most interviewees had considerable experience related to startups and had a key work position in the study units (see Figure 6 for experience and role). Most of the interviewees who belonged to software startups had product development experience. The software startups that we examined also belonged to different product and business domains, and they were selected based on characteristics mentioned in [1] (see section 3.2). Therefore, other startup ecosystems and software startups, whether they are more or less skilled in the technology sector, could benefit from the results of our study.

Reliability. This is achieved if other researchers conducting the same study would come to a similar conclusion as that obtained in the present one. To address the issue of validity, we ensured that we developed a case study protocol. The interview questions were also pilot tested, and the interview data were transcribed by a professional company so that the data could be interpreted in a rigorous way. The design of the theoretical framework and SQs was based on previous literature on the topic, and other researchers can use the same sources as references. A case study database was also created, in which information related to the data collection, such as the interviews and data analysis files, was stored and secured properly. Likewise, we shared the interview script (presented as supplementary material). Moreover, the interview questions and data analysis samples are shown in a distinct and clear way so that other researchers can verify the findings and apply the same methods to arrive at the same conclusion as in our study.

6. Conclusion

This study sought to determine how MVP development in software startups is influenced by the elements of a startup ecosystem. Product development is crucial for startups, and thus the role of MVPs is essential for product success. In our study, a theoretical framework of this phenomenon was created, and SQs were developed to explore it. Empirical research was performed to answer the SQs, which included interviews with practitioners (in software startups, accelerators, incubators, investors, etc.) to determine their perspectives and obtain their insights on the phenomenon. The study contributes to the literature in following ways:

- We explained the MVP development (see section 4.2) in the studied software startups in terms of the product idea and the requirements gathering to develop the MVP; and
- Our study explored and determined the effects of startup ecosystem elements on MVP development (see section 4.3).

Our study also opens new directions for future research. First, the theoretical framework we created needs to be evaluated in the startup ecosystems of other regions. Second, experiments and surveys can be conducted to examine the phenomenon further.

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