Qualitative Assessment of Software Entrepreneurship: Role of Standardized Software Process Improvement in Innovation and R&D

Ridaa Fatima
MS I&E 2K20

A thesis submitted to NUST Business School for the degree of Master of Innovation & Entrepreneurship

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THESIS ACCEPTANCE CERTIFICATE

It is Certified that final copy of MS I&E thesis written by Ms. RIDAA FATIMA Registration No. 330286 of NUST Business School has been vetted by undersigned, found complete in all aspects as per NUST Statutes/Regulations/MS Policy, is free of plagiarism, errors, and mistakes and is accepted as fulfilment for award of MS degree. It is further certified that necessary amendments as pointed out by GEC members and foreign/local evaluators of the scholar have also been incorporated in the said thesis.

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Student's Name RIDAA FATIMA

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LIST OF SYMBOLS, ABBREVIATIONS AND ACRONYMS

API	Application Programming Interface
CMMI	Capability Maturity Model Integration
GDPR	General Data Protection Regulation
ISO	International Standard Organization
PSEB	Pakistan Software Export Board
SDLC	Software Development Life Cycle
RUP	Rational Unified Process
SPEG	Software Engineering Process Group
SPI	Software Process Improvement
SPICE	Software Process Improvement and Capability Determination
SW-CMM	Software Capability Maturity Model
QAG	Quality Assurance Group
XP	Xtreme Programming

ABSTRACT

Software entrepreneurship involves generating an idea of some product, development, testing, installation, release, marketing and finally monetization of developed product. The concentration of Software industry is on skill. Prior studies indicate that software companies face issues and quality gets compromised in creation of a first-rate software product which includes time sharing, monetary arrangements and allocations of resources. For high quality software products, conformance to Software Process Improvement (SPI) models however requires a lot of cost, time, manpower and has requirements to fulfil which are sometimes not affordable for the small enterprises or SMEs and quality gets compromised. For this purpose, qualitative research is carried out as the already existing literature does not riposte the problem specifically in the context of Pakistan to reconnoiter the innovation performances of software firms with reference the process and SPI used – mainly CMMI as known as Capability Maturity Model Integration. The research is exploratory in nature based on interpretivist paradigm. Semi structured interviews of software corporations of Islamabad were conducted using purposeful and maximum variance sampling techniques. Thematic analysis was later done using ATLAS.ti software for results and analysis. The in-depth research discovered that the firms following and trying to achieve CMMI levels or other high-level SPI are involved in delivering B2B services and products. Their products are implemented and used on large-scale – they are expanding their business and bringing continuous innovation. Almost all the firms even if they do not possess any SPI framework, were found to be practicing agile software development in their firms. Thus, for lightweights approaches such as Lean, Scrum, XP, Kanban, or Agile – SPI can be endorsed, and it could be an easy way forward for firms. The study conforms to previous studies that in order to achieve different maturities levels of CMMI, agile procedures can be equipped with for continuous product and process innovation. That will allow software firms to nurture and capitalize in particular knowledge

mechanisms while practicing agile software process for development. Henceforth, for the small firms which believe that CMMI is expensive and not practical for their business – differing to widespread belief – the compliance will undeniably aid them in preparing enhancements as they expand their business. The proposed research adds value to the literature of both engineering and entrepreneurial innovation. One prominent theoretic contribution of this research is merging the literature of software process models, improvement processes, resource, and knowledge-based perspective into one context and the in-depth understanding of involvement of SPI. The research is however limited to software industry only and the results are software business based. Future research can be carried out to assess if the company size and maturity could make it more prone to conform with SPI frameworks or not.

Keywords: Entrepreneurship, software process improvement (SPI), innovation, CMMI, R&D.

CHAPTER 1: INTRODUCTION

This chapter includes introduction and background research of software entrepreneurship and software process improvement models used during software development life cycle. Furthermore, problem statement and research questions based on objectives and aim have been expatiated along with brief research significance and structure of overall research.

1.1 **Software Entrepreneurship**

As eminently stated by Cusumano (2004) *"Software is not like other businesses"*, when it comes to the word "Software", it is something that can be created by one person at home (CEO-the developer himself), with group of people in a company or collaboration at international level. Software platforms are considered enablers of inventive companies and development practices (Saarikko, Jonsson, & Burström, 2019)

Once the software is produced, it can be made accessible to anyone interested without any issue of high cost because the process of development is quick and cost effective (Arif, Mehmood, & Siddiqi, 2011); (Kerdpitak & Jermsittiparsert, 2020); no large scale industrial units are required to get started because of its digital nature. On the other hand, according to Batjargal (2005), software production is a protracted series of actions that ranges from design to testing and assuring consistency and hence productivity might risk the quality, consistency and functionality of a software.

The activities in a software process include the specification, requirement elicitation, implementation, validation and evolution (Almomani, Basri, Mahamad, & Bajeh, 2014). On the other hand, entrepreneurship is a polygonal idea covering an intricate set of adjoining and corresponding concepts (Bhattacharjee & Chakrabarti, 2017). Software entrepreneurship involves generating an idea of some product, development, testing, installation, release, marketing and

finally monetization of developed product.

The software industry includes small and medium software organizations with high novelty and absorptive aptitude because of having competent professionals in the field of information technology and improved organizational competencies (Budhwar & Mathew, 2007). Software entrepreneurship has caught attention and immense interest due to prosperous examples and the probable scalability of new-fangled businesses (Suominen, Hyrynsalmi, Aarikka-Stenroos, & Seppänen, 2017). Software entrepreneurs and firms focus on vastly innovative divisions of the sooq, usually operational on a particular core-product in great time constraint.

Software industry's concentration is on skill. When entrepreneurs don't have any prior acquaintance with software development they capitalize in the industry with alliance of experienced team and inaugurate businesses; Entrepreneurship in young people from IT and software engineering background is considered a peculiarity of IT business in Pakistan (Arif et al., 2011). The key challenge is to discover the precise entrepreneurship capabilities that should be endorsed when training mavens.

Growth and bankruptcy of software firms largely depends on the knowledge and expertise of business. Proportionate with entrepreneurship, software or technology entrepreneurship is an idea with multi dimensions encompassing an assortment of actors and diverse intensities of analysis (Giones & Brem, 2017; Mosey, Guerrero, & Greenman, 2017).

Testing and assessment could tell whether ideas are being precluded for not meeting rudimentary guidelines and the requirements provided by the user. (P. A. Quezada-Sarmiento et al., 2018). Collaboration in teams is essential to efficiently develop a product or work on a project in the software industry (López, García, Cano, & Casado, 2012).

When entrepreneurial practices are combined with creativity, the outcomes is greater propensity towards creation of high-tech innovations (Horwitz et al., 2017; P.-A. Quezada-Sarmiento, Enciso, & Garbajosa, 2016). Efficacious innovation results in viable benefit that can be realized as an entrepreneur (Rusu, Rusu, & Elliott, 2006). Innovation of software firms frequently necessitate to create and function with disruptive technologies in order to have influence on a high-potential market segmentation (Paternoster, Giardino, Unterkalmsteiner, Gorschek, & Abrahamsson, 2014).

1.2 Research Objectives

- To find the difference between software entrepreneurship and traditional entrepreneurship
- To explain SPI in-depth with context of resource-based theory and knowledge management
- To explore performance of software entrepreneurs regarding the software process and SPI framework used

The innovation performance and productivity requires the entrepreneur to be inventive which also comes with a cost (Quezada, Enciso, & Garbajosa, 2015). Software industry is rapidly evolving, and new businesses are emerging as software entrepreneurship is flexible and cost effective as compared to traditional entrepreneurship. However, limited studies have been conducted to evaluate the performances of such firms.

Moreover, there is lack of qualitative research in this field to reconnoiter and to have an in-depth understanding of the software development process and SPI framework's involvement in software firms on micro level in the capital city of Pakistan. Based on questions raised by Rose (2012), formally stated pragmatic interpretations, standard philosophies, and the research objectives subsequently lead to elicit the research questions identified in the next section below.

