Emerging Technologies for Innovation Management in the Software Industry

Varun Gupta
Universidad de Alcalá, Madrid, Spain

Chetna Gupta
Jaypee Institute of Information Technology, Noida, India

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701 East Chocolate Avenue, Hershey, PA 17033, USA
Tel: 717-533-8845 x100 • Fax: 717-533-8661
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Preface

AN OVERVIEW

Innovation is the key to maintain competitive advantage. Innovation in products, processes, and business models help companies to provide economic value to their customers. Identifying the innovative ideas, implementing those ideas, and absorbing them in the market requires investing many resources that could incur large costs. Technology encourages companies to foster innovation to remain competitive in the marketplace.

Emerging Technologies for Innovation Management in the Software Industry serves as a resource for technology absorption in companies supporting innovation. It highlights the role of technology to assist software companies—especially small start-ups—to innovate their products, processes, and business models. This book provides the necessary guidelines of which tools to use and under what situations. Covering topics such as risk management, prioritization approaches, and digitally-enabled innovation processes, this premier reference source is an ideal resource for entrepreneurs, software developers, software managers, business leaders, engineers, students and faculty of higher education, researchers, and academicians.

TARGET AUDIENCE

Entrepreneurs, Software Engineers, Scientists working as Researchers with research organizations, Universities, and Research & Development Units, Academicians, Business consultants, and others will benefit from the research findings presented in this book. This book gives readers a single point of entry to research on startup innovation in terms of empirical investigations and research solutions. The book's information provides significant direction to the startup community and other stakeholders for incorporating it into their actual business processes. The research papers presented in this book will assist the audience in the following ways:

Entrepreneurs

- Improving their current innovation strategies.
- Using the knowledge imparted in this book to solve their current business difficulties.
- Developing dynamic capacities to maintain a market competitive advantage.

Academicians

- Lecturing students on current innovation management strategies used by startups.
- Developing new research lines and innovating existing research lines using the book.
- Creating strong research proposals that can be submitted to funding agencies.

Scientists/Researchers

- Using the book as a source of information to start new research projects or improve on existing ones.
- Developing strong research project proposals for possible funding agency submissions.
- Strengthening their ties with industry and addressing real-world issues.
- Using a book as a main research study to find knowledge gaps and acquire ideas for future research in their professional and academic fields.

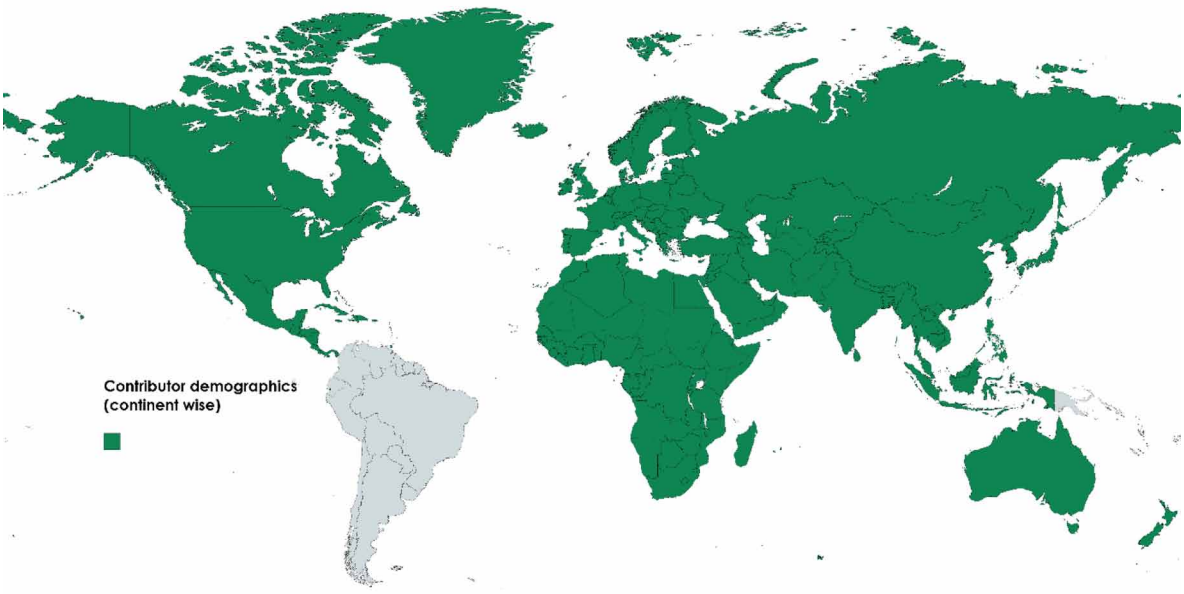
Software Engineers

- Improving startup business operations, for example, by making them better and more suited to startup working environments, based on knowledge imparted in the book.
- Incorporating the findings presented in the book into their daily work routines.

