The application of an entrepreneurial theory to study software development in startups

Anh Nguven Duc 1,2, Yngve Dahle1, Martin Steinert1, Pekka Abrahamsson1,2

¹ Norwegian University of Science and Technology, NO-7491 Trondheim, Norway ² Software Startups Research Network http://softwarestartups.org

Abstract. Software startups face with multiple technical and business challenges, which could make the startup journey longer, or even become a failure. Little is known about entrepreneurial decision making as a direct force to startup development outcome. In this study, we attempted to apply a behavior theory of entrepreneurial firm to understand the root-cause of some software startup's challenges. Six common challenges related to prototyping and product development in twenty software startups were identified. We found the behavior theory as a useful theoretical lens to explain the technical challenges. Software startups search for local optimal solutions, emphasize on short-run feedback rather than long-run strategies, which results in vague prototype planning, paradox of demonstration and evolving throw-away prototypes. The finding implies that effectual entrepreneurial processes might require a more suitable product development approach than the current state-of-practice.

Keywords: effectuation, entrepreneurial behavior theory, software development, software startups, prototyping, empirical study

1 Introduction

The software industry has witnessed a growing trend, where software products are developed by startup companies with limited resources and little operating history. With the advancement of technology development, it seems that everyone with a business idea, a website and a pitch can launch a new company. However, not so many business ideas are realized as concrete prototypes. Furthermore, even a smaller portion of prototypes is transformed into commercialized products. It is difficult to repeat successes, as startups operate in chaotic situations, where the links between startups' behaviors and their effects are often not detectable [1].

Decisions made by entrepreneurs is the direct force leading to the success or failure of the startup [3]. Startup's unique characteristics, i.e. dynamic, bootstrapping and multiple-influenced environments, make the decision-making tasks for entrepreneurs are different for project managers in more established companies [1]. Entrepreneurs often have to make decisions with little information about market, customer and product, and whether they will be accepted [2]. Entrepreneurial literature offers

several ways to understand the startup's decisions and behaviours [3, 4, 8]. One approach is the behaviour theory of entrepreneurial firms, which assumes the effectuation approach when developing startups' business [4]. Recent ideologists [5, 6, 7] encourage the co-development of business and product in startups. The combination of the two line of thoughts inspires us to explore the effectual behavior of startups from product development aspect. We are interested in understanding how the theory of entrepreneurial behaviors could help to explain the challenges faced during the product development. Our research question is "How are theories of entrepreneurial behaviors applicable to explain for startup product development process?"

The paper is organized as follows; firstly, we present related work about a behavior theory of entrepreneur firm (Section 2). Then, we describe our research methodology (Section 3). After that, findings are presented (Section 4). Finally, we will discuss and conclude the paper (Section 5 and 6).

2 Behavioral Theory of the Entrepreneurial Firm

Entrepreneurship literature is intensive on understanding the formation, development and influencing factors to startups. There has been an increased attention on the effectuation theory in explaining entrepreneurial behaviours [8]. Effectuation processes take a set of means as given and focus on selecting between possible outcomes that can be realized [8]. Alternatively, entrepreneurial firms are seen as heterogeneous, bounded rational entities [4]. In the face of environmental uncertainty, therefore, these bounded rational firms form expectations based on available means and information. Dew et al. proposed a behavioral theory of the entrepreneurial firm (BTEF) [4]. Assuming entrepreneurs as an effectual unit, Dew et al. [4] propose four constructs related to entrepreneurial decision-making:

- Means-driven transformation: startup companies tend to be effectual, and
 available resources drive their action. Effectual action involves transforming
 extant means into new possibilities, including new problems of interest.
 Transformation processes are actor-centric, as who comes on board
 determines goals, not vice versa. The transformation is appeared as a search
 activity, aiming at solving pressing problems rather than developing long-run
 strategies.
- Docility: conflict and difference among stakeholders is avoided through stakeholder docility, goals are residual of the process. Simon et al. defined docility as "the tendency to depend on suggestions, recommendation, persuasion and information obtained through social channels, as a major basic of choice" [9]. The decisions made by startups, for instance, can be done by in cooperating other's ideas and not necessary by going through conflict resolution.

- Leveraging contingency: avoiding uncertainty by short run feedbacks, but also encouraging surprise. For startups, even 'bad' surprises can be leveraged to provide new means and new opportunities. Actions emphasize commitment and contingency, not choice and determinacy.
- Technology of foolishness: insulation from learning sought through allowing experimental actions with regard to affordable lost. The technology of foolishness allows startups to relax the primacy of functional rationality, to temporarily suspend intentionality, and promote the openness to new actions, objectives and understandings.

3 Research Approach

We conducted this study by using a multiple-case study design with software startup as a unit of analysis [10]. Contacts for startups were searched via four channels, (1) startups within professional networks of papers' authors, (2) startups in the same town with the authors, (3) startups listed in the Startup Norway website and (4) the Crunchbase database. Twenty startups were eventually selected for investigation. The startup cases represent different startup phases, from prototyping to commercialization and scaling. Application domains range from marketplace, education, ecommerce, transportation, and Internet-of-Thing. Regards to software development approaches, startups with five or more people mostly adopt Agile and iterative software development. The sample is dominated by Norwegian software startups, with small teams and bootstrap financing models. We do not consider other types of startups, for example, internal cooperate startups, venture capital invested startups, and USA-based startups.

