Finnish Business Review Vol. 8 (2021), pp. 10-20

jamk.fi

Finnish Business Review

Finnish Business Review

Journal homepage: www.fbr.fi

Article

Applying the SHELL model to study the causes of high-tech start-up failures and finding ways to prevent them

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Abstract

This research aims to identify the causes of high-tech start-up failures and the ways to prevent them. It responds to calls for more research on why high-tech start-ups, potential drivers of economic development and growth, mostly fail during their early years. Following the work of Cantamessa et al. (2018), which adopted the SHELL model by Hawkins and Orlady (1993) to study start-up failures, this research adopts and applies the same model for the causes of failures of high-tech start-ups. Using a qualitative research approach, data is collected from interviews with 16 high-tech entrepreneurs, who have experienced failure in their past. Results suggest a taxonomy of four categories of the causes of failures, together with two sub-categories in each category, and several ways to avoid each of them are presented. Findings contribute to the scarce entrepreneurship literature on the failures of high-tech start-ups by providing a toolkit on how high-tech entrepreneurs can avoid different kinds of failures.

Keywords: Entrepreneurship, failure, high-tech, SHELL model, start-up

1. Introduction

Statistics indicate that about three-quarters of high-tech start-ups fail during their first year of operation and 90% in five years (Aminova and Marchi 2021; Gage 2012; US Bureau of Labor Statistics 2020). The high-tech industry is home to highly innovative start-ups, which offer technology-based products, services, and solutions (Wolf and Terrell 2016). These start-ups are valuable for the economy in that they are very promising for creating new growth and employment possibilities (Suleyman et al. 2014). The existence of strong high-tech companies is not only a sign of a competitive and innovative information and technology cluster in a region (Akpinar and Mermercioglu 2014), but as in the case of Nokia in Finland, it can affect the competitiveness of the whole country (El Husseini and Akpinar 2019). Technological innovations have a central role in the context of high-tech start-ups because these firms target to solve grand problems that will revolutionize the market, which can only be achieved with technological innovations (Aminova and Marchi 2021; Moroni et al. 2015). High-tech start-ups are also highly international from inception as their products and services are for global markets already from their launch (Joshi and Satyanarayana 2014). One reason for their rapid internationalization is that they need to scale their businesses fast to become profitable and pay for their financial liabilities from their high investments in technology development (Blank 2013). It is because of uncertainties and risks related to the adaption of technological innovations and international expansion that the success of high-tech start-ups is highly questionable (Preisendörfer et al. 2012). The high relevance of high-tech start-ups for the economy and their high rates of failure

in the early years demand an investigation to understand the causes of their failure and find out possible ways to prevent them.

Earlier research is mostly about the success factors of high-tech start-ups, not their failures (see Santisteban and Mauricio 2017 for a review). However, the literature on the failure of high-tech start-ups has been growing during the last decade (Akter and Iqbal 2020; Cantamessa et al. 2018; Giardino et al. 2014). In addition, there is no consensus on what the key failure factors are (Santisteban and Mauricio 2017). Furthermore, there is not any specific research that addresses how the failure of high-tech start-ups can be prevented. This is the research gap that this research contributes to by identifying the causes of high-tech start-up failures and the ways to prevent them. In doing that, the SHELL model is used as the guiding framework for the empirical study. The SHELL model was originally developed to understand the causes of aviation accidents by Hawkins and Orlady (1993), and it was adopted by Cantamessa et al. (2018) to study start-up failures.

The empirical study employs a qualitative approach. Using the SHELL model as the theoretical framework, data is collected from semi-structured interviews with 16 high-tech entrepreneurs, who have experienced failures in their past, and the analysis is made with the aid of codes derived from both the theoretical framework and the data. As a result, a taxonomy of the causes of failures and ways to prevent them is derived and presented.

The rest of the paper is organized as follows. The second section reviews the literature and presents the theoretical framework for the empirical study. Following that, the methodology is described in the third section, and the results are presented in the fourth one. Finally, the article ends with a discussion on findings in considerations of earlier literature, practical implications, limitations of the study, and suggestions for future research.

