Do software startups innovate in the same way? A case survey study

Jorge Melegati and Xiaofeng Wang

Free University of Bozen-Bolzano, Piazza Domenicani 3, Bolzano, Italy

Abstract. The research interest in software startups has expanded a lot in the last years as shown by the increase in the published papers, and the organization of research workshops. However, two recent systematic mapping studies recognize an inconsistency in the characterization of software startups in the literature, even though they acknowledge that innovativeness and uncertainty are the common themes the literature uses to describe these companies. In the new product development literature, even though not consolidated, innovativeness is usually related to technology and/or market discontinuities. These two different types of novelty could bring distinct consequences to software development activities in software startups. Using a case survey research approach, we analyzed 27 published papers from the period 2013-17. We identified and categorized the innovation in 18 software startups products or services from the perspective of discontinuities. We found that software engineering literature did not differentiate software startups based on the innovations they develop. Nevertheless, most studied software startups work on products with a market discontinuity and without a technological one.

Keywords: software startups · innovativeness · technology discontinuities

1 Introduction

Research in software startups has grown in the last five years as discussed by Berg et al. in a recent systematic mapping study [2]. Comparing the papers in this period to a previous systematic mapping study performed by Paternoster et al. [14], the authors conclude that the rigor of primary studies has increased in this period. Nevertheless, they also found an inconsistency of characterizing software startups similarly to what Paternoster et al. [14] have found. In this more recent study, the authors performed a thematic analysis of the software startup term used in research and their results indicated that no single factor was used by all papers to characterize software startups. They concluded that the lack of a proper definition make it challenging to develop a body of knowledge for software startup context. Similarly, Unterkalmsteiner et al. [17] proposed a research agenda for software startups and, in one of the tracks, remembered that software startups definitions are "not granular enough [...] making the transfer of practices from company to company difficult."

Still, in Berg et al.'s thematic analysis, the terms most used were "innovation/innovative" and "uncertainty" [2]. This relation between innovation and uncertainty is explored in new product development literature. Salomo et al. [15] mentioned "high innovative development may evolve along an unexpected path, thus requiring frequent or continuous information updating and generation of new information". Nevertheless, in innovation literature, product innovativeness has several conceptual configurations [11]. Garcia and Catalone [7] performed a literature review on innovation and product innovativeness terminologies and found several categorizations to label degrees of innovativeness. Nevertheless, according to the authors, "a single theme, however, does underlie all these classifications of innovations: innovativeness is a measure of discontinuity in the status quo in marketing factors and/or technology factors". Although Calantone et al. [4] concluded that product innovativeness has no direct effect on new product profitability, different degrees of newness and discontinuities change factors in new product development (NPD) processes [7].

To the extent of our knowledge, there is no discussion in software startups literature about the degree of newness of products developed by studied companies. Then, this study investigates the following research question:

RQ: What defines the innovation of a software startup?

To answer the research question, we performed a case survey on the papers published in the period 2013-17 covered by Berg et al. [2] in their recent systematic mapping study. We read all the papers, selected studied software startups that got the information that allowed us to analyze product and business models, and categorized them accordingly. The results indicate that scholars have studied companies developing products with discontinuities from technical and market perspectives without distinction. This lack of homogeneity could hinder generalization of results presented.

The remaining of this paper is organized as follow. Section 2 presents related work on the software startup term definition in software engineering literature and presents technological innovativeness as discontinuities, Section 3 describes the methodology used to perform this study and Section 4 presents the results and discuss them. Finally, Section 5 concludes the paper and proposes future work.

2 Background and Related work

The scientific interest on software startups has grown in the last years but the definition of what is a software startups is still not consolidated. Section 2.1 displays how this problem has been discussed in secondary studies on the topic. Given that, technological innovativeness is one of the most used themes to describe these companies, Section 2.2 presents some definitions from new product development (NPD) literature.

2.1 Startup definition

Sutton [16] is responsible for an early characterization of a software startup company back in 2000. According to him, these companies are widely represented by youth and immaturity, limited resources, multiple influences and dynamic technologies and markets. In their 2014 systematic mapping study, Paternoster et al. [14] concluded that there was no agreement on a standard definition and identified the most frequent themes used to characterize software startups: lack of resources, high reactiveness and flexibility, innovation, uncertain conditions, time pressure and fast growth. In the more recent SMS, Berg et al. [2] performed the same analysis and reached a similar result. Nevertheless, the most used themes were now innovation/innovative, uncertainty, small team and lack of resources.

2.2 Technological innovativeness

In a seminal literature review about innovativeness, Garcia and Calantone [7] recognize that the term was still not homogeneous in the new product literature, including what is considered what is new. Nevertheless, the authors recognize a consistency: innovativeness "is always modeled as a degree of discontinuity in marketing and/or technological factors."

The authors also emphasize that innovativeness should be analyzed from two different perspectives: a macro, related to the newness of that product to the outside of the firm, and a micro, related to the novelty to the firm. Based on these perspectives, they define:

- radical innovations as representing a technological and marketing factors in a macro perspective;
- really new innovations as showing a technological *or* a market discontinuity; and
- incremental innovations as those presenting any discontinuity only in a micro perspective.