CONTRIBUTOR DEMOGRAPHICS

This book includes contributions from 39 authors from prestigious universities throughout the world. These authors contributed to 14 of the book's chapters. Contributors came from all over the world, including North America (United States of America (USA)), Europe (Denmark, Norway Portugal, Russia, Spain, Turkey, United Kingdom (UK)), Australia (Australia), Asia (India, Pakistan, Vietnam, Malaysia) and Africa (South Africa) as graphically represented in Figure 1).

Figure 1. Contributor demographics (based on their affiliations)



ORGANISATION OF BOOK

This book is divided into 14 chapters, each of which focuses on innovation management in the context of a startup. These investigations are organized into 14 chapters, each of which is detailed in detail in the following lines.

Chapter 1 highlighted that Software startups have been widely known for their potential for disruptive innovation and their ability to generate wealth through unique value propositions and business models. The benefits that such organizations provide to the local and global economy are well documented. There is however that a concern when it comes to software startups is that most such startups fail in less than 2 years of inception. Given the invaluable contributions that these emerging organizations bring to the lives of their founding teams and the overall economic system alike, the causes, the current constructs contributing to the failure and possible success of software startups should merit further study.

From the perspective of business model development, much of the software startup space is presently dominated by the agile paradigm of business model creation using methodologies such as the Business Model Canvas, the Lean Startup and the Lean Canvas. The traditional business model development methodology has largely been abandoned given that it takes too much time to work through and the ever-changing fast paced nature of the software market would need business modelling methods which can easily pivot and is quick to develop, form hypothesis and test. The situation is not very different in the product development space, as the agile manifesto was originally conceived with the needs of the software space in mind. User stories are one of the most popular methodologies used when capturing requirements and prioritization is done using techniques like QFD, pair-wise analysis and MoSCoW analysis. Prototyping is used as a tool to help with testing out product concepts and getting user feedback. Some of the shortcomings observed during the creation of the startup is the lack of a holistic approach to the startup's development. The product and business model development efforts are rather created in silos with little interconnections. For instance, there is no commercial validation efforts done during

the product development process. All efforts during that point is made to ensure that the product being developed is useful to the user and has good usability. There are similar issues when it comes to business model development. A better paradigm could be to explore an integrated approach for development of the startup, where both product and business model development are explored as a part of the same process with a common goal in mind. Ideally, a framework developed using such a perspective will incorporate additional aspects such as making use of product evangelists to promote the value proposition, keeping a close watch on the evolutions within the user's problem space, creating potential product ecosystems around the core value proposition and leveraging metrics for better decision making.

Chapter 2 highlighted that the widespread use of digital technology in innovation processes and outcomes, has prompted scholars to develop new theories on innovation management. These theories challenge long-held beliefs about the relationship between company performance and innovation processes, as well as the boundaries between innovation and organizations. Researchers must study and investigate digital technology implementation in order to foster innovative activity, which necessitates new digital technology theorization. Scholars have developed various research directions to theoretically understand digital technology in relation to developing digital business strategies, reassembling current capabilities with digital resources to establish digital capabilities, and capturing or creating value using digital technologies.

A thorough understanding of how digital technology affects the management of the innovation process might lead to the creation of an innovation process framework. Based on these premises and the research streams mentioned, researchers argue that incorporating and using digital technologies in innovation processes forces organizations to reorganize their business models and manage the innovation process in a different way than previously stated in the literature. The mechanisms that digital innovation supports are sometimes forgotten in the story of digital innovation. The potential of digital innovation to reconfigure, revitalize, challenge, and rethink the way things are viewed and comprehended is its primary impact. To put it another way, digital innovation is all about what it changes and how it affects how things are done as a result of the use of digital technologies. To comprehend change, one must first comprehend the mechanism through which change occurs, and vice versa. As a result, in the context of digital innovation, business process management is becoming increasingly important.

Digital innovation is expected to alter the process by balancing new innovation features with immediate feedback, balancing adaptation freedom with predefined structure, balancing positive deviation with process compliance, and balancing inter-organizational emergence with intra-organizational optimisation, according to researchers' attempts to link digital innovation to BPM. A new stream of research has recently emerged at the interface of digital innovation and business process management. This stream presents new ideas to describe how digital innovation affects the design, analysis, and management of business processes by enabling, hindering, shifting, or constraining them. It also looks at how BPM theory, technology, and practices can help us understand the processes and outcomes of digital innovation. The goal of this stream is to bring together those two disparate and isolated fields so that their insights, ideas, and theories can collide and transcend the bounds of their own literature streams.

Despite the fact that the literature on BPM and digital innovation is fragmented, it is apparent that the two sectors are complementary and mutually beneficial. Scholars in both fields must examine their techniques, questions, and assumptions in order to assess this complementarity. Scholars must start listening in on each other's talks in order to contribute to this complementarity. Context comprehension is a significant source of research prospects in both digital innovation and business process management. Contextual factors have a significant impact on both digital innovation and business process management.