2. Literature review

This section reviews the literature on factors of success and failures for high-tech start-ups. High-tech start-ups are characterized by having little or no operating history, having limited resources, being under pressure from multiple stakeholders such as investors, customers, and competitors, and operating in dynamic markets with disruptive technologies (Sutton 2000). The success of a start-up has been defined in terms of the number of jobs created (March-Chorda 2004) and the growth of the start-up measured by market share, sales, and profitability (Van Gelderen et al. 2005; Wong et al. 2005). The study by Santisteban and Mauricio (2017) identifies 21 success factors. Some of these factors are related to the founding team members, such as their experience in the industry, their previous experiences of establishing start-ups, their motivation, their academic formation, their technological and business capabilities, their experience in research and development, and their leadership and management skills (Santisteban and Mauricio 2017). There are also organizational success factors such as organizational age and size, as well as external factors like the availability of government support, venture capital and partners, the dynamism of the business environment, a sound regional science and technology policy, and the level of clustering in the location of the start-up (Santisteban and Mauricio 2017).

In the case study of a high-tech start-up with disruptive innovation, Majamäki and Akpinar (2014) identify several challenges and success factors to overcome them. The main challenges are marketing the disruptive innovation, identifying the market potential of the disruptive innovation, the length and the riskiness of the commercialization processes, and access to financing during the early stages of the high-tech start-up (Majamäki and Akpinar 2014). To overcome the marketing challenge, the high-tech start-up can make the innovation easy to use, test the innovation personally, and communicate the uses of the innovation well to the market (Majamäki and Akpinar 2014). To overcome the challenge of identifying the market potential of disruptive innovation, high-tech entrepreneurs need to see beyond their preferences, evaluate the innovation critically, and have a good understanding of the industry (Majamäki and Akpinar 2014). Commercializing a disruptive high-tech innovation is a long and risky process; to overcome this challenge, high-tech entrepreneurs should have a clear vision and goals, good faith in the innovation, realistic expectations, and tolerance for uncertainty arising from the incalculable nature of disruptive innovations (Majamäki and Akpinar 2014). Finally, to overcome the financing challenge during the early stages, Majamäki and Akpinar (2014) recommend having a well-planned budget with realistic calculations and hiring a consultant to aid in the negotiations with financiers.

The start-up goes through several stages, including the seed stage, the early stage, the growth stage, and the expansion stage, and different factors are influential for success in different stages (Santisteban and Mauricio 2017). Whereas the founding team's experiences of establishing start-ups and government support are the most influential factors at the seed stage, the availability of venture capital is more important at the early stage, clustering, the availability of venture capital, and technological and business capabilities of the founding team gain higher influence during the growth stage, and clustering becomes the most influential success factor at the expansion stage (Santisteban and Mauricio 2017).

Regarding failures, both internal and external factors are influential. Internal factors of failure are weak management skills, the lack of human capital, improper training, ineffective planning and organizing, as well as the lack of proper business plans and strategies (Atsan 2016; Mehralizadeh and Sajady 2006; Shepherd et al. 2019; Van Gelderen et al. 2005). External factors in the general and immediate environment include not having enough customers to recover recurring expenditures, an economic crisis, a pandemic such as COVID-19, sudden fluctuations in prices or inflation, and a weak network of lenders resulting in undercapitalization (Cantamessa et al. 2018; Kuckertz et al. 2020; Ooghe and De Prijcker 2008; Scaringella 2017). In another classification, Akter and Iqbal (2020) provide six types of failure factors, namely organizational factors, product factors, human factors, financial factors, market factors, and ecosystem factors. Whereas organizational factors include the lack of strategy, poor marketing, poor management, and internal clashes among team members, product factors cover a user-unfriendly product or mistiming of the product, and human factors consist of a lack of commitment, a lack of experience, the fear of failure, overconfidence, and a lack of willingness to utilize mentorship (Akter and Iqbal 2020). Financial factors include the lack of cash and financing possibilities, wrong pricing, and the mismanagement of funds, while market factors are about strong competition, and ecosystem factors reflect the failure to make use of existing networks, legal challenges, and negative customer reactions (Akter and Iqbal 2020).