Given a startup is generally considered a new company with little or no operating history, we can limit our analysis to the macro perspective, that is, only radical or really new innovations.

3 Research method

As Larsson [9] mentioned in his paper about the methodology, the case survey is an inexpensive and powerful method to identify and statistically test patterns across studies. The author describes the basic procedure to perform such study:

- to select a group of existing case studies;
- develop a coding scheme to systematically analyze and convert qualitative descriptions into quantified variables;
- based on the coding scheme, several raters code the cases;

– analyze the quantitative data.

Then, the first step was to select the primary studies to be analyzed. Given that Berg et al. [2] published a systematic mapping study on software startup engineering on *The Journal of Systems & Software*, the primary studies they identified are high probably the most important also to this study. Another interesting feature of this study is that it separated the papers from period 2013-2017 against the whole studied period from 1994-2013. Since this study is focused on how current researchers are selecting software startups to study and that the authors also concluded that the rigor has increased in this period in comparison to before, it is reasonable to focus on this more recent time period.

Then, we got the 27 full text papers and read them carefully. Only 7 of those provided information that allowed us to describe the business model of, at least, some studied software startups. Table 1 displays the papers that contained at least one describable software startup and the number of software startups described in each of them. Based on the descriptions and the authors, we could infer that some software startups were mentioned more than in one paper. Then, their descriptions were merged and analyzed as one. The total number of descriptions was 23 but only of those 18 were unique cases.

Table 1. List of empirical papers on software startups reviewed.

Paper	Number of software startups described
Giardino et al. [8]	2
Nguyen-Duc et al. [12]	3
Bajwa et al. [1]	4
Nguyen-Duc et al. [13]	5
Marks et al. [10]	1
Chanin et al. [5]	2
Duc et al. [6]	6

The software startups' descriptions were extracted and classified according to if they present or not technological and market discontinuities. According to Garcia and Calantone [7], a technology discontinuity represents "a paradigm shift in the state of science or technology in a product" and a market one "may require new marketplaces to evolve, and/or new marketing skills". In our classification, a new product or service to contain a technology discontinuity, it had to represent a product that demanded the creation a new technology like a prediction tool for financial markets. Meanwhile, a market discontinuity represents the application of a well-known technology (like web development) into the creation of a new product, or the application of an existent product to a new market. Products could also display both types of discontinuity when its creation demands a new

technology to be applied in a product without a similar solution in the market like a new real-time solution to support sales.

4 Results and discussion

Table 2 displays a summary of the software startups descriptions presented in the analyzed papers and if they present or not a technical or market discontinuity. Figure 1 depicts a graphical representation of the analysis. In the lower-left quadrant where a product would not have neither a technical nor a market discontinuity is empty. This was expected: software startups as innovative enterprises should present at least one discontinuity. Most of startups (13 out 18) are in the lower-right quadrant, that is, they display a market discontinuity without a technical one. The companies apply well-known technologies to create a product to tackle a problem in an existent market or they pretend to create a new market. Meanwhile, only 2 of them are in the upper-left quadrant, showing a technical discontinuity without a market one, that is, they are focused on the creation of a new technology to tackle an existent problem, a new solution to compete with existent products or services. The remaining 3 software startups are in the upper-right quadrant presenting both types of discontinuities: they develop a new technology to tackle a problem that has not been solved before. This last group represents the most challenging environment to a software startup.

In relation to software development challenges, the two groups that present only one type of discontinuity could be also summarized as follows:

- Only technical discontinuity: these teams develop brand-new technologies for some consolidated markets. It was possible to observe that their members generally have strong research backgroun and some of these companies were created in universities. Their challenges are situated more in technical problems than customer/market problems. .
- Only market discontinuity: these teams develop new products or services with well-know technologies like websites or mobile apps. We observed that these companies are generally formed by recent graduated students. Their challenges are situated more in market problems that is, their major risks are finding customers or users.

These two clusters could also be viewed as teams trying to solve different issues on the problem-solution space. The first group focus on a *solution* issue to a well-defined or well-known problem meanwhile the second group focus on finding the right *problem* to tackle. For this group, once the problem is found, the solution is, at least at a higher level, straightforward. Those software startups which product presents both discontinuities face problems from both spaces.

This difference influences the software development process in these companies. For instance, if the problem is not well-understood, requirements engineering practices should be less effective and the team may need to use other techniques like, for instance, brainstorming and ideation. That is, they can take more advantage of Customer Development and other lean startup practices [3].

Table 2. List of software startups described in the literature.