1.3 Research Questions

1. How can the use of software improvement process framework make a software firm more competitive through quality, innovation, and optimization?
2. How can computational and entrepreneurial thinking be made effective in software entrepreneurship?
3. How is software entrepreneurship different from traditional entrepreneurship?
4. How can resource-based theory and knowledge management be incorporated with SPI frameworks?

There are sub-questions within the above wide-ranging inquiries. Firstly, exploring how is software entrepreneurship differs from traditional entrepreneurship in terms of the way firms carry out their operations. Secondly, it will also assist in getting answers to the question of R&D involved for the firms i.e. the ones which are practicing SPI or are certified firms vs the one without the certifications and not following standardized processes. Thirdly, it would explore and get the deeper understanding of subject matter as to what extent SPI assists organizations with high revenue generation. Lastly, how the standardized process assists firms in attracting clients when knowledge and resource-based perspective is incorporated alongside SPI.

It is significant to notice at the outset that the qualitative research is focused on the aspects that envisage the performance of software firms of Islamabad. The reason to only consider firms in Islamabad is firstly the time limitation of research. Similarly, Islamabad being the capital of Pakistan represents the overall trend followed in software firms of Pakistan that are affiliated with technology parks under PSEB[1]. Last but not the least, recent studies conducted for software firms were mostly based in Islamabad which is why expanding the sample size would not have enabled the research to answer some specific questions about software entrepreneurship and use of SPI

[1] Pakistan Software Export Board

frameworks.

1.4 Research Rationale

As the research is qualitative in nature, it aims at attaining better understanding and more knowledge of the SPI involvement in software firms. Previous studies done on software firms in Pakistan targeted the firm growth's drivers and labour throughput. Hence, posing a limitation on lack of literature regarding the performance of SMEs in Islamabad region. Either past studies have been purely related to software development process applicable for software industry only or focused on the financial performance of such businesses.

There is a need of qualitative research to combine and examine the software processes and SPI frameworks with software entrepreneurship to understand their linkage to the quality production, user satisfaction and performance of the organizations at micro level. This study explores the subject matter to have an in-depth understanding of software firms' operations and performance keeping in view the software process and SPI they follow and how it aids them in performing better than others.

1.5 Overview of the Thesis

The thesis illustrates the pursuit of finding answers to the research questions. Chapter 2 examines the relevant literature on software entrepreneurship, software development process and, use of standardized practices and the role of these certifications on the performance of firms; the innovation performance and R&D involved. It also has thrown light upon the entrepreneurship theories that fit in the scenario of software entrepreneurship. Lastly, insights from previous literature about software entrepreneurship and firms performances have been elaborated.

In Chapter 3, In order to explore more about software entrepreneurship, software engineering process used in the development of software, standardized practices and to get a deeper

understanding on the overall performance of the firm – a qualitative research is carried out. The description of the companies involved research criteria and the data collection phase is elaborated.

In Chapter 4, the research methodology adopted, the thematic analysis and the coding process involved are discussed. It also outlines the analytical procedure and interpretation of results with the development of conceptual framework based on those results and codes. It elaborates the finding of the research and the discussion on those findings. Measures taken to avoid saturation and bias is also discussed. Chapter 6 comprises of the conclusion of the dissertation, the limitation of the research, contribution to the existing literature, and future research directions.

CHAPTER 2: RELATED LITERATURE

This chapter thoroughly discusses the existing literature and work done so far in software entrepreneurship and the gap in context of Pakistan in this field. It also discusses the main two SPI frameworks that have been focused on during the research. It has also discussed the entrepreneurship theory and how it is linked to SPI. Lastly, insights from previously done research which worked on software entrepreneurship have been discussed.

2.1 Entrepreneurial Vs Computational Thinking in Software Entrepreneurship

Entrepreneurship fosters innovation and SMEs act as the backbone of a country's economy. Hence, to remain competitive – ICT adoption is necessary for the firms. It is necessary to learn skills that promote computational thinking which will permit the firms to find new opportunities and solve complex problems (Boltz, Henriksen, & Mishra, 2015; Kang, Lee, & Technologies, 2020; Nuar & Abd Rozan, 2019; Voskoglou & Buckley, 2012).

Computational thinking involves breaking down complications and complex problems into sub-problems by utilizing the algorithms that stipulate an order of steps to resolve problems; investigating how the solution can be applied to analogous problems by using abstraction (Kong & Abelson, 2019). Resultantly, when it is discovered that the problem can be solved by the computer, automation is applied. Computational thinking also fosters innovation by hypothesizing the issue in a conceptual manner. It is considered a key expertise in Industry 4.0.

Entrepreneurship is concerned with actions and goals whereas the entrepreneurial thinking is about mindset and values. Entrepreneurial thinking requires essential skills for the workforce. Hence, it is not necessarily stuck to entrepreneurs, it is an important ability to bolster effectiveness and employability. The software entrepreneurship course presented by Melegati, Guerra, Knop, and Wang (2019), combines computational thinking and entrepreneurial thinking enabling

entrepreneurs to find out high-tech innovation based on their problem. Aforementioned, entrepreneurial thinking is not solely tied to entrepreneurs – similarly computational thinking is also not only relevant to programmers or IT personnel.

2.2 Software Development Life Cycle

Quality of a software is determined largely by the process used in software development (O'Neill, 2012). The framework proposed (see Figure 2.1) also outlines the software development process or (SDLC) software development life cycle (Shylesh, 2017) which consists of series of steps that lead to formation of a software product. These processes could be mainstream like a waterfall model which refers to completion of each step to get to next one (Diebold, Scherr, & Process, 2017). Other processes models include involve customer's feedback at each step i.e. Scrum/Agile etc. as shown in Figure 2.1 (Ambily & Malliga, 2011).

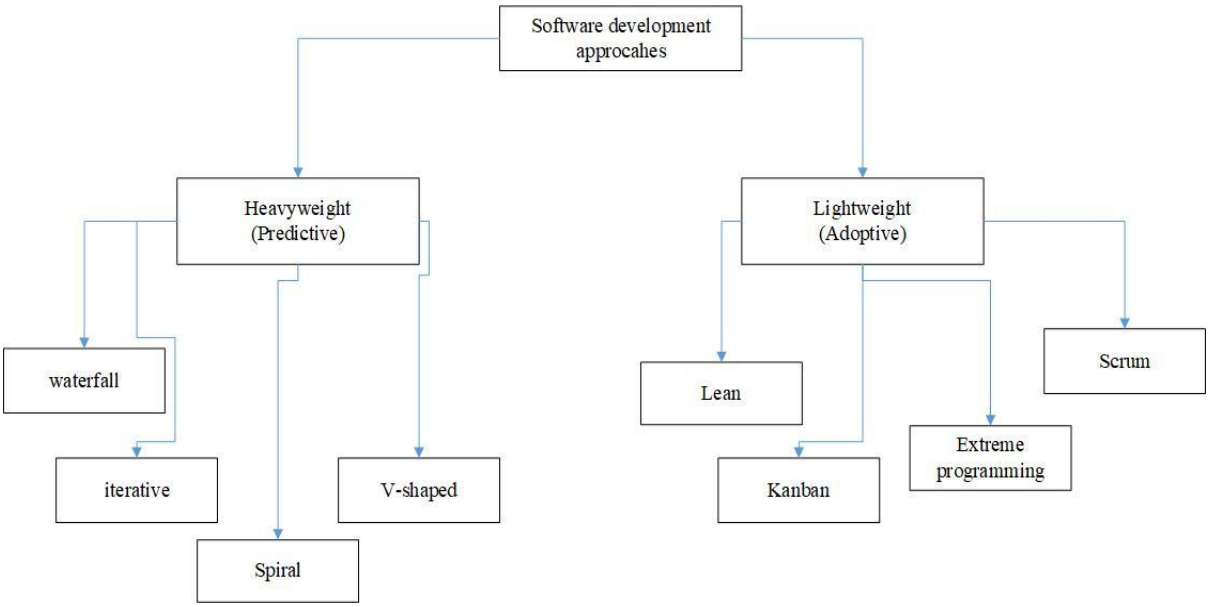

Figure 2.1: SDLC approaches

Processes are followed based on firm's ability to carry out operations. In case of heavyweight processes, the work scope is predefined in advance and hence these processes are predictable. However, these processes would require extensive documentation and programmer's involvement. On the other hand, lightweight processes are adaptive in nature and require less

documentation; customer is involved to get feedback and the alterations can be made during the process compared to heavyweight where changes at the very end after the deployment are accommodated making is difficult for organization and the customers.