The BPM field has produced context-aware methodologies, tools, and conceptualizations. To address context, the digital innovation area has used computational and empirical methodologies. The possibility arises from using digital innovation research methodology to the development and improvement of BPM technology, such as process analysis and process mining, and vice versa.

Chapter 3 introduced an area of research related to the implementation of emerging Unified Communications and Collaboration (UC&C) technologies for productivity and innovation management within the context of large-scale automotive design, manufacture and business operations at General Motors (GM), a leader in the global automotive industry. It further discusses how the chapter bridges the gaps presented through the design of the research developed with the purpose of evaluating the impact of said emerging technologies. In terms of mentioning what problems existed, prior to the research undertaking reported on in this chapter, General Motors had not implemented unified communications within its manufacturing, design or business operation functions and had not engaged in the development of an Internet of Things (IoT)-related digitization strategy.

Chapter 4 highlighted that the hardware startups are increasingly popular due to recent advancements in hardware technologies. Nowadays, hardware product development involves the process innovation not only at the hardware level but also at software components. The scarce of knowledge on hardware startup product development motivates us to carry an empirical investigation on five hardware startup companies. This chapter reported some common good practices among hardware startups, i.e., process definition, evolutionary development process and document management. Several factors that are different from software startups, such as low priority of product quality, product pipeline and unrecognized product platform, are revealed. An integrative process model of hardware product development that shows the connections between human factors in the startups, their speed-prioritized development processes, and the consequence of hindered productivity in the later phases, is finally proposed. The model has some implications for hardware startup founders to plan for the trade-off between team, speed, quality, and later productivity.

Chapter 5 highlighted that in highly dynamic situations, entrepreneurs build value propositions in resource-constrained conditions. The activity is set up as a series of experiments, with each one aimed at validating value proposition-related assumptions with customers. Validation entails interactions between potential customers and the startup team utilizing prototypes, which leads to the confirmation of current assumptions as well as the discovery of new insights that lead to more experiments. The main features of the value proposition identification model are highlighted, and a novel value prioritizing approach is proposed in this chapter.

Chapter 6 highlighted that in today's world of strong competition, firms aim to minimize costs as much as possible while enhancing efficiency and quality. As a result, in order to keep the company afloat, managers must manage multiple crises at the same time. Organizations are putting a larger focus on concepts like novelty, creativity, and speed as a result of the rapid rise of technology and globalization, which allows knowledge to become a strategic value. To manage turbulence while maintaining long-term survival, businesses must participate in innovative operations. The notions that are currently separating companies are knowledge and the human factor that creates knowledge. The development, sharing, application, and management of knowledge are all elements of the organizational culture. The relevance of knowledge management is demonstrated by the fact that knowledge may be exploited as a competitive weapon by businesses in a global society, and that capital-intensive enterprises are being replaced by knowledge-intensive businesses. Organizations, on the other hand, may encounter a knowledge gap between their existing level of knowledge and the amount of knowledge required to create

new items, processes, or services. Businesses will need to conduct new research to close this gap. The most important factors for a corporation at this time are the quality and quantity of knowledge, as well as how it will be employed to carry out innovative operations. Integration of knowledge management and knowledge processes boosts a company's innovation and performance.

Knowledge management strategies and initiative actions used by businesses include knowledge development, transmission, application, and storage. A company's ability to innovate is boosted by effective knowledge management. Knowledge development in enterprises serves as a foundation for innovation and competition. As a result, companies can use knowledge management to help them launch new goods and services. In knowledge-based economies, knowledge is a critical resource for businesses to develop effective management policies and practices. Thanks to knowledge management, businesses improve their ability to innovate, increase productivity, and, as a result, gain a competitive advantage in the medium to long term. Firms aim to extend their innovation activities and produce value with their growing expertise. In terms of businesses, knowledge management is at the heart of the innovation process and organizational harmony.

Businesses should focus on a variety of activities that allow them to both follow and develop innovations while also taking advantage of available capabilities since exploratory and exploratory activities compete for precious resources. The purpose of this chapter was to investigate the impact of ambidexterity on company success via knowledge management and innovation. As a result of the analysis within the context of a designated model, we concluded that there is a positive and significant effect of knowledge management over innovation, a positive and significant effect of innovation over ambidexterity, and a positive and significant effect of ambidexterity over business performance. After using the structural equation modeling linearity hypothesis to run the model, it became clear that seeking ambidexterity through inventive activities had a greater impact than other approaches.

In today's environment of fierce competition, businesses must make numerous modifications. These changes emphasize the provision of higher-quality products and services, as well as the development of new strategies and innovation. Firms that place a stronger emphasis on innovation are more likely to use knowledge management successfully and seek out new skills while sharpening old ones. The complexity and dynamism of the firms' environment can hinder their shift from short-term to long-term success. Businesses can both carry their existing successes into the future and respond to probable future environmental changes due to their ambidexterity.