High-tech start-ups do not usually fail because of their shortage of technology but for their inability to access customers (Blank, 2013). They either fail to integrate customer insights into product development to get the right problem/solution fit, or they have challenges in finding the first customers both in the home country market and foreign markets to get the right product/market fit (Blank, 2013). Macmillan et al. (1987) analyze differences between successful and unsuccessful start-ups along the dimensions of product, team, business, and market. While the product dimension studies product development strategies, the team dimension checks characteristics of the people who establish the start-up, the market dimension investigates customer acquisition strategies, and the business dimension analyzes the business model and the profit logic (Macmillan et al. 1987). Giardino et al. (2014) adopt these dimensions in their behavioral framework for studying the failure of high-tech start-ups. Seeing the start-up process consisting of an exploration stage, where a viable solution is sought for a meaningful problem, and a validation stage, where the solution is tested in the market, Giardino et al. (2014) argue that a high-tech start-up will fail if there are inconsistencies in the implementation among the product, team, market, and business dimensions when the start-up progresses from the exploration stage to the validation stage. Failure will occur if the start-up starts to grow at a time when it is not yet ready for it (Giardino et al. 2014).

The theoretical framework adopted for this research is the SHELL model, which was originally developed by Edwards (1972) and later adapted by Hawkins and Orlady (1993) for understanding the causes of aviation accidents. This model has been utilized for understanding human risk factors in different sectors (see Chang and Wang 2010; Metso et al. 2016), and it has also been adapted to the context of start-up failures (see Cantamessa et al., 2018). The original model consists of the components of Software, Hardware, Environment, and Liveware, which surround people, or the Central Liveware component (Hawkins and Orlady 1993). The model focuses on the interactions of the Central Liveware, i.e., people, with each of the other four components, and it argues that failures occur because of mismatches between the Central Liveware and the four components (Hawkins and Orlady, 1993). In its adapted version for start-up failures by Cantamessa et al. (2018), Central Liveware refers to the organization, and Software refers to the intangible and nonphysical components of the start-up, like having a business model, positioning in the market, and product-market fit. The Central Liveware component focuses on the management of the organization: within this component, a start-up will fail if there is inexperienced or bad management, wrong scaling, issues within the team, financial issues, or lack of business development (Cantamessa et al. 2018). The Software component tells how a start-up will succeed or fail in creating value for the market: according to interactions with this component, a start-up will fail if there is a wrong business model, wrong

positioning in the market, no product/market fit, loss of the original vision, no analysis of customer segments, bad marketing, or no traction (Cantamessa et al. 2018). The Hardware component is the tangible and physical component of the start-up and refers to the product itself: according to interactions with this component, a start-up will fail if the product is of bad quality, not feasible, or not well-focused to the needs of the market (Cantamessa et al. 2018). The Environment component defines the environment where the start-up operates: according to interactions with this component, a start-up will fail if there are more capable competitors, there is a lack of financing or investors, or there are political, legal, and economic problems in the business environment (Cantamessa et al. 2018). Finally, the Liveware component refers to customers and users: according to interactions with this component, a start-up will fail if there are few or unfaithful customers, or if the cost of customer acquisition is high (Cantamessa et al. 2018).

3. Methodology

The research utilized an exploratory qualitative approach because the research on failures of high-tech start-ups and their prevention is emerging, and the objective is to gain deep insights into the phenomenon being studied rather than generalize (Yin 2017). Data was collected through semi-structured interviews with founders of 16 different high-tech start-ups. In line with their wishes, the identities of all participants are kept anonymous. The participants were selected following a careful analysis of potential alternatives from the 500.co global network of start-ups (see 500 n.d.). Eight of them are from the United States, four are from Canada, and four are from Finland. 11 participants are male, and five are female. Their ages vary from 27 to 48, and the duration of their entrepreneurial experiences is from three to 23 years. The interview questions were designed based on codes derived from the components of the adapted version of the SHELL model by Cantamessa et al. (2018). The interviews took place during 2020 and 2021 through an online video conferencing platform in English, the common language for the researchers and the participants. The interviews varied in length from 30 to 60 minutes, and they were all recorded and transcribed. Following Creswell (2014), data were first reduced and then transferred from Microsoft Word to Microsoft Excel, where it was analyzed with the aid of filter, sort, and comment functions using codes, which were from the adapted version of the SHELL model or emerged from the data. The analysis benefits from the cross-case synthesis and thematic analysis techniques across the 16 cases (Glaser and Strauss 2000; Yin 2017). After the initial analysis, the main findings were checked with some of the participants as well as expert faculty on entrepreneurship, which helped to increase the dependability and credibility of findings (Lincoln and Guba 1986).

4. Results

The empirical study identifies four types of problems, each of which has two sub-problems, and possible ways to prevent them. These problems and sub-problems are positioned at the interactions between the Central Liveware and the other four components in the SHELL model (see Figure 1). They are explained below together with ways to prevent them.