Hence the heavyweight processes are no longer popular and have been abandoned by many organizations as these decrease the efficiency of the overall projects. Software companies face issues in creation of a first-rate software product which includes time sharing, monetary arrangements and allocations of resources whilst not compromising the quality of a software artefact which is goal of any firm to deliver high quality software to stay lucrative and competitive (Almomani et al., 2014).

2.3 Standardized Processes and Firm's Performances

For the enterprises and larger firms, various standardized software process improvement models also known as SPI are offered in the market. To get certified and the implication of these however requires a lot of cost, time, manpower and has requirements to fulfil which are sometimes not affordable for the small enterprises or SMEs (Sharma, Dadhich, & Cryptography, 2020). Software development models introduced until now to produce reliable high quality products include: CMMI, ISO, Bootstrap (Martins & da Silva, 2010), SPICE (Emam, Melo, & Drouin, 1997; Sivashankar, Kalpana, & Jeyakumar, 2010), and Six Sigma (Mishra & Mishra, 2008) etc.

The main goal of practicing SPI in software firms is to rally the process and quality of software developed along liability, reliability and manageability (Kerdpitak & Jermsittiparsert, 2020). Software development happens through some process that requires some degree of accuracy and direction.

Some companies like the software start-ups often skip the process in order to market the product and because of limited resources (Devadiga, 2017). As software firms grow into larger companies they naturally carry out a growing number of practices in the SPI frameworks (Lester,

Wilkie, McFall, & Ware, 2010). The research also aims to find answer to this question that to what degree a process is followed in the development of a software product.

2.3.1 Capability Maturity Model Integration (CMMI)

To implement CMMI both top-down and bottom-up methods are adopted (Almeida, Amaral, & Entrepreneurship, 2019). CMMI can be applicable to several fields for example in the field of IT, the model normally applied are CMMI, ITIL or service integration maturity. Similarly for education and business several other models are applied to enhance quality of the processes and the products. The reason behind use of CMMI is due to its resolute adherence to software engineering field and for providing as a starting point for the production of other maturity models. Software Engineering Institute of Carnegie Mellon University proposed the CMMI and presented a source model which comprises of procedures that permits evaluating the maturity of software development companies (Almeida et al., 2019).

For firms incorporating the CMMI by stages, maturity is assessed by the processes individually. It allows these companies to have various processes at different levels. It is discovered from previous studies that the incorporation of CMMI by stages is for the firms that focus on a particular and crucial process for the firm and enhance it in order to make immediate profits for their organization (Rocha, Zabeu, & Machado, 2018). Similarly, for these firms, the maturity is then assessed by the processes that have been established for each level of CMMI. These levels of CMMI have been depicted in the Figure 2.2 (Capability Maturity Model for Software (Version 1.1), 2002) below:

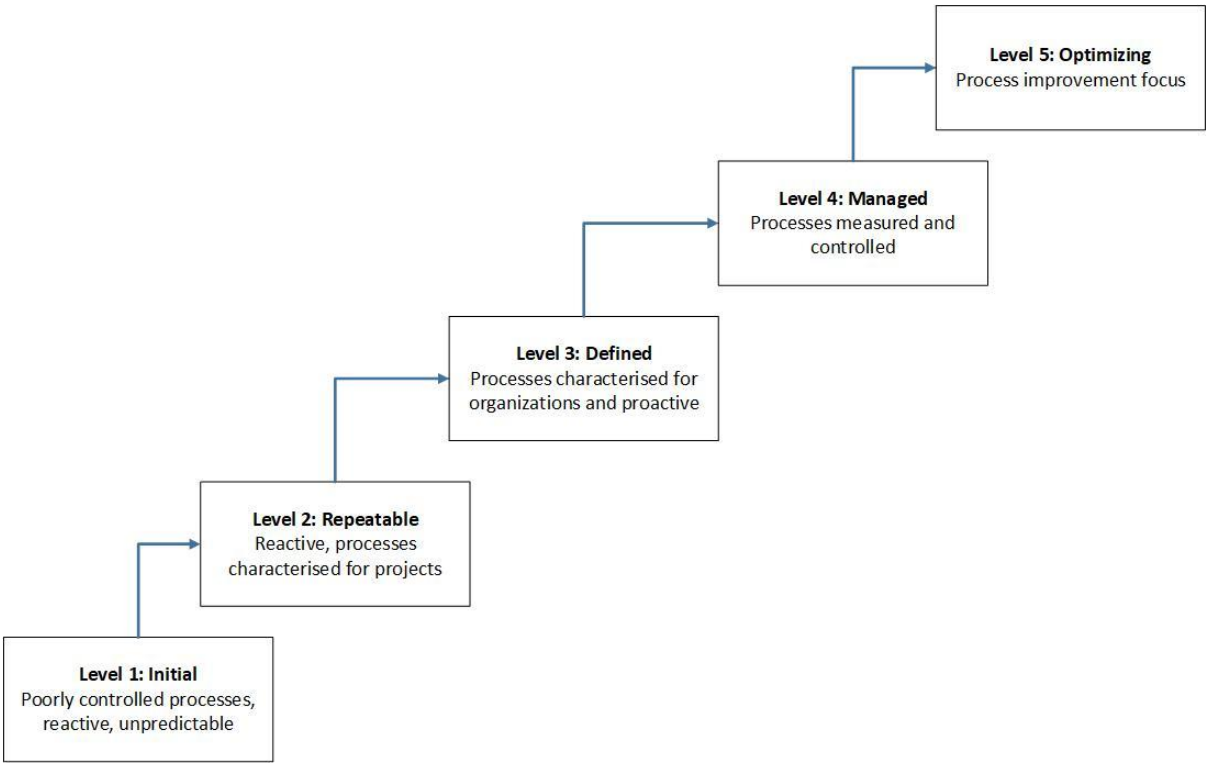

Figure 2.2: CMMI levels

This SPI model improves the efficiency, lessens the time and expenses incurred during the software development projects. The models like ISO 15504, CMMI, and others focus of achieving satisfaction of customers by offering quality products and services – establishing mutual trust (Machado, Mexas, Meza, de Oliveira, & Proceedings, 2022).

2.3.2 ISO/IEC[2] 15504

ISO/IEC 15504 is also sometimes referred as SPICE or Software Process Improvement and Capability Determination (SPICE) model which reviews the processes for software development. It was established with collaboration of ISO and IEC. As CMMI is a process model, ISO is an appraisal standard. ISO allows organizations to create a portfolio of standards that is aligned with the international scope. An organization with any ISO certification indicates that it is concerned about the processes, provides quality products to the customers, and fosters continuous improvement. These are based on Plan, DO, Check, Act cycle. ISO 15504 and CMMI are vital for

[2] International Standard Organization/International Electrotechnical Commission

assessing and enhancing the software processes in development of software and overall performance of software firms.

Nonetheless, CMMI is more suitable and apposite for software process improvement compared to ISO 15504 that mainly addresses the evaluation and contrasts the capability of software process. A software firm following of both models can lead to cooperation and enhance the quality of software processes (Machado et al., 2022). However, for ISO 15504 or SPICE to alone achieve recognition and capturing audience in the CMMI subjugated market is still a challenge.

2.3.3 CMMI and six sigma combined framework

Habib, Ahmed, Rehmat, Khan, and Shamail (2008) presented a framework for process improvement which was called "blending the CMMI and six sigma". The purpose of this framework is to help SMEs in advancing the CMMI to address their requirements and aligning the process with Six Sigma's Define, Measure, Analyze, Improve and Control framework. The significance of this blended model will be reduction of time that is consumed in achieving level 2-Repeatable and level 3-Defined of CMMI as they take up capital, effort and time of small firms making things complicated (Iqbal et al., 2016). This model can allow them to have a competitive edge and survival chance in the market among software giants. However, CMMI is the most practiced in software industry hence the focus will be upon CMMI.

