

Key Challenges in Early-Stage Software Startups

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Abstract. Software startups are newly created companies designed to grow fast. The uncertainty of new markets and development of cutting-edge technologies pose challenges different from those faced by more mature companies. In this study, we focus on exploring the key challenges that early-stage software startups have to cope with from idea conceptualization to the first time to market. To investigate the key challenges, we used a mixed-method research approach which includes both a large-scale survey of 5389 responses and an in-depth multiple-case study. The initial findings reveal that thriving in technology uncertainty and acquiring the first paying customer are among the top challenges, perceived and experienced by early-stage software startups. Our study implies deeper issues that early-stage software startups need to address effectively in validating the problem-solution fit.

Keywords: Software startups · Early-stage · Challenges · Validated learning · Customer value

1 Introduction

Software startups are newly created companies with little or no operating history, producing cutting-edge products¹. The environment of software startups is extremely dynamic, unpredictable and even chaotic. A systematic mapping study (SMS) [1] identifies the most frequently reported contextual features of a startup: general lack of resources, high reactivity and flexibility, intense time-pressure, uncertain conditions and tackling fast growing markets. Even though startups share several similar contexts (e.g. small and web companies), the co-existence of all these features poses a new, unique series of challenges [2], especially in their early stage (i.e. from idea conceptualization to first time to market).

Despite several studies reveal the need of early-stage startups to understand the problem/solution fit [3,4], actual executions prioritize development. Results in [5] show a necessity to improve practices for a more effective process to obtain validated learning. However, to achieve this an understanding of the key challenges faced by startupper is needed.

¹ In this study we refer to products as software products or services.

This study aims at understanding the key challenges that are perceived and experienced by software startupperes at the early stage of their startup initiatives. The main research question asked in our study is:

RQ: what are the key challenges that early-stage software startups face?

To answer the research question, a mixed-method research approach was employed, including both survey and case study. We first conducted a survey to obtain a general overview of the challenges that early-stage software startups face. A multiple case study was then undertaken to achieve a deeper contextual understanding of the key challenges identified in the survey.

The rest of this paper is organized as follows: in Section 2, background and related work are presented drawing upon relevant software engineering and business literature. Section 3 presents the empirical research design. It is followed by the presentation of the survey and case study findings in Section 4. The findings are further discussed in Section 5, together with the limitations of the study. The paper is summarized in Section 6 outlining the future research.

2 Background

Sixty percent of startups do not survive in the first five years, whilst 75 percent of venture capital funded startups fail [6]. A study [5], trying to understand the failure of two early-stage startups, presents some anecdotal challenges that are posed to them due to neglecting learning processes. In the two case studies presented in the paper, the startups invested in product/market fit strategies prematurely given that users were not yet sold on the product. Involving the customer to activate the learning process has also been discussed by Yogendra [7] as an important factor to encourage an early alignment of business concerns to technology strategies. Learning mechanisms (e.g. learning about one's strengths, weaknesses, skills etc.) have been widely researched by Cope [8], who reveals a deeper conceptualization of the process of learning from venture failures.

However, a SMS [1] reveals that little rigor and relevance exist in the studies about software startups, and they are not focused on investigating issues and challenges. Bosch et al. [9] claim that challenges in early-stage startups are related to the decision of when to abandon an idea. However the focus of the study shifts on methodologies to develop multiple products, rather than clarifying the nature of the challenges.

Based on the observed knowledge gap that there is a scarcity in the literature to investigate the challenges faced by early stage software startups, we focus our study on discovering and understanding the key challenges, using the four dimensions discussed in [10] and the product development and learning stages [3] to make sense of them.

In order to classify the challenges we make use of a framework, draw upon the study of MacMillan et al. [10], applied in startup contexts. Four holistic dimensions are taken into consideration to present how the challenges impact on the different development and learning stages. The first dimension is the **team**, as the main driver of development. The **product**, as often startups are

developing technologically innovative solution [2]. The **financial** and the way it evolves can set the company growth and its place in the market [11]. Ultimately knowing the **market** is essential to evaluate the needs of the final customers [3].