The major data collection instrument is semi-structured interviews. The interviewees were focused on exploring startup's decision making and their behaviors related to their business and product development. The interview guideline is published online¹. We used a thematic analysis to analyze the data, a common technique for identifying, analyzing, and reporting conceptual themes found from qualitative data [17]. To support the data analysis, we used a tool namely NVivo 11², to code, and to categorize such codes in higher order levels, representing different technical challenges when going from ideas to commercialized product. Several theoretical frameworks were considered, such as Cynefin model [11], boundary spanning object theory [12] and BTEF [4]. With the focus on exploring the decision making process behind startup's behaviors, we attempted to apply the four principle of BTEF to explain for how do startups face with such technical challenges.

¹ www.goo.gl/r9okCu

² www.qsrinternational.com/product

4 How are theories of entrepreneurial behaviors applicable to explain for startup product development process?

Six identified themes were directly related to startup's decision making. We found that BTEF can be useful to explain for such themes, as shown in Table 1. The challenge name and description were given along with the theoretical explanation in the table.

Table 1: Explanation for startup's technical challenges

Challenges	Description	Interpretation via BTEF
Vague	Prototypes were created in an	Startups emphasizing short-run
prototype	adhoc manner, mostly throw-	reaction rather than
planning	away, lack of upfront design for	anticipation of long-run
	learning, sometimes little lesson	uncertain events focusing on
	learnt, lack of early-stage product	the search for a suboptimal set
	roadmap	of features or functionalities
		[4]
Feature creeps	Startups implement requirements	Startups tend to perform
	from many customers with	different experiments with
	different needs, divergent product	technology, i.e. features, user
	roadmap. "We are adding features	experience etc. Many startup
	all the time. This is not a product	features are a good
	that will ever stop evolving We	representation of technology
	are talking about this being the	of foolishness
	core of the company's	
	competence"	
Paradox of	Early demonstration needs to be	Startups operate based on
demonstration	impressive to attract funding.	mean-driven transformation
	However there is often a limited	[4]. Demonstrated prototypes
	budget for developing a minimum	were limited by the current
	viable product	human and financial resources
Evolving	Many throw-away prototypes	Startups leverage
throw-away	accidentally become evolutionary	contingencies [4]. Tolerating
prototypes	ones. Technical debt caused by	surprises during a series of
	the lack of proper refactoring	prototypes might lead to utilize
	threatens the quality of product in	the business-fit prototype for
	later phases of software startups	long-term development
Sharing	Communication of business or	Conflicts do not necessarily
visions	technical details can be difficult	happen in a startup context, as
between	between entrepreneurs and	startup team members are both
Business and	developers. "it always takes a	persuadable and persuasive to
Technology	long discussion to explain her	different degrees about
	[the CEO] about the importance	different matters [4]

	of having flexible product design"	
Lack of sufficient and relevant user involvement	Balancing learning fast and learning the right things is a challenging task. Startups might have problems with finding feedbacks from relevant users. "Most of them don't understand the idea It probably came ten years before the app developers can recognize its benefit"	Challenges of early user involvement can be tracked to two problems, 1) to find appropriate early innovators and 2) whether there actually is a market for the product

5 Discussions

The technical challenges were interpreted in a context of a prototype-centric development paradigm [13, 14, 15]. Literature reveals that startups adopt rapid releases to build a prototype in an evolutionary fashion and quickly learn from the users' feedback to address the uncertainty of the market. The rapid development approaches were found to improve the effectiveness of the requirement elicitation of any software development [15]. However, in many cases software startups do not throw away quick-and-dirty prototypes and evolve them (or part of them) into the final products.

By using an effectuation theory [4], we can explain different technical challenges that startups face with during their journeys from idea to commercialization. Technical challenges related to prototyping and product development are linked with startup's current capacity, experimental nature of technology development, risk tolerance and favor of short-run feedbacks. Driven by the existing means and resource, startups search for local optimal solutions, emphasize on short-run feedback rather than long-run strategies. This results in technical challenges, such as vague prototype planning, and paradox of demonstration. All in all, the theory suggests the observed product development approaches do not likely support the entrepreneurial processes or vice versa. Alternatively, the effectual decision making might need a better software development paradigm that can fit to the uncertain and dynamic situations of startups.

6 Conclusions

This paper portrayed six technical challenges in early phases of software startups. Entrepreneurs make decisions to search for local optimal solutions, emphasize on

short-run feedback rather than long-run strategies, which might require a more proactive, flexible and agile approach than the state-of-practice software startup product development. Our contributions are two folds. Firstly, we illustrate for the application of firm's behavior theory in the relation to technical decisions, which are essential for achieving core values of software-based startups. Secondly, this is among the first attempt to bring a theoretical framework from entrepreneurship literature in Software Engineering. This is encouraging due to the current limited theoretical contribution to software startups research [13, 14].

There are several possibilities for future work on software startups. Our next step is to extend the map of startups challenge to include non-technical challenges that we identify from the cases, such as lock-in to external resources, changing team composition and market uncertainty. Furthermore, we found that entrepreneurial theories are helpful in understanding and explaining the context of technical challenges and decision-making. Future work would investigate more on how other theories can be adopted in software startup research.

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