2.4 Resource Based Theory and Knowledge Management

A firm's resources could be anything that can be identified as a strength or vulnerability. These can be considered the subsets of beneficial assets which are economically indefeasible. Resource-based theory according to Grant (1996), suggests that these resources could comprise of investment, exchange connections, experienced workforce, brand names, understanding of tech,

equipment or the economical practices; whichever would contribute in acquiring competitive edge over the others (Alonso & Kok, 2018; Theriou, Aggelidia, & Theriou, 2009).

The article by Barney (1991) "Firm Resources and Sustained Competitive Advantage" is largely quoted as a fundamental contribution in the advent of the resource-based view. Knowledge according to Grant (1996), is also considered as a firm's intangible asset or resource retaining a significant strategical objective. Hence, knowledge-based theory and the analysis of knowledge is apposite when software firm's resources are studied systematically. It would include creation, sharing and implementation of knowledge (Intezari & Gressel 2017).

Similarly, the knowledge management theory that comes under resource-based theory suggest that firms displaying robust dynamic capabilities are hugely entrepreneurial for not only adjusting to the enterprise ecologies but also defining these through cooperation or innovation (Grant, 1996). By identifying components that are specifically firm-related capabilities and can become a source to get edge over the competitors.

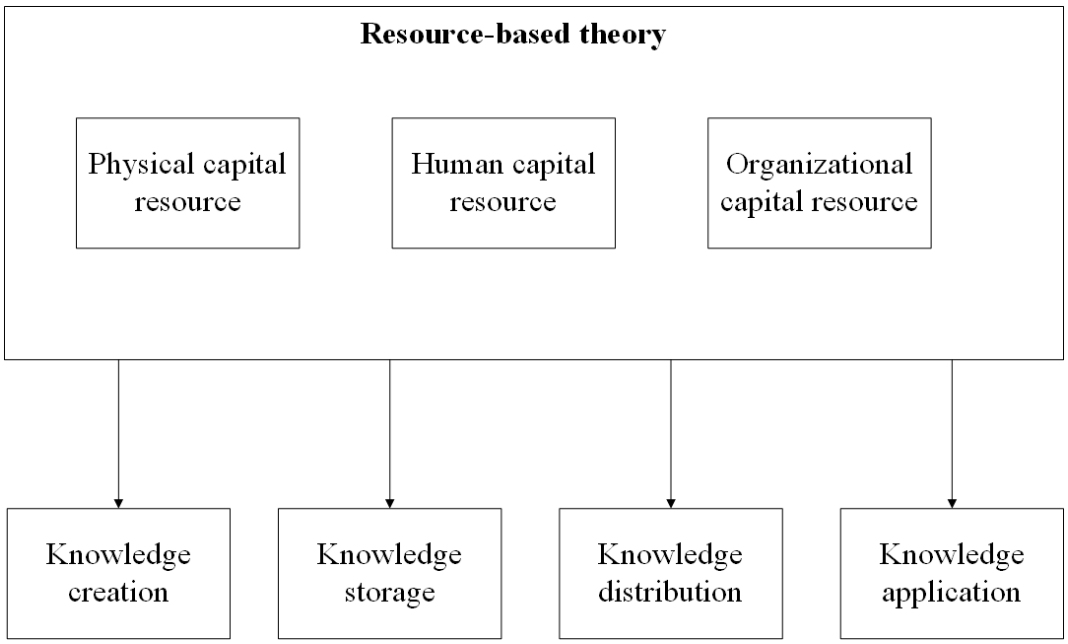

Figure 2.3: Resource-based theory and knowledge management

Hence, it explains how these resources when combined can be utilized, guarded, or advanced. Figure 2.3 (Behm, 2019) shows the context of resource-based view to knowledge-based view.

Instead of analyzing both resource and knowledge based perspective separately, this research is evaluating resource-based theory and knowledge management as an amalgamation where both entities are connected and bolster each other (Behm, 2019). Hence, in order to understand these two entities deeply and to provide insights – these are studied in parallel with CMMI. The emphasis is to determine how CMMI maturity levels alongside resource and knowledge-based perspective benefits companies to capitalize on achieving CMMI levels and gain competitive edge.

Keeping both disciplines in context, main objective of CMMI is also to appraise and enhance software development process, improve capabilities of software companies, and assist these firms to enhance the maturity of software structure and quality by achieving the levels of CMMI; being people, process and technology oriented all at once (Lee & Wu, 2007). As discussed by Siepel, Camerani, and Masucci (2021), the recognition of dynamic capabilities is inexorably itself a component of learning procedure. Hence, it cannot be considered as a sophisticated theory that enables scholars to forecast results or a straightforward formula that will allow managers to accomplish corporate achievement (Grant, 1996).

2.4.1 Software process improvement (SPI) and organizational learning

SPI is skill, learning and knowledge intensive work (Dyba, 2005). Continuous software process improvement enables software firms to adapt well to dynamic business, attain better performance of software development while maintaining competitive edge over the others (Chen, Lee, & Interfaces, 2022). For this purpose, software firms are required to reach, accrue, and apply

improvised SPI knowledge to stay adaptive in encountering and solving impromptu problems and imminent challenges.

Many studies in the past have exclusively pointed out various knowledge-based antecedents that are crucial in the success of software process improvement across the organization. The most common ones are based explicitly on organizational learning (OL) theory. In this regard, the two strategies "exploration and exploitation of knowledge" have been deemed most feasible in assisting firms to effectually explore and reprocess knowledge in software development (Dyba, 2005; Mathiassen & Pourkomeylian, 2003; Vidgen & Wang, 2009). These two are also discovered as critical factors for SPI success and thus organizations must wield effort to efficaciously oversee knowledge and stay updated for SPI to be successful.

2.4.2 CMMI and Organizational Learning

The two strategies in organization learning theory on which ability of an organization learning depend are exploration and exploitation (Choi & McNamara, 2018). Strategy of exploration is concerned with an organization's quest on seeking knowledge, continuous evolvement, and novel skills. Whereas exploitation strategy stresses on salvaging, improving, and advancing the already existing knowledge of an organization to enhance organizational capabilities.

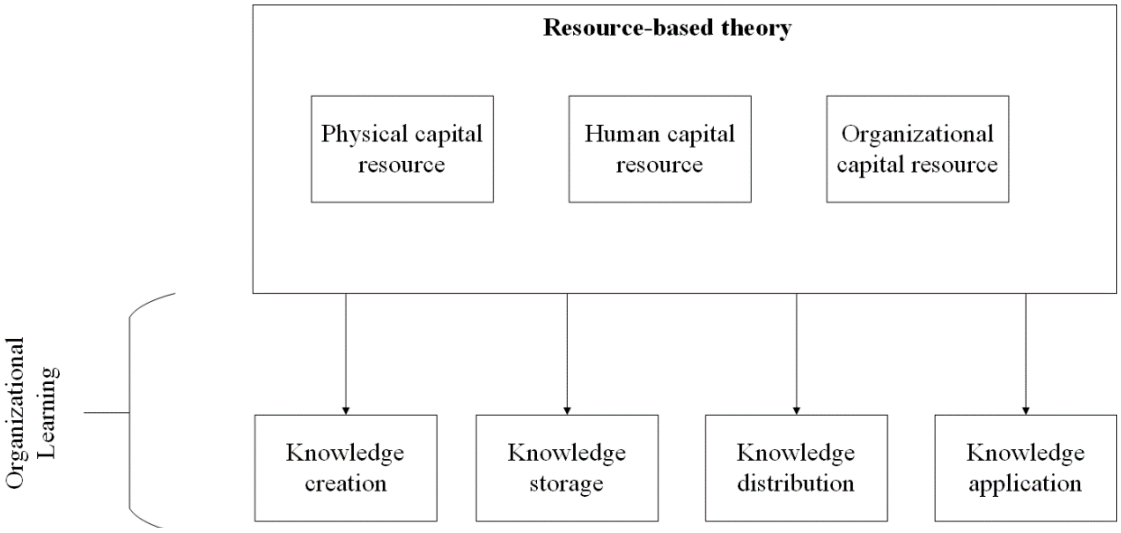

Figure 2.4: Organizational learning and knowledge management

These two strategies are considered knowledge-based enablers in the creation of software (Chen et al., 2022). As knowledge acquisition, transfer and retention are three vital factors in organization learning (Garratt, 1990). Hence Figure 2.3 can be modified including organizational learning with knowledge-based view as depicted in Figure 2.4.