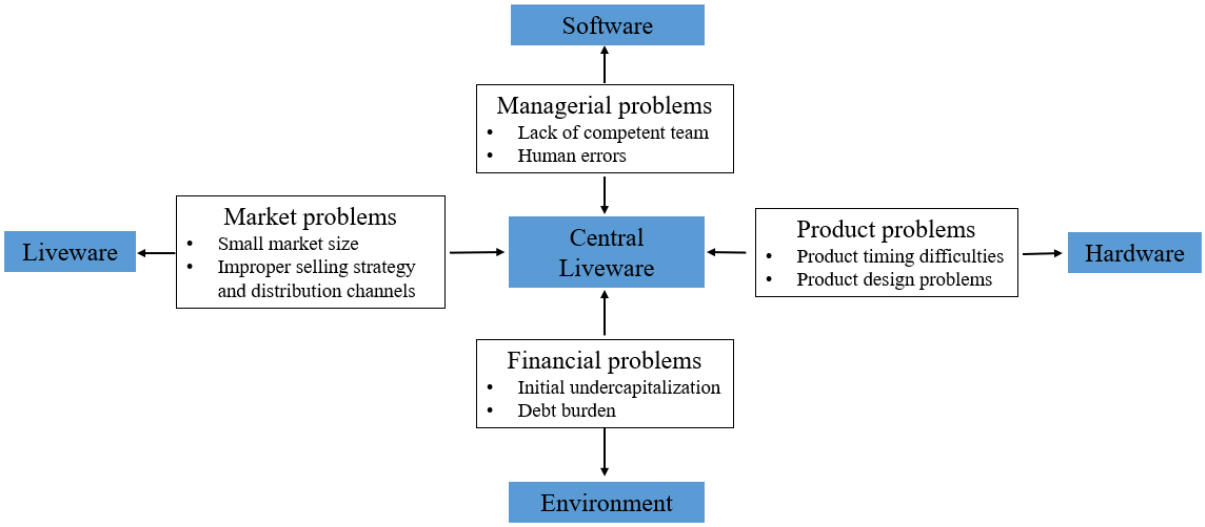

Figure 1. Causes of high-tech start-up failures. Adapted from Hawkins and Orlady (1993), and Cantamessa et al. (2018).

Product problems

Product problems lie at the intersection between the Central Liveware and the Hardware components and relate to issues of product management. These problems can be of two types: product timing difficulties and product design problems (see Figure 1).

Product timing problems are very common for high-tech start-ups. High-tech products become obsolete within a short period, so start-ups that introduce their products late to the market end up failing. This is because it is difficult to acquire customers from first-mover competitors. Vice versa, high-tech start-ups can also introduce their products prematurely before the market exists, and as a result, they fail. In both cases, the launched product misses the chance to make an impact in the market and generate the desired cash flow. This problem is reflected very well in the following quote compiled from participant interviews.

> "*Starting a high-tech firm that provides solutions to problems that do not exist already is one of the main causes of start-up failures. For instance, a high-tech start-up that focuses on uncrewed vehicles is likely to struggle or fail because the driverless vehicle industry is very small or inexistent.… The high-tech industry is very competitive, and technology changes every day. New entrants that introduce products that already exist in the market also fail because customers tend to stick with the ones, they already know…"*

To prevent this type of failure, high-tech start-ups must be careful with the timing when to launch their products in the market. Good market entry timing of a product is a strategic decision for start-ups, and it is strongly recommended to take customers` preferences, other competitors` product launches, the quality of the developed product, and the marketing processes into account for launching the product at the right timing.

Product design problems are also common for high-tech start-ups. Many start-ups have little knowledge of their products' effectiveness to solve the designated problem in advance. Many founders conceive their ideas from scratch and create their products through a learning process, which results in a significant number of design problems. Furthermore, it takes a longer time to actualize some designs than planned. As a result, delays occur, and operating costs increase. Given that most high-tech start-ups are resource-constrained, a prolonged period of product design leads to their failure. In these situations, some high-tech start-ups decide to compromise some features of their products. This choice also leads to failure if the omission of features results in the product's underperformance against the products of competitors. This problem is captured in the following quote compiled from participant interviews.