In order to position the challenges we make use of the customer development methodology stages. Blank [3] presents the objectives of scaling a business concept, who discusses that the first learning process is concerned in understanding the problem/solution fit. The learning process is presented as follows: defining or observing a problem; evaluating the problem; defining a solution; and evaluating the solution. Also the product stages are defined as: conceptualization phase; development phase; working prototype; full-functional product. It is worth emphasizing that these stages are not linear.

3 Research Approach

We have employed a mixed-method research approach by combining both survey and case study, which provides more richness of data and more reliable results [12]. Survey results can be greatly improved when combined with other qualitative research methods (e.g. case study) [13].

We first conducted a web-based survey (available at www.leanstartup.bz) advertised by means of blogs and attendance at workshops and competitions related to software startups. The questionnaire contained four main parts. The first part was introductory, providing a definition and examples of software startups. In the second part, the respondents were asked to provide background information about their organizations, including the principal domains, the countries they work in, and their roles within the organization. The third part contained the questions related to learning processes and product development status. The fourth part asked about their perceived challenges. The questions were in the form of multiple choices, with one open-ended option. The participants were asked to provide the most significant perceived challenge. The terminology used in the questionnaire is based on two exploratory studies [1, 5]. The participants were not obliged to answer all the questions, in order to maintain response quality when they were not sure about the involved concepts. The data collection lasted for approximately one year, from September 2013 until September 2014. In total 8240 responses were received, among which 5389 responses (i.e. 65,40%) have completely answered questions on background information and the perceived challenges, which are mandatory for us. As the first step of analysis, we obtained a list of key challenges by calculating the frequency of them in the responses.

In the second phase, we conducted a qualitative study by means of two cases, to provide a deeper contextual understanding of the key challenges identified in the large-scale survey. The case study approach improves the degree of realism to the research phenomenon [14]. A multiple case design allows us to apply literal and theoretical logic through the comparison and contrast of multiple cases that are analyzed through the same lens [15]. For the purpose of this study, we selected the two cases that represent two early stage software

startups, EasyMedicine and MovyNext. The interviewees include the two CEOs of the startups and a developer from EasyMedicine. First, we conducted a first round of interviews as a pilot study in these two startups. The initial results of the pilot study established the two startups as suitable cases for further investigation. Then we conducted a second round of interviews. Both rounds of interviews were semi-structured with open-ended questions. They lasted between 30 minutes to 1 hour, and interviews were recorded and transcribed verbatim for the analysis purpose. The specific data analysis technique, for within-case analysis, was coding using the identified challenges in the survey as seed categories. An online tool² was used to manage interview data and coding process. In the cross-case comparison, the challenges that EasyMedicine and MovyNext face were compared and contrasted.

4 Results

4.1 Key Challenges Perceived by Early-Stage Software Startups

Based on the frequency calculation of the challenges perceived by the respondents, we obtained a list of top 10 challenges (contained in 4709 responses, i.e. 87,38% of the 5389 complete responses). The startups in the 4709 sample vary in different market sectors (predominately in the consumer market, such as mobile and Internet, i.e. 64,40%). They come from 90 countries around the world (the majority is from United States 52,60%, Canada 7,94%, United Kingdom 6,71%, Israel 5,30%, India 4,50%). These startups are young, on average 10 months, and small in size, predominately having 2 founding members.

The top 10 critical challenges are presented in Table 1.

To make better sense of the challenges, we plotted the occurrence of the top 10 challenges along the two stages [3]: product development stage and learning process stage that the software startups were at when the survey was responded. The result is shown in Figure 1. The Figure is a bubble chart (“x-y scatter plots with bubbles in categories’ intersections”), where the size of the bubble is determined by the number of challenges corresponding to the x-y coordinates.

Inspecting Figure 1, we can notice a malformed distribution: the respondents perceive the importance of challenges during their problem evaluation phase, however there is not a corresponding perception during the first phases of product development (e.g. only 3 out of 10 before having a working prototype).