Similarly, agile methodology in software development team persistently influences participants' knowledge and skills i.e. exploitation and seeks for innovative practices and approaches i.e. exploration to accomplish superior performance in dynamic advancement (Fontana, Meyer Jr, Reinehr, Malucelli, & Software, 2015). Other studies by Temizkan and Kumar (2015) and Dyba (2005), also validated implementation of these strategies for SPI success and firms shall participate in utilizing both learning strategies for the efficient management of knowledge. In the case of SPI success with CMMI maturities, the main knowledge antecedents differ at several stages of SPI success dependent on how their particular knowledge-processing practices correlate with CMMI maturity levels (Chen et al., 2022).

By combining resource-based perspective with organizational learning in this research, we will be able to ascertain potential factors that inhibit or have high value for software firms to effectively capitalize on CMMI or other SPI frameworks. Thus, based on previous studies,

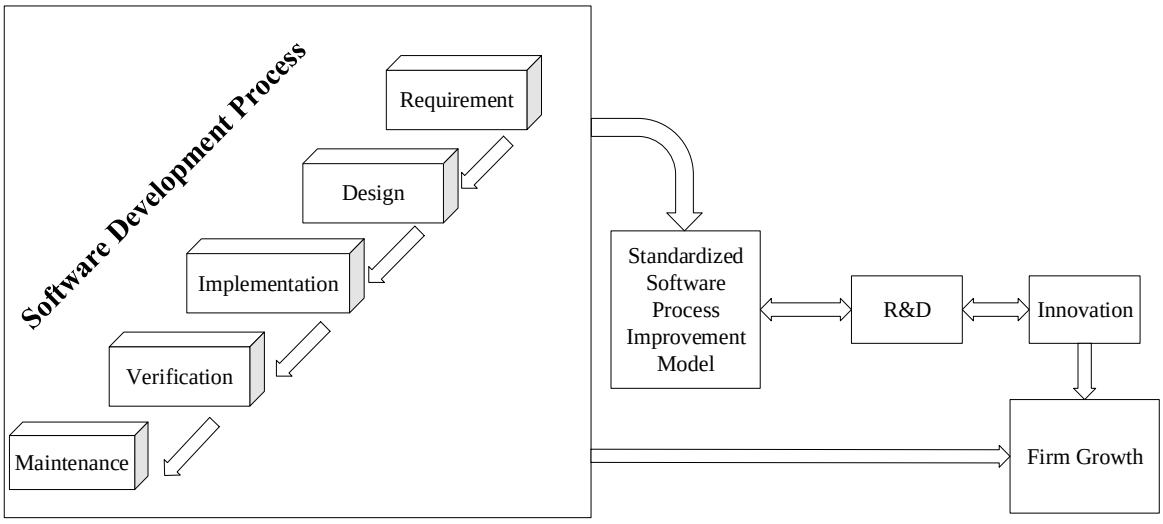

Figure 2.5: Proposed conceptual framework

conceptual framework was established considering the fact that SPI fosters organizational learning within an organization. The more firms practice CMMI, the more is their learning, resource utilization, R&D, and innovation performance leading to firm growth and gaining competitive advantage in terms of quality and client satisfaction as depicted in the proposed conceptual framework (see Figure 2.5).

Consequently, it could be deduced that software firms following CMMI and achieving its levels are exhibiting what a knowledge or learning theory suggests. The conceptual framework and the research outcomes will offer a thorough stance on achieving the CMMI levels and the software processes that are expected to facilitate software firms to conduct and successfully utilize CMMI or other SPI frameworks**.**

2.5 Insights from the Previous Studies

Pakistan is presently home to approximately world's leading and most conspicuous IT multinationals (Rehman, 2014). Deficiency of research in software firms inspired Rehman (2014) to ascertain and evaluate the problems in the development of software firms of Islamabad but some questions remained unanswered regarding the process followed by these firms (Rehman, 2012, 2014). Moreover, the most recent research was conducted by the same person in 2015 (Rehman, 2015) and this area needs further exploration at micro level in the current scenario. Software industry of Pakistan endured deprivation of policy consideration until mid-1990s (Mehmood & Siddiqi, 2011). Some of the regulatory authorities (CSP, PASHA, PSEB,)[3] are working in Pakistan to improve the software industry.

As digital technologies created for a segment can be used for other applications of market, digitalization carries substantial possibility for innovative products and invention. Development of

[3] Computer Society of Pakistan, Pakistan Software Houses Association, Pakistan Software Export Board

a software can be considered as making use of an ever-escalating set of Lego bricks (Belitski, Caiazza, & Lehmann, 2021). It allows alterations in the conceptual form of business models, services, and products across various industrial segments (Porter & Heppelmann, 2015; Spiezia, 2011) – which assists in creation of novel structures of nascent innovation and entrepreneurship (Caiazza, Belitski, & Audretsch, 2020).

According to Andersson, Kusetogullari, Wernberg, and Change (2021), there are mainly three lines of research that address the connection between the development of a software and innovation. One addresses the relationship between the performance of firm and the software patents' growth. Software patenting is the process of capturing the activity that involves development of a software which refers to patent the unique and novel intangible assets i.e. an algorithm or a computer program. According to Hall and MacGarvie (2010), patenting of software is likely to be linked with greater market value. Firms having larger software patents share are found in superior position to make their product distinguishable to avoid the competition in the corresponding product markets (Chung, Animesh, Han, & Pinsonneault, 2019; Kim & Lee, 2018).

The second one determines software intensity in innovation based on citations. This approach refers to data patenting in order to examine the "software-intensity" of the citations that have been patented which also involves the non-software ones that allude to software patents. According to Bessen, Hunt, and Strategy (2007), the higher he software-intensity, the higher is the research and development efficiency in various countries among a variety of manufacturing firms.

These research studies are not examining the innovation performance but the impact that firms with more engagement in developing of software activities and innovation have better performance that other firms. Positive influence of big data is also analysed as it provides new insights and assists in decision making high in turn puts software firms in a superior place to invent. Prototyping and simulations help the firms to restructure the innovation process. Whereas the last

one aims at the innovation process and the direct use of software in it.

In highly advanced technology-oriented companies, innovative activities are performed by the R&D department. These activities are mainly systematic and/or technical. The involvement of firms in research and development shows their need to enhance their already existing products, technology, and processes to introduce new ones. With the advancement and of technology – more innovative products are demanded by the R&D department (Edison, Smørsgård, Wang, Abrahamsson, & Software, 2018).

However, there are misfit technologies which means the ones that are created after the research, but they do not directly aid in the business goal of the company. In case of misfit technologies, companies either sell them, keep the research, or launch spin-off. Research shows that these days research on innovation of software product is based on three factors "early user integration, continuous experimentation and open innovation". Here the first one focuses on getting ideas from other outside sources like users, companies in competition and market – then turning them into products (Backlund, 2002; Blohm, Bretschneider, Leimeister, Krcmar, & Organisations, 2011; Heitmeyer, Jeffords, Bharadwaj, & Archer, 2007). Second one as the name suggests, is related to experimenting till reaching a viable solution. Whereas open innovation involves partnership with outside units.

An engineering literature survey suggest that research on software development and innovation is highly subjective because of counting on limited and fewer samples of possibly unreliable products and firms. Nonetheless, software has come to be a progressively critical contribution into innovation and product distinction across various engineering industries far yonder the outmoded description of information technology (Branstetter, Drev, & Kwon, 2019).

2.6 Chapter Conclusion

Keeping in view the RBV perspective and the work cited and done in software innovation, it has been more clarified why the study of SPI and software entrepreneurship is needed. This century is all about technology and businesses moving to digitization, more work from home practices and entire businesses shifting online is giving software industry edge over the others. This industry is assisting all businesses either it is health or automobile or education – all have been in need of latest technology and deploying software in their structure for modernization and ease of use.