> "*Many high-tech start-ups face delays in product design and development for various reasons. As a result of this, they run into financial problems and must consider a trade-off between delaying their product and launching a sub-standard product in the market. In both cases, they will fail because either their competitors will occupy the market first, or the sub-standard product will underperform."*

To prevent this type of failure, the high-tech start-up should have the skillset for both designing the product and managing the design process. The start-up should collaborate with customers and users from the early stages of

product design. Targeting to deliver a well-functioning minimum viable product fast to the market should be their priority. The start-up can add more features to the product over time based on customer feedback.

Market problems

Market problems lie at the intersection between the Central Liveware and the Liveware components and relate to issues with the market. Two types of market problems were identified from the data: small market size, and improper selling strategy and distribution channels (see Figure 1).

The issue of the small market size emerges from the fact that high-tech start-ups are highly dependent on a small number of customers at their initial stages. As a result of this, revenue generation is slow, and possible damages in the relationships with these few customers may fail the high-tech start-up. This situation is emphasized by the following participant quote.

> "*Income and revenue generations in high-tech start-ups are very slow due to reliance on a few customers… Some start-ups produce their products exclusively for one or two customers. In the case of disruptive innovations, we are talking about a few early adopters. Both cases are risky because when some of the few customers withdraw from purchasing their products, these start-ups will collapse."*

One suggestion to prevent this kind of failure is to make a proper market segmentation study in advance. Since high-tech start-ups have limited resources, the segmentation study should be limited to get a good enough assessment. In this way, the start-up can assess the target groups of potential customers for its product and make realistic growth and revenue estimations. It is also recommended that high-tech start-ups design their products for a larger group of customers and avoid overreliance on a few of them. In doing that, however, start-up managers should avoid unrealistic expectations.

The second identified problem in this category is improper selling strategy and distribution channels. High-tech start-ups, being new to the market, lack access to proper distribution channels. They also face challenges associated with their selling strategy because they do not yet know well the preferences, tastes, and reactions of their customers. They can end up selling their products in the wrong markets. Furthermore, offering a small sales commission doesn't attract talented salespeople to the start-up. Lacking a qualified salesforce causes market failure. Another cause of failure is misalignment between distribution and selling strategies. It is not possible to sell a product without having the means to deliver it to the customer. Many start-ups often lack a selling strategy, and as a result, they try to sell their product to everyone, which again is a cause of failure. These issues are exemplified by the following quote from participants.

> "*In some cases, you will find that your salespersons do not pay attention to your products because they find the sales commission low. If such products constitute the backbone of a start-up's income, then it fails… A high-tech start-up must align its distribution and selling strategies. You cannot purport to sell a product without having the means to deliver it to the client."*

One possible solution to prevent these problems is to develop a quick go-to-market strategy, a short-term marketing plan covering strategic choices on the mode of entry, pricing, distribution channels, and partners.

Financial problems

Financial problems lie at the intersection between the Central Liveware and the Environment components and relate to issues of financial management. Based on the data from interviews, the most common types of these problems are initial undercapitalization and debt burden (see Figure 1).

Initial undercapitalization is a major problem for high-tech start-ups because all high-tech start-ups require financial resources to cover the high initial costs required to design and develop their products. This demands that they attract a large pool of investors. High-tech investments, however, are highly risky. Investors do not only want to see financial gains in the short term but also earn high returns in response to high risks. This situation may result in undercapitalization during the early stages of the start-up. As a result, a struggle between working within tight budgets and meeting investors' goals constrains start-ups' abilities to operate and causes them to fail prematurely. This is reflected in the following participant quote.

> "*Many investors are not enthusiastic about investing in high-tech start-ups because of their vulnerability to fail. As a result, high-tech start-ups are in a constant struggle between working within the budget to make their products and meeting investors' goals. Sometimes, they incur sunk costs, and in most of the cases, they will go bankrupt if they cannot generate sufficient revenues in the short term."*

To prevent this type of problem, it is crucial for start-up founders to be as appealing as possible to multiple investors and to be efficient with cash flow management. Timing is important in asking for funding. It is good to consider having several funding rounds during the growth of the start-up instead of asking for all the money at once from the beginning. The idea here is to continue scaling the start-up while improving its operational efficiency and not losing company shares unreasonably from the beginning. Typical amounts for the seed round funding ranges between 50 000 € to 500 000 €, and it is often spent for product building, prototypes, and market entry planning. The funding increases over time when the market value of the business also increases. Investors have different budgets, interests, and priorities. Therefore, it is important to understand the interests of different types of investors when seeking funding at different stages of the start-up.