In order to enhance the granularity of the distributions of the challenges we also present a multi-dimensional chart (see Figure 2) in which the 10 challenges are grouped into four Macmillan et al. mentioned dimensions. A close look at Figure 2 reveals that the most common perceived challenge is related to *market* and *product* (both representing the 30% of the challenges).

While market and product related challenges are equally important in the problem evaluation stage, in the mature stage of the product development the market significantly impact their perception. This might be expected, however,

² Dedoose is a tool for analyzing qualitative data, available at www.dedoose.com.

Table 1. The list of top 10 challenges

Challenge	Description	#	Dimension
Thriving in Technology Uncertainty	developing technologically innovative products, which require cutting-edge development tools and techniques	1132	Product
Acquiring First Paying Customers	persuading a customer to purchase the product, e.g. converting traffic into paying accounts	870	Market
Acquiring Initial Funding	acquiring the needed financial resources, e.g. from angel investors or entrepreneurs' family and friends	682	Financial
Building Entrepreneurial Teams	building and motivating a team with entrepreneurial characteristics, such as the ability to evaluate and react to unforeseen events	436	Team
Delivering Customer Value	defining an appropriate business strategy to deliver value*	393	Market
Managing Multiple Tasks	doing too much work in a relatively short time, e.g. duties from business to technical concerns	351	Team
Defining Minimum Viable Product	capturing and evaluating the riskiest assumptions that might fail the business concept	307	Product
Targeting a Niche Market	focusing on specific needs of users willing to take risks on a new product, such as early-adopters and innovators	212	Market
Staying Focused and Disciplined	not being particularly sensitive to influences from different stakeholders, such as customers, partners, investors and competitors (both actual and potential)	165	Team
Reaching the Break-even Point	balancing losses with enough profits to continue working on the project	161	Financial

*The difference between what a customer gets from a product, and what he or she has to give in order to get it (www.businessdictionary.com).

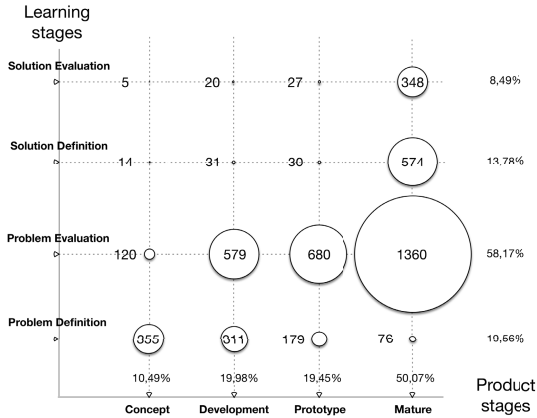


Fig. 1. Challenges map - learning and product stages

challenges related to the market, such as strategies to acquire the first customers can reasonably be considered from the very early stages of a startup company.

In the following subsection, the top 10 perceived challenges are further illustrated in two real startup settings that were investigated in our multiple-case study, to provide a richer and contextual description of the challenges.