Chapter 7 highlighted that Software development is one of the most knowledge-intensive jobs possible. Moreover, it requires you to have different kinds of constantly updated information about the software processes themselves, in addition to the products and services you are working on. Software developers repeatedly create various processes for development, which causes software development to be inherently experimental; software engineers thus continually gain knowledge with every development project. Therefore, knowledge management is vital for the software industry.

Knowledge Management covers 4 phases which are: Create, Structure, Share and Apply. Successfully management of these phases leads to successful knowledge management outcomes. Knowledge management has become more efficient by using emerging technologies. These emerging technologies allow the above-mentioned phases of knowledge management to be implemented more effectively.

The Internet of Things (IoT) applications have radically changed our lives by adding great value to the lives of both individuals and organizations. Today, billions of everyday objects are equipped with advanced sensors, wireless networks and innovative computing capabilities. This means that very large data can be transmitted quickly. One of the biggest operational challenges for knowledge management

systems is to access the real-time data necessary for optimal and effective decision making. From the moment it emerged, the Internet of Things has made a positive difference in providing high-volume and instant data communication, especially between computer systems, which are one of the basic components of knowledge management systems.

Today, the opportunity to have big data has also led to the need to use advanced technologies in transforming this data into information and knowledge. As the amount of information created and shared increases, the difficulty of discovering information increases in coordination. Artificial intelligence uses modern technologies to simplify the discovery of knowledge. Artificial intelligence powered knowledge bases use new technologies such as semantic search, natural language processing, and machine learning to make it easy for employees to find the information they are looking for quickly and easily. Artificial intelligence powered tools help us consolidate information across multiple systems, making information accessible to all employees, wherever they are.

Artificial intelligence connects data from different sources. Artificial intelligence helps us keep our knowledge base content up to date. Artificial intelligence tools provide key knowledge management metrics. Artificial Intelligence contribute to knowledge management in software industry in some major activities:

- Knowledge distribution: Online databases can provide AIs with knowledge spanning different fields and application areas according to software.
- A well-built machine can extract from the actual data store, which increases with the number of interactions with users feeding new information into the algorithm. This means new information retrieval and therefore a larger data repository for customers or system users.
- The act of delivering (or transferring) knowledge is often performed by chatbots: artificial technologies based on NLP that analyze and interact with human language through a speech-like simulation environment during software development.
- The information caught from the software running on production can automatically be analyzed and fix or improvement areas can be automatically determined.

Chapter 8 highlighted that Software Startups bring innovative products to the market. However, such innovation is at the cost of highly educated guess work about customer expectations and quick decision making by persons responsible for strategic planning and implementation. It is therefore of interest to understand the challenges and practices faced by startups that aim to release something innovative in selected market segments. Hence this paper investigates the challenges faced by entrepreneurs of startups and the practices they follow to become successful. The specific challenges explored include: (i) How startups handle software evolution (ii) Challenges faced in releasing products to the market, and (iii) the state of affairs of Software Engineering in startups. Results indicate that despite guidance and support in terms of well-known and documented development methods, practitioners find it difficult to implement and apply these in practice. They must quickly evolve their products to sustain in the market and the market is highly uncertain which makes the complete process highly probabilistic.

Chapter 9 pertains to the innovations in requirement prioritisation process. Software requirements prioritisation is an important task that ultimately determines whether the software is successful and achieves customer satisfaction. Most software projects have a large number of requirements, so there is a need to prioritise which requirements to include. Startups use agile methodologies to deliver innovative software solutions, as agile adapts to requirement changes well and delivers software quickly in short increments,

called sprints. Benefits may be more notable for smaller companies and startups as they tend to have a greater focus on the customer and on process improvement, whereas large companies may suffer from a rigid organisation and functional silos. The product owner is responsible for managing and prioritising a dynamic product backlog, to reflect the continuous re-prioritisation of the requirements. Developers are often delegated this decision-making role, particularly for small organisations or startups who may not have IT domain knowledge and cannot afford an IT consultant to act on their behalf. However, there is little research about the practices of agile requirements re-prioritisation, the activity to reprioritise requirements at the start of each sprint. This research contributes to this gap by identifying the factors considered when prioritising requirements for five popular prioritisation approaches. This research also compares these factors to the agile requirements re-prioritisation process to see how well these popular approaches support the agile process. The five popular requirements prioritisation approaches are Analytic Hierarchy Process (AHP), Quality Functional Deployment (QFD), planning game, binary search tree, and $100 allocation. Framework synthesis was used to identify a best-fit framework developed by a robust methodology, and relevant for the agile requirements re-prioritisation process. The chosen best-fit framework considers six factors when prioritising requirements, business value, risk, effort estimation, learning experience, external change, and project constraints. First. the factors considered by the five popular approaches were identified. The results show that five factors were reported in literature for the planning game, three were reported for AHP, one was reported for QFD and no factors were identified for binary search tree and $100 allocation. Although, the factor business value was not identified in the literature for $100 allocation or binary search tree, it is likely that stakeholders consider business value for $100 allocation as they allocate more dollars to the requirements, which are more important. It is also likely that business value is considered for binary search tree, while determining the placement of each candidate requirement on the tree. Second, the factors from the agile requirements re-prioritisation process were compared with the factors considered by the five popular approaches. The results confirm five of the factors identified in the agile requirements re-prioritisation process, the sixth factor external change, was not reported in the literature for the five popular approaches. The planning game covers five of the factors whereas AHP covers three of the factors. QFD only covered one factor and both the binary search tree and £100 allocation approaches did not report any of the factors. Although, the Binary search tree and $100 allocation approaches have numerous benefits, including being fast and easy to use. This may influence the choice of approach used for agile requirements re-prioritisation. This study contributes insights that are important for requirements prioritisation literature and practice.