Hence software entrepreneurship comes in handy as all these businesses are dependent on software firms to have their advanced systems developed, deployed, and updated with time. Thus, they will always be looking for software firms that are performing better than others and have been fulfilling quality benchmark and/or follow certain protocols and posses certain certifications. This emerging issue of developing software yet not compromising on quality has been in talks as past literature also states that often quality gets compromised when firms try to avoid having standard SPI frameworks to save the time and cost.

This study will be focusing on the in-depth understanding of subject matter i.e. how are software entrepreneurs conforming to SPI frameworks performing better, how does SPI assists in better product and process innovation performance and those who avoid such certification are facing what challenges? The aim is to have clear and thorough understanding and to reach a conclusion of SPI involvement in software industry that SPI shall be the ultimate goal of firms to progress as the technology gets advanced and more businesses look for software solutions. The aim is to address these issues of quality and innovation performance in context of SPI frameworks discussed above, the lightweight and heavyweight software processes' involvement and presence or absence of SPI assisting them in revenue generation – alongside RBV of entrepreneurship.

CHAPTER 3: RESEARCH STRATEGY AND FIELD RESEARCH

This chapter explains the research strategy, design, and approach to carry out the proposed research effectively. Description of participating companies, interview process is thoroughly explained. It also incorporates the measures kept under consideration during the research along with the final approach for the analysis of the data collected.

3.1 Research Philosophy, Design, and Approach

Interpretivist research philosophy is followed using the qualitative research method based on concrete research objectives. This research paradigm follows the principle that a certain responsibility is performed by the researcher in examining the social world. The main stance of Interpretivist paradigm is that the research depends on the interests of researchers. Here as suggested by Packard (2017), interpretivist paradigm is apposite meta-theoretical base to relate to study that involves entrepreneurship as it indicates their orientation along individualist lines.

The research is exploratory in nature, conducting semi-structured interviews with software corporations of capital city Islamabad. The results are later analyzed using Computer-assisted qualitative data analysis software ATLAS.ti. The analysis and results are gathered based on the research process followed by Pollock, Chapple, Chen, and D'Adderrio (2022). It includes generation of themes based on the quotes by respondents and deriving categories from these.

The interview guide contained set of questions but there was room left to add more questions, suppress, or change the order of them based on the interview progression. This technique assisted the interviewee to convey new facts that the interviewer has no acknowledged before and saved the time that would have been wasted on redundant digressions (Lester et al., 2010).

3.2 Sampling Technique

In qualitative research, the sampling techniques can be used alone or in amalgamation with other techniques (Patton, 1990). The two most common sampling techniques adopted that make even the best within almost all in qualitative research design are purposeful and convenience sampling. These will allow the research to examine the SPI and the corresponding innovation performance from various angles and identify common patterns (Palinkas et al., 2015).

3.2.1 Purposeful sampling and convenience sampling

Purposive sampling also known as selective sampling, is a technique for sampling in qualitative dissertation that allows researchers to select participants for research that can provide comprehensive and in-depth information on their respective research subject (Patton, 1990, 2002). This technique nonetheless is subjective and depends on the researcher to create the qualifying conditions that the participants must meet to become part of the research. Hence this study seeks to find how the involvement of the SPI helps software entrepreneurship – generating criteria for firms in Islamabad that is later explained in next section.

In qualitative research, the main idea behind convenience sampling is to allow researcher to select participants for research who are readily accessible (Patton, 1990, 2002). This at times would involve utilizing resources and terrestrial locations that will make participant selections for research convenient and reliable. However, despite the convenience in participant recruitment, it still requires the researcher to obtain permission and follow necessary steps to avoid any ethical lapses during the research. This answers the argument of choosing only software technology parks of capital city.

3.2.2 Maximum variation sampling

According to Patton (1990), there are various technique that fall under purposeful sampling umbrella. However, keeping in view the software firms in Islamabad and their involvement in SPI, the purposeful sampling technique adopted for participants selection is maximum variation sampling. This strategy seeks to capture and illustrate the main subjects or primary results that involve wide range of participants or program variation. As for small sample sizes, wide ranging heterogeneity could be a weakness in research and problematic if individual cases are highly diverse from each other. Hence, maximum variation sampling here resolves that concern by applying the logic stated by Patton (1990):

> "Any common patterns that emerge from great variation are of particular interest and value in capturing the core experiences and central, shared aspects or impacts of a program."

Therefore, the same strategy is applied in this research in selecting participants in software firms that range from highly experienced to less experienced individuals. By using maximum variation sampling, the research does not attempt to generalize outcomes to all people or groups but seeks to gather information that clarifies programmatic disparity and considerable common patterns.

The researcher using a maximum variation sampling strategy would not be attempting to generalize results to all other groups or people but would be looking for information that clarifies programmatic disparity and considerable shared patterns. Hence it is feasible to expatiate the difference in the group and comprehend variations in experiences of research participants while also examining core components and common outcomes (Patton, 1990).

3.3 Participants and Procedure

The unit of analysis for the research are the firms as only software firms are being targeted

and compared overall than performance of individuals working in them. The research will be analyzing firms' performance regarding the software development process and SPI framework they follow.

The participants qualified for research based purposeful and convenience sampling were primarily the software entrepreneurs that are registered from Pakistan Software Export Board (PSEB). In order to not compromise on research (Smit & Onwuegbuzie, 2018), the research focused on quality instead of quantity by enlisting the right participants – those who will meet the right criteria which included the following:

- Company is registered with PSEB
- Company is in software technology parks (STPs) of Islamabad
- Company has a functioning website
- Company is involved in following:

  Product development, customized and general software development, business software solution, and R&D.

Supplementary criteria such as experience in the software industry or level of software education will guarantee that research participants have same foundation. The Criteria is further elaborated in the table below (see Table 3.1)

Table 3.1: Selection criteria of the participants

Criteria	Definition
PSEB registered company	Pakistan Software Export Board is a top Government body that has authority to promote the industry 4.0 of Pakistan in national and global markets – assists local firms to reach out to potential international clients. PSEB is also a quality standard for software firms as it has conformance requirements that firms must meet to be registered with it. PSEB is to IT industry as HEC is to education sector of Pakistan. Thus, the research aimed at the companies that are registered with PSEB in order to not compromise on quality of the data collected.
STPs	Software technology parks were only targeted that come under PSEB. Three such STPs are functioning in Islamabad hosting multiple software firms. This criterion also narrowed down the sample to firms that are in STPs instead of firms working independently in the capital city.
Functioning website	This criterion was put in to further narrow down to the firms which have a functioning website, excluding the ones that do not possess a proper, formally developed website. However, all the firms used for interviews had the websites functional.
Company's operations	This last criterion excluded plethora of firms keeping only the ones specifically involved in Software business and excluding the ones in hardware business. Hence, the firms involved in digital solutions, customised and general mobile and web application development, telecom services, and R&D were chosen.

3.4 Description of Participating Companies

Initially, the software houses were contacted via portal on their website or telephone, social media i.e. Facebook page, LinkedIn to apply. However, this method did not help in getting the consent, hence, an in-person visit was paid to all firms to ask for interviews and set up an appointment. Interview request letter, information leaflet and consent form were also distributed. Following table (see Table 3.2) shows the participating companies' interviewees information, their age, experience, and interview duration. Some of the interviewees did not agree on recording of the interview and hence the notes were taken for those.

The semi-structured interviews enhanced the flexibility and allowed to get adequate answers to the resultant research questions. Although the sample size is comparatively small, but the interviews can be deemed substantial as the respondents were all high-level professionals who contributed to the interviews and shared credible knowledge about internal operations of their company. Hence the information and comments shed light on some significant aspects to contemplate in software entrepreneurship. All participants were given enough time to articulate their thoughts, understand the questions and ask any questions they have about the research.