Number	Software Startup	Description	Discontinuity	
			Technical	Market
1	Milkplease [8]	Deliver grocery shoppings from local supermarkets to customers' doors with the collaboration of neighbors		X
2	Picteye [8]	On-line service to sell pictures of public and private events		X
3	Story A [12], StartupC [13]	A platform to sale photos to local event participants		X
4	Story B [12]	A sonar system to produce video-type imaging underwater where normal cameras don't work	X	X
5	Story C [12], Hooka [1]	An online ticketing system focused on small companies that cannot afford expensive solutions		X
6	Dicy [1]	Video service for other startups to create their own promotional videos		X
7	DocMine [1]	Unified API to access different social media sources		X
8	EasyLearning [1], Startup A [13], CT5 [6]	Game-based learning platform for teachers give quiz to students in a classroom		X
9	StartupB [13]	Real-time sale support solution	X	X
10	StartupD [13]	App for share meal		X
11	StartupE [13], CT2 [6]	A mobile solution that allows different departments of a construction project to collaborate.		X
12	Optimality Technologies [10]	Software tool to database modernization	X	
13	StartupA [5]	Mobile application to link organic food producers to consumers		X
14	StartupC [5]	Online invest platform with predictive capabilities	X	
15	CT1 [6]	An spin-off of a social media corporation that develops a hyper-local news platform.		X
16	CT3 [6]	To facilitate events organization and tickets purchase in Norway.		X
17	CT4 [6]	An Airbnb style solution (sharing economy) for shipping services.		X
18	CT6 [6]	An IoT solution to be used by fish farms for tracking and management.	X	X

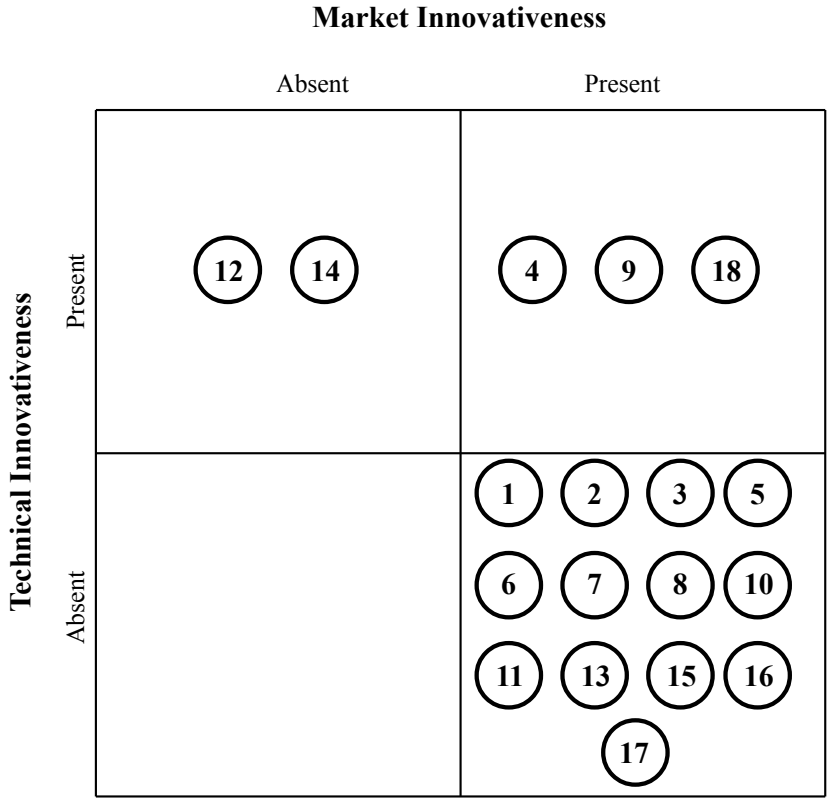

Fig. 1. Diagram of software startups innovativeness

Whereas if the customer problem is clear and the solution is not well-understood and need to be developed, the focus will be more in software design and the implementation itself.

4.1 Limitations

This paper has as a clear limitation based on the reduced information provided in the papers on how software startups studied create value to their users or customers. Although this lack of details could make difficult to classify the products, even this limited amount of information was enough to determine the discontinuities present. It is possible, tough, that we were mislead and some software startups were wrongly classified. Nevertheless, it is highly unlikely that several were wrong at the point to change the main result: software startups that face different discontinuities are grouped and have their practices analyzed together.

To increase validity and reliability, both authors did the classification and compared their results. The table presented in the paper also helps readers to verify the analysis.

5 Conclusion

This paper investigated the innovativeness of software startups analyzed in the literature. Using a case survey approach, we read 27 published papers and were able to gather 17 software startups that had their products described. Then, we classified them according with the presence or not of market and technology discontinuities. The results highlights that most studied software startups present an innovation with a market discontinuity and without a technical one. Nevertheless, there are also software startups that present a technical discontinuity with or without a market one. This phenomenon could explain why the software startups literature still struggles to define what a software startup is. Besides that, the lack of homogeneity in the studied subjects hinder the application of research results by practitioners and also to compare conclusions from different authors. Such distinction is also important to compare results or import them from other research fields like the new product development or entrepreneurship literature.

A solution to such problems could be a deeper description of studied software startups. Several reasons could prevent researchers to give more details about studied software startups: sometimes founders do not want their idea to be published. Authors can also be limited by the space provided in a conference paper. Another solution could be an explicit commitment from authors that software startups studied in that work are of one kind or a discussion why these differences does not matter to the topic discussed.

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