Chapter 10 pertains to innovation in risk management. Risk is an inherent part of a startup journey, and software startups need to deal with different type of risks, including technical and product risks. In established companies, risk management is well-established research and practice area, and proof to be helpful for successfully managing software development projects. However, it is less known in a software startup context whether risk management also work as they are in established contexts. This paper reports a result from qualitative studies in nine software startups in Denmark and Finland. The outcomes indicates that startups founders do not believe in risk management methods and prioritize other tasks on their to-do list. These findings might not be generalized for a larger population; however, they could be useful for startups companies in Nordic countries, which share similar environmental contexts with our cases. We believe that the insights from this study would be helpful for people who are doing or want to start their software business. However, there is a need to further explore if there is any impact on startup performance when risk management is used versus when it is not.

Chapter 11 highlights the importance of scholarly literature on startup capacities to stimulate innovation in pandemic times is highlighted in this chapter. The scholarly literature can help startups looking for opportunities or solutions in the face of a pandemic, but knowledge acquisition from secondary materials may be limited due to the growing number of publications, retractions, and Preprints. The growing number of publications and venues makes it more difficult for entrepreneurs to get the information they need, analyse it, and then use collective intelligence to turn it into useful business knowledge. Retractions may steer startups in the incorrect direction, resulting in a waste of financial resources. Preprints are non-peer reviewed research articles that may provide some direction to startups but should not be relied upon entirely. The solutions to these issues are finally provided. Addressing these concerns could make scholarly literature beneficial to startups, allowing the global community to respond to the pandemic as a whole.

Chapter 12 reported the innovative IT-technologies in the field of mechanical engineering, allowing to increase the efficiency of production. This chapter reflects a particular task of automation of a particular branch of mechanical engineering - the technology of mechanical engineering. New methods of calculation of typical multivariable tasks are considered, as well as the effectiveness of the introduction of automation at the level of the design office.

Chapter 13 pertains to process innovation in requirement prioritisation. Agile software development is popular among startup companies, who quickly develop software with a focus on innovation. Software can be developed for a variety of applications, including mobile phones and the controls of an aeroplane. Prioritisation is an essential process of any software development project, as there are usually more requirements than there is time and budget. There are various approaches available, to help decide which requirements to prioritise for inclusion in the software. The wrong approach could waste resources and cause customer dissatisfaction. There are also constraints for startups, such as small teams and multiple influencers which must be considered when choosing a suitable approach. An awareness of limitations with prioritisation approaches could help inform software developers with this decision. However, there is limited research linked to the limitations of requirements prioritisation approaches. This research helps to address this gap by identifying limitations for five popular approaches. The five requirements prioritisation approaches studied were Analytic hierarchy process (AHP), quality functional deployment (QFD), the planning game, binary search tree, and $100 allocation. A search of academic literature was conducted to identify sentences and paragraphs describing the limitations. With little research on prioritisation approach limitations, Grounded Theory was chosen. Verbatim text about the limitations was inductively analysed to identify which were reported for each of the five popular prioritisation approaches. The findings contributed sixteen limitations associated with the five popular prioritisation approaches. Nine limitations for AHP and QFD, seven for the planning game, six for $100 allocation, and four for binary search tree. While analysing these limitations dependencies were reported among them. For example, the quality of the requirements limitation could impact the validity issues limitation. Therefore, this study also contributes a framework showing these dependencies, how the limitations can impact or influence other limitations. The results could help software developers to understand the limitations of each approach and inform the approach they choose for requirements prioritisation. With the fewest limitations, this study shows that the binary search tree could be the best approach. However, an approach with a high number of limitations may be preferred if the benefits outweigh the limitations. Therefore, further research is needed to provide a balanced view, and also consider the benefits of these five popular approaches. Future research could also be used to verify the framework.