Table 3.1: Details of participating companies

Participants	Gender	Position	Experience	Qualification
Firm V	Male	People & Business Operations	3.5 years	Software Engineering +MBA
Firm R	Female	Senior SQA	4 years	Computer Engineering
Firm H	Male	Director Business Development	20 years	Software Engineering + PhD
Firm A	Male	Founder & Director	5 years	Software Engineering
Firm E	Male	Development Head	12 years	Telecommunication and Networks
Firm S	Male	Technical Specialist	5 years	Software Engineering
Firm K1	Female	Team Lead	7 years	MS Data Science
Firm P1	Male	Project Officer	8 years	MS Project Management
Firm P2	Male	NTA	5 years	Information Technology
Firm P3	Male	Assistant Manager	10 years	Manager Administration
Firm P4	Male	Project Officer	7 years	Manager HR
Firm P	Male	Head Technical	8 years	MS Urban Planning
Firm C	Male	Quality Assurance Head	5 years	Computer Science
Firm A1	Male	Head Testing & Deployment	3 years	Software Engineering
Firm K2	Male	Project Manager	8 years	MBA + Engineering

3.5 Data Collection

Over a period of four months, qualitative data was collected to cover the overall objectives, performance of the participants involved in the research and the challenges. Due to sensitive nature of the data and the companies concerns about their information being leaked it was made sure that data will be kept anonymous and confidential, multiple visits were paid to conduct interviews and to gain trust to prompt truthful responses.

As Bell, Harley, and Bryman (2022) have stated, a sample size of research comprises of all the entities which fit in the research project. Similarly in the qualitative research, researcher does not need to follow any set formula to apply to find out the sample size (Kostere & Kostere, 2021; Peterson, 2019). This research has population that is chosen from top level management and these participants have in-depth knowledge about software entrepreneurship. Initially, purposeful and convenience sampling was implemented. However, in the later stages snowball sampling technique was also adopted as some entrants referred other pertinent companies to contribute to the research as well.

The obtained interviews were recorded after getting consent but some of the participants did not agree on recording of the interview. As settled in the consent form and information leaflet, the participants information is kept anonymous, and they are allocated pseudonym as first initial of first and last name i.e. RF for Ridaa Fatima and firms indicated with their initial i.e. Firm S. However, the gender, their designation and work experience are mentioned. Some of the participants agreed on giving interview in Urdu and those were later transcribed and translated into English.

Appendix 4 shows the interview questions and the sub-questions. However, this format was not followed in some interviews and questions got omitted, added and compressed based on the direction of the interview and the interviewee's responses and availability.

The interviews provided a micro-level insight of the motives and purposes, essential challenges, target properties, marketplace contexts, and widespread sense of implementation of each participating firm. The responses provided a sufficient contextual knowledge and focus on time of conducting interviews of individuals. It assisted in spotting and acquiring any noticeable inconsistencies as more and more responses started coming. This also refined the questions conserving the time of interviewer and the interviewee.

3.6 Ethical considerations of the research

Data saturation was avoided by making sample adequate enough to expatiate the phenomenon of interest as the research will be covering only the capital city of Pakistan, hence balancing the sample size to the quantity of gen required from the research (Saunders et al., 2018). A total of 15 interviews were conducted of the software houses that are based in software technology parks (STPs) of capital city Islamabad. In order to ensure that the research is familiarized and acknowledged by the public, specialists and the researchers – trustworthiness of research was established (Lincoln & Guba, 1985) based on the techniques discussed below.

Credibility was achieved by continued engagement with the participants. Firstly, the information sheet was distributed to all the participants who were willing to give the interview and a time slot was reserved based on participant's availability. Before the interview, the consent form was filled out by the participants. After the approval, the interviews were held in-person, and through audio call. Each firm required three to four visits and were kept in touch with via emails and LinkedIn. To protect the identity of participants, each participant was given a pseudonym.

Some software firms had reservations regarding interview recoding, data and revenue sharing. In order to address all the privacy concerns, it was ensured that that the data collected will be kept anonymous and confidential; no results will be associated to any specific organization. One to one interview reduced the chances of biasness that could be expected in focus groups (O.

Nyumba, Wilson, Derrick, & Mukherjee, 2018). Gatekeeper was also used once who acted as mediator to present the research to the relevant participants (Archibald & Munce, 2015).

Thick description was also focused on for transferability by paying attention to details participants' behavior and maintained in reflexive Journal. Because of interviewing one key informant, data triangulation would not have been achieved (Lester et al., 2010). Similarly, if some software firms have not agreed to give interviews, then the external validity would have been limited. To address the concern of triangulation, support of peer debriefers, who are familiar with qualitative data analysis, was acquired. To assess the quality of final report, "Critique checklist" will be presented to research committee. Participants were allowed to withdraw at any point during the research.

To accomplish conformability, reasons for hypothetical and practical indicators were included throughout the study, so that others can understand in what way and wherefor interpretations and conclusions were derived from the data. Similarly, thematic analysis in next chapter was also outlined in an effective manner as presented by Braun and Clarke (2006) to meet the criteria of trustworthiness delineated by Lincoln and Guba (1985).

CHAPTER 4: THEMATIC ANALYSIS AND CONCEPTUAL FRAMEWORK DEVELOPMENT

In this chapter, the data gathered from interviews is analyzed and the procedure is thoroughly explained. It also discusses the thematic analysis with the creation of conceptual framework and discussion based on themes and categories derived from thematic analysis.

4.1 Analytical Procedure

Thematic analysis is done to classify, analyze, and infer the patterns of the results gathered through interviews; involving 15 software entrepreneurs (Braun & Clarke, 2013). Before the analysis, transcription will be done on all the interviews, interpretations, documents, and field notes. Compared to quantitative data, the qualitative data can be gathered from various sources such as files as text files, images etc. (Saunders et al., 2018). Thematic analysis is a supposedly adaptable technique and works with broad array of research questions.

First step involves transcription of all the interviews that were recorded, it also includes transcription of the notes taken during the interviews of the participants who did not agree for the interview to get recorded. Coding styles could be axial coding, selective coding, and open coding. However, this research incorporates the open coding i.e. making sense of initial raw data. The data is to be analyzed on the basis of meaning of analysis i.e. coded by meaning. Thematic analysis however also holds the probability of missing distinctions in the data as it is a subjective approach and involves opinion of the researcher.

The reactions, expectations, beliefs, feelings, and partialities during the research are recorded in the reflective journal. After the interviews and final analysis, an email will be sent to the interviewees containing summary of outcomes and an online survey link with five-point Likert scale regarding overall characteristics of the results, including an open question as well. Later

emails and follow-up emails will be sent to those who had not responded.

4.2 Thematic Analysis Process

The primary technique adopted for data analysis was thematic analysis to analyze and infer from the data collected from semi-structured interviews. Several researchers accentuate that thematic analysis is a general method in qualitative research. Braun and Clarke (2006) acknowledge the effectiveness of this technique as a method for recognizing, examining, and discovering themes or patterns within the gathered data. Aronson (1995) further expatiates that thematic analysis is mainly related with distinguishing themes at the time of analysis of participant's performance and opinions.

In this type of analysis themes and patterns are identified by spotting the repetitive key words, concepts, interpretations etc. Hence, thematic analysis gathers and focuses on phrases and words that occur frequently. Similarly, case studies, data interpretations and answers that are applicable to the research questions of the research are also focus of thematic analysis giving voice to the participants.

In this study, thematic analysis begins with getting familiarization with the interview transcripts, coding, defining categories, reviewing, and defining themes leading to a final write up. For this purpose, In vivo or verbatim coding is incorporated using ATLAS.ti software. The emphasis is put on the spoken words of the participants and themes are generated based on those words or short phrases gathered from interviews.

In conformance to the process suggested by Braun and Clarke (2006), following procedure was adopted to perform thematic analysis on the date gathered:

1. Transcription of all the interviews
2. All the transcriptions were thoroughly read and reviewed thrice
3. Generation of summaries of data
4. Sorting various sections into themes via verbatim coding
5. Defining categories for the themes
6. Report writing and discussion outlining and elucidating the themes and categories identified

Transcripts were scanned in the corresponding round of coding. In vivo phrases conveyed the significance of targeting the "influence of SPI frameworks on software firms' performance", "Innovation and R&D correspondence" and "suitable software process used" by firms etc. In the later stage of coding, larger second-order themes were generated by observing the associations among first-order quotes as demonstrated by Pollock, Chapple, Chen, and D'Adderrio (2022). In the last stage of coding, the second-order themes were combined to reach the aggregate final themes (see Figure 4.1).