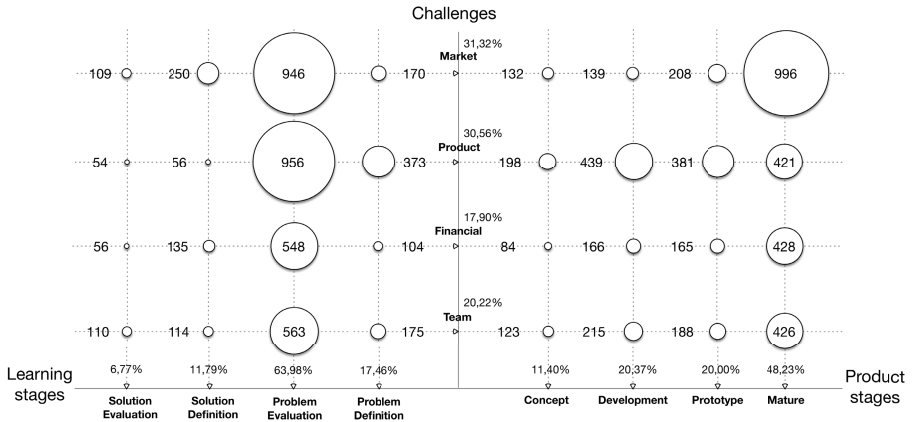


Fig. 2. Challenge map along the four dimensions

4.2 Key Challenges Experienced in Two Early-Stage Software Startups

EasyMedicine is a software startup that offers a mobile app for travellers to solve their health problems during their trips abroad. This app aims at helping travellers to find medicine, that they normally take in their home country, when abroad.

MovyNext is a software startup that has developed a web-based movie recommendation system as a “better movie filter”, customized according to viewers’ interests.

The profiles of the two cases are presented in Table 2

Table 2. Profile of two cases

Profile	EasyMedicine	MovyNext
Idea/Business domain	Health	Entertainment
When started	Idea: July 2013, Development: November 2013	Idea: July 2012, Development: December 2013
No. of founding team members	4	4
Current composition of team	2 (Pharmacists), 2 (Businessmen)	1 mentor (from an incubator), 4 Software developers, 1 designer (Free lancer)
Current Product Development Stage	Mature	Prototype
Current Learning Process Stage	Solution evaluation	Solution evaluation
Application Nature	Android Mob app	Website

Both *EasyMedicine* and *MovyNext* have experienced the key challenges identified in the survey. They are re-organized under the four dimensions of MacMillan et al. [10] and presented with case contexts.

Product related challenges: The first product related challenge is thriving in technology uncertainty. In the EasyMedicine case, it is manifested as a lack of supporting technologies in collecting specific drug information from different countries. In addition, the CEO of EasyMedicine commented on the lack of resources to tackle this challenge:

“Our search criteria to find medicine was not efficient. We wanted to implement multiple search criteria with optimized search within the database, but we were unable to implement it because of not enough resources available for these problems.”

On the other hand, even though all of the founders of MovyNext were quite experienced in developing recommendation systems, they still had issues in adopting a new crawling algorithm for accurate information about movie trailers and providing an effective user-interface design for their early adopters. Moreover, the implementation technologies were not flexible to adapt to unforeseen changes or alternative breakthroughs.

Both EasyMedicine and MovyNext initially developed their MVPs based on their own intuitions and experiences. In the case of MovyNext, as a consequence of not properly defining MVP, the team spent a lot of time on developing the features (e.g. server side optimization) that users were not interested in. They tried by prototyping to gather early feedback and to address their technology uncertainty, however the novel solutions had negative impact on the early adopters, without engaging them effectively to obtain useful feedback.

Market related challenges: Attracting customers to buy a startup product is a challenging endeavor. In the case of EasyMedicine, the travellers were treated as paying customers initially. The CEO observed:

“There was positive feedback at the beginning. We got some downloads and we were satisfied. But it became quite apparent after a while that we were not making lots of progress. Lots of nice perks at the beginning, and lots of frustration in weeks after, but as soon as you launch, you discover.”

Meanwhile the interviewed developer mentioned:

“If we are not getting users, we should analyze the reason. There can be many reasons e.g. difficulty in using the application, application with low quality etc.”

In the case of MovyNext, the team did not have a specific type of paying customer in their mind when they developed their application. They did not have a specific strategy to attract them, as illustrated by the comment from the CEO:

“You think that your product is cool. Friends are using it, and that’s it. Paying customers are not coming. How to get this? that’s a challenge.”

Targeting a niche market is particularly critical in the case of EasyMedicine. The CEO commented:

“At this moment, pharmacies are not seeing big numbers (users). They are saying, why should I invest, if you don’t have lots of users. This is a two sided platform. If you don’t see people on the other side, you don’t want to be part of it. Pharmacists want to see more users.”