The debt burden is also a common financial problem for high-tech start-ups. It occurs because many start-ups use loans, and when they are not able to generate their forecasted cash flows, they end up not being able to pay the loans back. This is captured in the following participant quote.

> "*Loans and other forms of borrowings constitute a large part of the capital that start-ups use to fund their operations. If planned revenues do not materialize, the debt increases, and it becomes a burden when it cannot be paid back on time."*

For start-ups, cash flow management is highly important. Since cash is liquid, it enables acting fast when a problem occurs. Therefore, it is vital to always keep a reasonable amount of cash available. Financial planning also necessitates conducting scenario analysis. Start-ups should be conservative in their planning and ask for loans on their good days. They should not wait to enter financial problems for seeking financial help. In the worst case, a restructuring of financial loans may be needed. Having a financial expert in the team and realistic cash flow management are highly recommended to avoid this problem.

Managerial problems

Managerial problems lie at the intersection between the Central Liveware and the Software components and relate to the management of operations. The most common types of these problems that emerge from the interviews are the lack of a competent team and human errors (see Figure 1).

The lack of a competent team is the first type of managerial problem. Founders of most high-tech start-ups have an engineering background, and they lack corresponding management and marketing skills. The absence of qualified personnel and consultants in the management team makes founders of high-tech start-ups vulnerable to making wrong assumptions and judgments related to management, product development, marketing, and sales. High-tech start-ups also often lack competent advisors on legal matters. As a result, incompetent teams end up making bad decisions that lead to failure. These issues are highlighted in the following participant quote.

> "*Many start-up founders do not understand the strengths and weaknesses of their entities. As such, they fail to capitalize on their strengths and compensate for their weaknesses. In addition, most high-tech start-ups lack mechanisms for measuring the satisfaction of their customers. As such, they ignore customers' feedback, which in turn leads to the withdrawal of customers from consuming their products."*

Human errors are the second type of common managerial problem for high-tech start-ups, given that founders and employees operate through a learning process. These errors can be of different reasons. One issue is the lack of entrepreneurial experience. Another issue is that most high-tech start-ups operate under stress and time pressure in fast-changing environments. These lead to human errors. We can also include possible disputes between founders under this type of problem. These errors lead to the use of resources inappropriately and in extreme cases to their exhaustion, as reflected in the following participant quote.

> "*Start-ups are run by individuals who rely on thrills and trials. While they operate under stress, they can make decisions that turn out to be costly mistakes. Even experienced entrepreneurs make mistakes, but those by inexperienced ones tend to be more costly."*

To prevent these two types of problems, it is recommended to involve experts from diverse fields as members of the team in return for shares of the start-up. Offering shares is a more reasonable option than paying high fees for the resource-tight start-up. It is also important that competent team members have entrepreneurial experience, they are team players and establish mechanisms for measuring and monitoring performance; especially related to customer satisfaction.

5. Discussion

This study aimed to understand the causes of failures of high-tech start-ups and find out possible ways to prevent them. In doing that, it utilized an adaptation of the SHELL model by Hawkins and Orlady (1993), and Cantamessa et al. (2018). The empirical study was based on qualitative data collected from 16 entrepreneurs who had earlier failure experiences from high-tech start-ups. Results suggest eight causes of failures grouped under four categories. This taxonomy is the contribution of this research to the growing literature on high-tech start-ups. The suggestions to prevent these causes offer a toolkit for entrepreneurs to avoid failure.

Product problems cause the first category of failures. They are related to product launch timing and product design. Launching the product too early, i.e., providing solutions to problems that do not exist, or too late can both be fatal. Facebook and Twitter succeeded because they entered the social media market at the right time. Late entrants, such as Google Buzz, Meerkat, Friendster, and Google Plus failed because customers had already adapted to the services of Facebook and Twitter. This is in line with Atsan (2016), who argues that late entrants find themselves acting as copiers of what already exists and fail to draw customers from existing competitors. Timing also influences the quality of the product. If the launch is too early without proper product development, the life cycle of the product can be short. Therefore, it is important to make a pilot rollout and develop the product properly for the target market, and a good time to launch the product is when the minimum viable product is ready, which allows generating cash flows and customer feedback for further product development (Aulet 2013). The synchronization of product launch and marketing efforts is also crucial for success since bad launches are often recognized by poor marketing strategies (Anand et al., 2014). Moreover, the design of high-tech products requires cutting-edge technologies and equipment: lacking these technologies delays product development, causes errors in product design, and increases operational costs (Giardino et al. 2014). In such situations, high-tech start-ups can opt to compromise in some features of their products, considering that if the released product does not perform well, it will result in low sales. The suggestions to launch a minimum viable product and add features over time are in line with Moogk (2012) and the lean start-up method of product development by Ries (2011). This kind of product strategy allows, on the one hand, to validate the product`s value and growth potential, and on the other, it ensures that the product is profitable also during its development stage (Moogk 2012).