Chapter 14 pertains to technology enhanced business model innovation. Innovation is critical for any forward-thinking organization. This is where technology plays a major role. Choosing technologies that will empower an organization is challenging. Even a good development strategy needs to be implemented properly. To innovate enough, start thinking about what kind of technology is actually required in order to be benefited with outcomes. Information technology (IT) innovation in an enterprise involves using technology in new ways to create a more efficient organization and improve alignment between technology initiatives and business goals. IT innovation can take many forms like turning business processes into automated IT functions, developing applications that open new markets, or implementing desktop virtualization to increase manageability and cut hardware costs. Information and Communication Technologies (ICT) are emerging as a promising paradigm for creating a profound change in digitizing technologies. Technology innovation can take many forms, for instance, novel software implementing new algorithms and data processing models; or new hardware components (sensors, processors, components); or improved user interfaces offering seamless experiences; it can also happen at a higher level, in the form of new processes, business models, monetization engines, and so on.

To bring in technology into business model entrepreneurs must involve themselves into research and development (R&D), generating new ideas, conducting experiments, designing and implementing new changes into the system. To achieve better performance appropriate strategy has to be followed. To bring in technology into business the first step of the entrepreneur must be recognizing the unanswered or unresolved customer needs. There are three characteristics to be considered for technology with respect to the business model development. Technology supports business model through various supporting functions for a specific business model. Technology acts as the enabler for a business model and business model enables an innovative technology.

Both innovation and technology are tightly interlaced. Two very notable ways technology propels innovation forward is that it boosts tinkering and experimentation, and that in itself accelerates innovation processes. Earlier experimentation with new technologies was only possible by multinational corporations or government-funded research labs. Today, affordable technology digital and others make it possible for most enterprises big and small to experiment with ideas and concepts in whole new ways, and also in reality instead of only in test labs. Innovation must be socially desirable, economically profitable, and technologically feasible.

Technology, Innovation and Ventures capabilities should be brought together to support the clients' needs for sustainable growth. Approaches to anticipate the new trends, assess their potential, validate their enterprise-readiness, and exploit them responsibly should be enabled. Applied innovation in industries has enabled scaling, with certainty and trust, and with the power of data and intelligence built in.

This book includes research articles on several forms of startup innovations, such as process innovations, business model innovations, and product innovations. The expertise imparted by the book will assist its readers in adapting the knowledge to their startup context in order to overcome difficulties that are specific to their situation. Furthermore, the book makes a significant contribution to the body of knowledge by expanding on innovation-specific knowledge in the context of startups. This book will be especially valuable to startups with a high failure rate and minimal resources. By embracing an interdisciplinary approach integrating computer engineering and business management, this book provides a good range of research studies to stimulate further research in innovation management relevant to startups. Interdisciplinary solutions are needed by the startup community to be inventive and gain a lasting competitive edge in extremely dynamic markets. This book will be an amazing source of instant

knowledge for startups, boosting their innovative capabilities and success rates, with a perfect blend of empirical research and evaluation study kinds.

The editors hope that the intended audience will benefit from this book, and we wish them a Happy Reading, Learning, and Adoption.

Varun Gupta
Universidad de Alcalá, Madrid, Spain

Chetna Gupta
Jaypee Institute of Information Technology, Noida, India

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Chapter 8: Empirical Insights into Software Startups.

Varun Gupta[1], Zoe Hoy[2], Chetna Gupta[3]

1 University of Alcala, Spain

2 University of Portsmouth, UK

3 Jaypee Institute of Information Technology, India

Abstract

Software Startups bring innovative products to the market. However, such innovation is at the cost of highly educated guess work about customer expectations and quick decision making by persons responsible for strategic planning and implementation. It is therefore of interest to understand the challenges and practices faced by startups that aim to release something innovative in selected market segments. Hence this paper investigates the challenges faced by entrepreneurs of startups and the practices they follow to become successful. The specific challenges explored include: (i) How startups handle software evolution (ii) Challenges faced in releasing products to the market, and (iii) the state of affairs of Software Engineering in startups. Results indicate that despite guidance and support in terms of well-known and documented development methods, practitioners find it difficult to implement and apply these in practice. They must quickly evolve their products to sustain in the market and the market is highly uncertain which makes the complete process highly probabilistic.

Introduction

Startups are the ventures laid by Entrepreneurs, which emerge newly in the marketplace and present a new idea. A startup is usually a temporary organisation that produces innovative products in the market (Blank, 2014). Product-oriented software practices help startups to be flexible and quickly adapt to the target market (Paternoster et al., 2014). The product must have a strong value proposition providing benefits to the customer and solving customer problems (Gupta & Fernandez-Crehuet, 2020). Software startups need to formulate business models and validate them before finalizing a more appropriate model to use in the future (Gupta et. al., 2020). The business model evolves through a series of interactions with customers (customer development) (Blank, 2014). Uncertainties are usually handled in startups by increasing the

interactions with their customers (Gupta et. al., 2020) and producing products in the shortest possible time, often adopting agile principles (Paternoster et al., 2014).