In terms of delivering customer value, both EasyMedicine and MovyNext did not define and validate the needs of their potential customers. In the EasyMedicine case, also their understanding of customers was changing. In a similar manner, MovyNext did not have any customer acquisition strategy when they started developing the application either.

Financial challenges: EasyMedicine was in critical need of initial funding to continue their project, as the CEO commented:

“It’s a challenge especially in a small city. There are not so many people to invest in startups if there is not a clear product/business plan. In software business, it is more challenging. You can create, change, and revolutionize several times. There were many apps similar to our app in our case.”

In contrast, since MovyNext grabbed the opportunity to work in an incubator in Oxford, acquiring initial funding is less of an issue. The CEO said:

“The goal of startups should be to enter an incubator. Because this is kind of validation of your idea that it works.”

Reaching the break-even point is important to keep the business running. However, neither EasyMedicine nor MovyNext has enough customers yet to be self-sustainable.

Team related challenges: Building an entrepreneurial team implies several challenges related to teamwork and team motivation. It also includes appropriate composition of the team. For example, in the case of EasyMedicine, it was about keeping people involved. The CEO recalled:

“We did not update our developer for the past two months. We lost him and he took another assignment. He is not available anymore”.

In comparison, the challenge in building an entrepreneurial team faced by MovyNext is more related to a lack of diversity in the team composition. The CEO described the situation:

“We are all computer scientists. There is no one, who work on user experience. To build product/feature, this is one part of the business. You need people, that market it, sell it, reach to customer, perform user based experiment. In our case, we don’t have them.”

Moreover the entrepreneurial teams in the two case studies are overburdened with lots of activities in a short time. In the case of EasyMedicine, for example, the team identified that they needed to conduct interviews with the stakeholders e.g. pharmacists and practitioners. The data from these sources was needed for the improvement of their business. However, all of the four founders were doing this as a part-time job, and they did not have time to conduct interviews. Similarly, MovyNext was also overburdened by various activities. There were some features (e.g. movie recommendations according to users’ preferences) that they wanted to add to their website, but they were unable to do so due to a lack of time. As the CEO said:

“We know what we want to do, but we are overwhelmed by other work. There is no time. Everybody is extremely busy and no one would dedicate full time to that.”

Staying focused and disciplined is not easy for these two startup teams. If any team member were less focused or lacked self-discipline, he would have affected the whole team, as the CEO of EasyMedicine commented:

“Two of the co-founding team members could not dedicate time to the project for three months because of personal commitments. The issue is that you do not only lose productivity. The remaining team becomes less motivated too.”

In the case of MovyNext, three of the co-founders were geographically distant. Hence, this decreased coordination among the team members, and self-discipline became even more crucial. Everyone needed to work hard and contribute, as the CEO commented:

“Nobody respects you if you don’t do anything, especially in a startup where the team is small. Everybody has to contribute.”

In summary, there are many challenges that are common to both the cases e.g. acquiring first customers, building an entrepreneurial team, delivering customer value, etc. MovyNext is fortunate enough that they do not have financial issues being in an incubator, however they are not yet self-sustainable. In contrast, EasyMedicine is in severe need of initial funding to continue operating.

5 Discussion

Among the challenges identified in our survey, the most prominent one is thriving in technology uncertainty. This is consistent with the nature of software startups, who are often chasing new technological changes, disrupting the software industry. In turn, developing new technologies might require innovative tools and techniques with little community support. EasyMedicine has evidenced such lack of support.

However, focusing only on technological solutions will not guarantee survival and success. In order to develop something valuable for customers, startups need to understand their real problems [3]. However, startups are not consulting the necessary processes for this need. Both EasyMedicine and MovyNext have not obtained the necessary validated learning in this aspect. This can be a potential root cause for other key challenges revealed in the survey, including acquiring the first paying customers. As presented in Figure 2, often the concept of product/market fit significantly impacts the operational decisions of early-stage startups. During a previous study [5], we explored how rushing to market can lead a startup to a misalignment between business and development activities, without prioritizing the evaluation of the challenged problem.