Market problems cause the second category of failures. They are related to either having a small market or lacking a proper sales strategy and distribution channels. Most high-tech start-ups suffer from a few customers or the “one big customer" trap. Heavy reliance on a few customers is risky, and it limits their abilities to expand their operations (Giardino et al. 2014). The suggestions of this research are in line with Aulet (2013), who recommends that high-tech start-ups should segment the market for identifying potential customers and assess customers’ need for the product and the nature of competition in their target segments. Furthermore, practice shows that a good product will not always attract customers if it is not delivered through the right distribution channel (Huffman 2018). As Bruno et al. (1987) note, expensive products like high-tech products suit better to direct sales rather than marketing through trade shows, which unfortunately many high-tech entrepreneurs prefer.

Financial problems cause the third category of failures, and they are related to initial undercapitalization and debt burden. The problem of initial undercapitalization emerges from the fact that very few investors want to invest in highly risky high-tech start-ups (Richter et al. 2016). In addition, most investors also seek short-term returns on their investments, and this restricts the possibilities of high-tech start-ups from developing their products over time. As high-tech products have short life cycles, the inability to develop products over time leads to having inferior products against competitors. Debt financing is a problem for most high-tech start-ups since it takes a while before they start making profits (Bruno et al. 1987). As Beverly (2017) suggests, start-ups need at least three months of cash burn available to be able to survive without income generation. Conservative forecasting, good cash flow management, fundraising in successive rounds, and borrowing surplus cash at good times will increase the chances of a high-tech start-up’s survival.

Finally, managerial problems cause the fourth category of failures. These problems arise due to the lack of a competitive team and human errors. Giardino et al. (2014) argue that high-tech start-ups will fail due to lacking a well-organized and motivated team, having incompetent friends and relatives in the team, and lacking communication channels between the team and external stakeholders. The lack of diversity in the team, especially in fields of financial management, sales, marketing, and product development, is another reason for failure (Giardino et al. 2014). Another issue is that most high-tech start-ups are not able to hire an adequate number of qualified employees because of their budget constraints (Bruno et al. 1987). When there are not enough employees,

they will get overburdened, and as a result, they will be more likely to make mistakes. Bruno et al. (1987) further highlight that an entrepreneur can sometimes lose sight of what the business needs in the excitement of running a business. Having prior entrepreneurial experiences is an asset for the management team for not falling into the trap of former successes. According to Stevens and Campion (1994), there are several knowledge, skill, and ability requirements for creating a good team, such as conflict resolution, collaborative problem solving, communication, goal setting and performance management, and planning and task coordination. Entrepreneurs can encourage these skills through training and applying diligent recruitment procedures to hire competent team members. They can also promote good knowledge management practices, which will reduce human errors (Mahdi et al. 2011).

This research is subject to one limitation, which offers two possibilities for future research. The limitation is that it is based on the perceptions of 16 high-tech entrepreneurs. In line with Greener (2018), some of these entrepreneurs may have been untruthful about the causes of their failures, or they may have overstated their experiences. As a result, there may be some information left unrevealed about the failures of high-tech start-ups. As the first avenue for future research, it is recommended to test the findings of this research with a suitable sample of high-tech entrepreneurs using the survey method. The second avenue for future research related to this limitation would be to interview other stakeholders, such as employees, investors, creditors, and customers of high-tech start-ups. This would validate the findings of this research and provide further insights.

Acknowledgment

An earlier version of this article was presented at the 35th Research in Entrepreneurship and Small Business (RENT) conference in Turku, Finland during November 17-19, 2021 (see Öndas and Akpinar 2021), which was prepared based on the master's thesis of Vedat Öndas (see Öndas 2021). We thank the JAMK University of Applied Sciences for providing financial support to attend the conference.

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