The startup must overcome challenges they face and must focus on strengthening their customer base. Startups differ from mature organisations in that they usually have minimal resources and are under time pressures (Kemell et al., 2020). Rather than produce documentation startups prefer to use their limited resources for product development (Paternoster et al., 2014). Startups face challenges not only from other startups but also from well established companies, trying to release a better product than a startup. Keeping existing customers and attracting new customers is difficult under extreme competition situations. To become successful the startups must satisfy the customer requirements and must deliver quickly (Giardino et al., 2016; Souza et al., 2017; Chanin et al., 2017).

Paternoster et. al. (2014) conducted a systematic mapping study of software engineering work practices in startups. Their study found that agile methodologies were considered the most viable for startup processes as they support fast releases with a short lead time between idea and software deployment. Lean startup, a variant of agile considers the most-risky parts and provides a minimum viable product (MVP) (Paternoster et. al., 2014), the minimum amount needed to satisfy the customer needs, which is usable by the customer, and no more (Patton, 2014, p. 34). Another agile variant used for startups is Extreme Programming (XP) which has minimal documentation and processes. In summary, startups preferred light-weight software practices which support fast software iterations (Paternoster et. al., 2014).

Research on software practices of startups is still scare and further studies are needed (Kemell et al., 2020). This study contributes towards this gap with empirical results of software practices followed by three startup companies, addressing three research questions (RQ).

RQ1. How startups handle software evolution?

RQ2. What are the challenges faced in releasing product in the market?

RQ3: What is the state of affair of Software Engineering in start-ups?

Methodology

Telephone interviews were conducted with three startup organisations, selected using convenience sampling as they were already known to the first author. Table 1 presents demographic information about the three startups who participated in this study. Unstructured

interviews were conducted to prevent bias and allow the startup entrepreneurs to drive the conversation. First informed consent was sought through e-mail followed by two rounds of interviews. The first round conveyed more details about the research and instructions to participate. The second round conducted the interviews. Each interview took an average one hour. Notes were taken throughout the interview and discussed at the end to ensure nothing was missing or misinterpreted. The data were categorized into three themes, each theme representing a research question. Anonymity was maintained for the startup companies which are referred to a case A, B and C.

Case name	**Location of case**	**Other locations**	**Software product portfolio**
A	India	Global	Large
B	USA	Global	Large
C	UK	Global	Large

Table 1 Demographic information about the three startups

Data Collection

Theme	**Case A**	**Case B**	**Case C**	**Overall**
RQ1. How startups handle software evolution?	There is an evolution that significantly takes place in the idea and the concept of building a startup. The idea upon which the startup was established	There is evolution but only in the field of technical prospects of the project. The idea had evolved but there is not much significant	The idea evolves and a big change is seen whenever the idea is implemented. When the idea is in the production phase it changes.	Evolution was constricted with either the concept of startup or with the technical prospects. Evolution depended on

	evolves by the time its first product is launched.	evolution in the idea.		the maturity level of the startup.
RQ2. What are the challenges faced in releasing product in the market?	The key challenges that were faced comprised of funding problems at different phases of the project and maintaining the speed so that they can move one step ahead of their competitors.	The key challenges that were faced comprised of funding and resources problems. It is never easy to gather correct resources in a limited period of time.	The key challenges that were faced comprised of funding at the right time to get the project working. Also gathering the right team in place was found difficult at the start of the startup.	Funding problems were identified by all three startup companies. One startup faced a problem of maintaining speed faster than their competitors and one startup faced the challenge of gathering the right team.
RQ3: What is the state of affair of Software Engineering in start-ups?	It always aims to have a high agility which is provided by using the most accurate and precise software models in practice. This doesn't mean that a single software model is used in	It also aims to have high agility. Using more than one software model and their principles in different stages of the project is carried out. It is found very	The aim is again the same, to have high agility but the software model used is agile. The model is used in the project phases. But there are difficulties	Startup companies prefer not to use a single software model. It was found very hard to stick to any modern-day model so

	practice. A mixture of principles is used which enhances the vulnerability of the software product.	difficult to stick to a single software model.	following the agile model as it is not easy to completely follow its principles.	various other principles were also used.

Table 2 Interview results

Results Analysis

Research Q1:-

For a start-up company there prevails a highly competitive ecosystem, which they focus on to explore the highly innovative segments of the market. The software startups handle their software evolution by identifying ideas which they believe are innovative, continuously modifying ideas as per customer feedback and launches by competitors. The idea gets modified very frequently. In the evolution of the software startups, one of the most challenging features is the correct level of funding at different stages of the project so that its execution can be done smoothly without any time delay. Maintaining speed in terms of time to market is also an essential practice that is followed. Moving faster than your competitors is utmost required otherwise any company may lose the effectiveness of its newly launched product.