In order to learn fast from failures, Ries [16] suggests: try an initial idea and then measure it to validate the effect. This implies an evolutionary approach to gather knowledge by feedback from stakeholders. He states “Validated learning is a rigorous method for demonstrating progress when one is embedded in the soil of extreme uncertainty in which startups grow. It is the process of demonstrating empirically that a team has discovered valuable truths about a startup’s present and future business prospects.” When uncertainty is high, startups should focus on knowledge acquisition. As presented in Section 4.1, during the problem evaluation stage, there is a relatively high number of perceived challenges. Yet, during

the development of the product, the main challenges are predominantly present in the mature stage.

Making use of user interface prototypes and technical spikes or experiments are current practices for gathering knowledge and reducing risks. Many studies have been focusing on finding low footprint methodologies towards Lean and Agile principles [17, 18]. However, presenting just debt-laden features, as discussed by Tom et al. [19], can frequently impact users, which will cost real money in support (for motivated evaluators/customers), sales (through turned-off evaluators), and renewals (through dissatisfied customers). Lack of structure and time pressure lead startups to lose their focus, investing resources in ineffective practices. In the case of EasyMedicine, they were trying to get more users showing prototypes without any strategy to persuade potential customers, and get paid for their product. Similarly, MovyNext did not have validated learning process, and spent huge amount of time on developing features that users were not interested in.

Effective requirements elicitation would improve knowledge acquisition by engaging stakeholders in understanding the product concept and underlying problems that need to be addressed [20]. Besides specific features, requirements elicitation would identify system boundaries and goals especially during the early-stage of a startup. In this regard, studies about how to support effective practices during or before development are still lacking and the topic requires further investigation [1]. Examples of starting validating the problem statement even before investing on development solutions are the use of pre-orders [21] or evaluation techniques through crowd-funding projects (e.g. Kickstarter and Indiegogo) [22]. Identifying the valuable but missing knowledge early in the project and by defining/tailoring the SE processes to focus on getting/creating the required knowledge can shift development paradigms in the early phases and thus reduce the investment in developing ineffective solutions. It is critical to investigate practices for knowledge acquisition. When uncertainty is reduced, a startup can gradually focus more and more on customer value. By employing learning process on the problem statement since the very early-stage, startupperes can provide more value to their customers [23].

The validity threats to our study design and findings are hereby discussed. One threat to validity is the selection of subjects. We centered our results on respondents' opinions. In order to mitigate this threat, we selected interviewees holding the position of CEO. Their broad perspectives on their startup organization were the only data taken into consideration in the study. In addition, we employed a two-dimensional research approach by integrating on-line surveys and multiple case studies. However, threats might be the bias by contextual factors, such as type of product, competitive landscape etc. To mitigate this threat, we constructed the framework using Macmillan et al. dimensions, widely used in previous software engineering studies [24, 25], enabling a broader reasoning related to the factors that hinder the success of software startups.

6 Conclusions

Software startups are able to produce cutting-edge software products with a wide impact on the market, significantly contributing to the global economy. Software development, especially in the early-stages, is at the core of the company's daily activities. Despite their severely high failure-rate, the quick proliferation of software startups is not supported by a scientific body of knowledge [1]. This paper provides an initial explanation of the perceived and experienced challenges by means of an online survey and multiple-case studies based on two software startups, focusing on early-stage activities, from the *product*, *market*, *financial* and *team* perspectives.

A large-scale survey, with 5389 complete responses, shows that thriving in technology uncertainty (21,01%) and acquiring first paying customers (16,14%) are among the top challenges that most software startups are facing at their early stage. In conjunction with the multiple-case study, we described how early-stage startups are still too keen to develop mature products without understanding the business problem. When it comes to validating the problem/solution fit, they continue to develop software, with little focus on the learning process.

To continue the current study we will conduct a more in-depth analysis to reveal the linkages among the described challenges and with other factors, such as user growth rate. We call for further investigations on improving validated learning processes for more accurate and comprehensive evaluation of business problems from the first stages of product development.

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