Research Q2:-

The parameters for selecting the project for the main market is firstly to categorize your project as either Mass or Bespoke. Before releasing any product, it is a pre-requisite to define which audience is to be targeted, and categorizing your project as either Mass or Bespoke, identifies not only the targeted audience but also about the size and requirements of the audience, which in turn helps to release a better product which touches upon the maximum requirements of the targeted audience. However, for startups with low funding, mass market development is usually uncommon practice.

There are several key challenges that are tackled while running a software startup. One of the most important challenges is to get the right team in place. Secondly right levels of funding to keep your project execution going must be ensured. Thirdly speed is a factor that can play a major role. Moving faster than your competitors is required because a slow and steady production rate may enhance your development quality but on release of the product it might

not create a buzz in the market probably due to a similar release of product already being done. Further, high release speed ensures fast feedback and immediate modification of the software product.

Research Q3:-

Startups should generally have high agility so that they can change their direction quickly and according to the industry. The software models used highly affect the agility of the startups. Nowadays the startup does not use a single software model rather they prefer to follow principles of more than one software model, which actually provide them flexibility and agility. It is very hard for people to follow a single methodology or models for software. The best principles are taken out of the models which can fulfill the requirements of the undergoing phases to completion. Also, resources are never easy to find for a startup company. The deadlines are always taken care of as a software company but for startups it is required to release the first best product in hand that start-ups can launch to customers. That impact of the first launched product is required for a startup to carry on its further execution. Generally, the interviewed companies do not follow the principles strictly.

Conclusion

The research has been concluded on various parameters which includes handling the evolutions in software practices, selecting a main stream project for the main market and the challenges faced during different phases of the project and state of affair of software engineering in start-ups. Collectively in a highly competitive ecosystem, the software start-ups need to touch upon highly innovative segments of the market. The software models that are used are not a single model but a mixture of principles that help them to maintain their agility. It is observed that the companies need to reach out to their targeted audience and it is most important to define a targeted audience.

Therefore, before selecting a project it is necessary to categorize the project as Bespoke or Mass so that the targeted audience is set and now company can focus on fulfilling the maximum requirements of the targeted audience. Also, there are a handful of challenges that the start-up companies face which includes the funding problem and the resource allocation problem. Also there are challenges faced in gathering the correct team and moving faster than the competitors in market. Moving faster than your competitors is utmost required otherwise any company may lose the effectiveness of its newly launched product. Also resources are

never easy to find for a startup company. The deadlines are always taken care of as a software company but for startups it is required to release the first best product in hand that startups can launch to customers.

References

1. Blank, S. (2014, March 4). *Why Companies are Not Startups*. Steve Blank. https://steveblank.com/2014/03/04/why-companies-are-not-startups/

2. Paternoster, N., Giardino, C., Unterkalmsteiner, M., & Gorschek, T. (2014), "Software development in startup companies: A systematic mapping study", Information and Software Technology, pp. 1200-1218, vol. 56, Issue 2014.

3. Gupta, V., & Fernandez-Crehuet, J. M. (2020), "Online feedback management tools for early-stage startups: Hidden treasures in the Rocky Mountains", IT Professional, pp. 67-72, vol. 23, Issue 5.

4. Gupta, V., Fernandez-Crehuet, J. M., Hanne, T., & Telesko, R. (2020), "Requirements Engineering in Software Startups: A Systematic Mapping Study", Applied Sciences, pp. 1-19, vol. 10, Issue 6125.

5. Kemell, K. K., Ravaska, V., Nguyen-Duc, A., Abrahamsson, P. (2020). Software startup practices – Software development in startups through the lens of the essence theory of software engineering. In: Morisio, M., Torchiano, M., Jedlitschka, A. (eds) Product-Focused Software Process Improvement. PROFES 2020. Lectures Notes in Computer Science, vol 12562. Pp. 402-418. Springer, Cham. https://doi.org/10.1007/978-3-030-64148-1_25

6. Chanin R., Pompermaier L., fraga K., Sales A and prikladnicki R (2017), "Applying Customer Development for Software Requirements in a Startup Development Program", 2017 IEEE/ACM 1st International Workshop on Software Engineering for Startups (SoftStart), Argentina.

7. Giardino C, Paternoster N., Unterkalmsteiner M., Gorschek T and Abrahamsson P (2016), "Software Development in Startup Companies: The Greenfield Startup Model", IEEE Transactions on Software Engineering, pp. 585-604, vol. 42, Issue 6.

8. Souza R., Malta K. and Almeida E. (2017), “Software Engineering in Startups: A Single Embedded Case Study”, 2017 IEEE/ACM 1st International Workshop on Software Engineering for Startups (SoftStart), Argentina.

9. Patton, J. (2014). User story mapping: Discover the whole story, build the right product. O’Reilly.