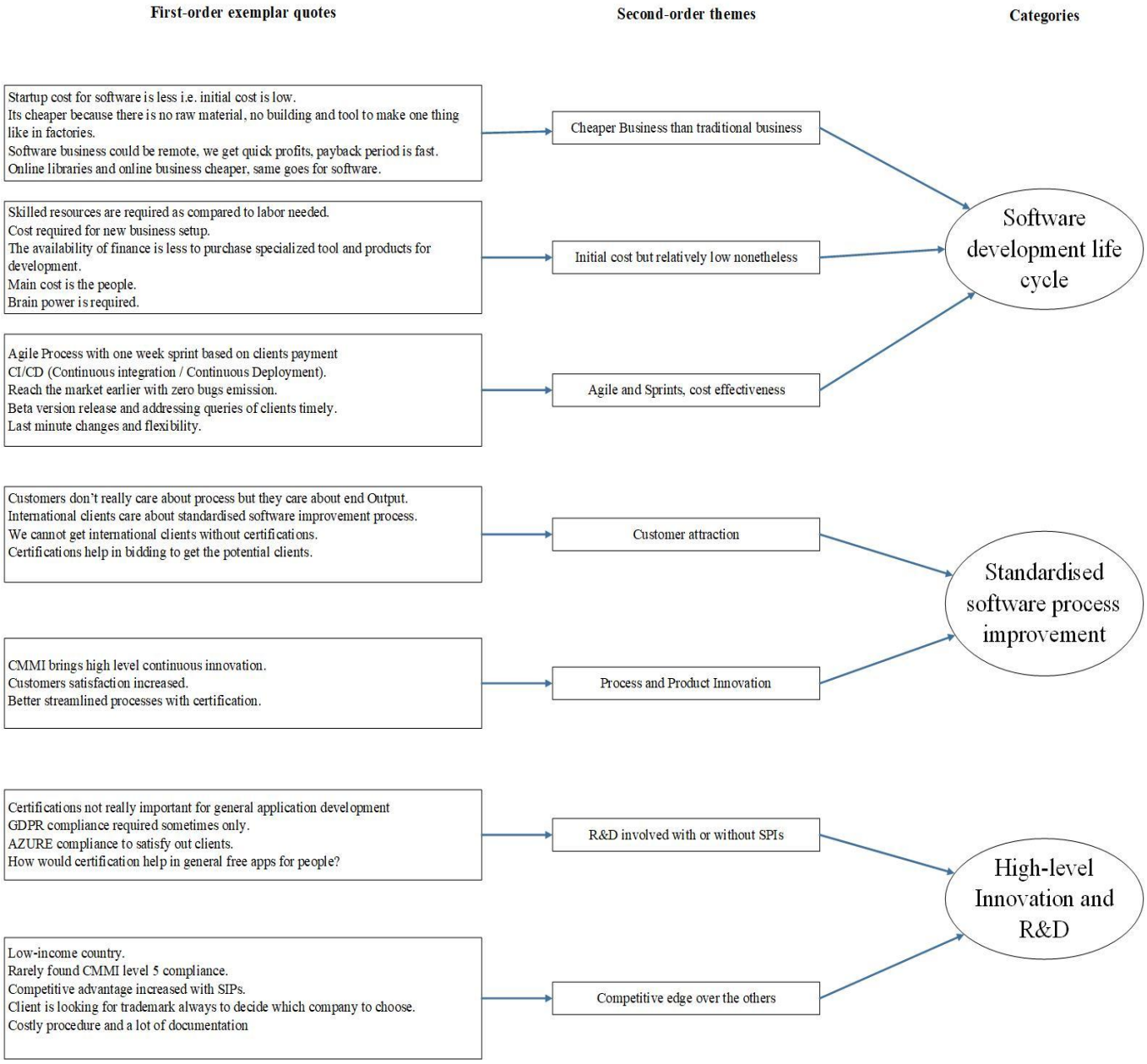

Figure 4.1: Data structure

4.3 Data Analysis and Interpretation of Results

To achieve the research objectives of finding how the software entrepreneurship differs from traditional entrepreneurship, and examining the performance of software entrepreneurs regarding the software process and certification used – three processes surfaced that enabled to get an overall view of research objectives in form of three main categories starting from the 'software development life cycle (SDLC)' to the consequence of 'standardized software process improvement' on the 'innovation and R&D' performance of firms.

4.3.1 Software development life cycle

Similar answers were gathered from all the participants which altogether aided finalizing first category of 'software development life cycle' which is cheap and makes software entrepreneurship cheaper than traditional entrepreneurship.

Cheaper business than traditional business. It was discovered from the themes generated that almost all the participants except three had viewpoint that software business is cheaper than traditional business. The corroborated many examples to expatiate how software entrepreneurship is cheaper and easier. A participant from Firm V stated:

> *It is cheaper because there is no raw material, no building and tool to make one thing like in factories. For us the hardware is laptop that you need. You need to have an office but not necessarily you can work from home. Specially after corona we more focus on remote work that is cost effective. We do not need raw material, so the main cost is the people. So for example getting your people laptops is not that much of a cost. It is one time cost* (Firm V, interview).

According to a participant from Firm S:

> *Let's take a basic example to understand it better. We have online and offline stores*

example over here. In order to create an online store, the cost is quite less as compared to renting out space, decoration, having employees, utility charges etc. for an offline store. Relative to that an online store consume domain and hosting plus the development charges which is quite less as compared to traditional business. Marketing is required for both and in current age one must do digital marketing for their survival even for offline business. This was a basic example, and we can scale it up to enterprise level software (Firm S, interview).

Initial cost but relatively low, nonetheless. The participants who seemed to disagree with the notion could not really substantiate their argument. However, they did agree that the start-up cost is low. The CEO of firm A stated:

Start-up cost for software is less, but when salaries are concerned, recurring cost is high because skilled resources are required as compared to labour needed but initial cost is low (Firm V, interview).

Similarly, a software engineer from Firm A1 were of the view that:

I don't think software industry is cheaper as at times we are doing innovation and we get caught up in challenges which are financial social like brain power is needed (Firm A1, interview).

These answers however did somehow state that apart from human resource, the cost is relatively less one way or another.

Agile and sprints, cost effectiveness. The participants were of the view that the payback period for software businesses is shorter, and profits are generated quickly. This led to creation of this second-order theme. All the participants confirmed the use of Agile methodology and the release of sprints as the process of software development. A sprint is a

set period mainly of two to four weeks in which a set of activities and tasks are to be achieved and prepared for evaluation (Kurnia, Ferdiana, & Wibirama, 2018). Agile methodology was followed by all the firms regardless of the certifications or SPI frameworks used. According to Firm A participant:

> *Agile allows us to accommodate last minute challenges it has flexibility, so this is not available in other process. Firstly we finalize SRS, we start sprints like in one month this is to be done. Before starting new sprint, we evaluate previous sprint* (Firm A, interview).

Some participants stated that their sprints are based on clients payment i.e. Firm H that has applied for ISO certification, their participant stated:

> *Waterfall or other models where we develop & take payment at the end will get us in trouble. We use agile. As soon as first sprint is released to the client, we get payment i.e. 25% in advance after all initial settlement done, 50% after deployment and rest will be pay after testing. We can also pay employees this way* (Firm H, interview).

However, Firm E participant with ISO and CMMI conformance stated:

> *In case of product we follow agile, we have adopted sprints style and applying that throughout. But in case of project we are dependent on the client. We go according to him, like some of our international clients like the one in Iran or other central Asian countries – in their case we are on waterfall process but for the clients in middle east and Pakistan, we go sprint wise. Both models are followed depending on which client is stable* (Firm E, interview).

DevOps CI/CD (Continuous integration / Continuous Deployment) allows reaching the market earlier with zero bugs emission. The perfect way to take maximum advantage is to balance processes and discuss the development methodologies earlier so client knows the changes minimizing the development cost more in terms of time and budget. Agile saves the cost and damages that a company has to bear when a product is delivered at the end and customer is not happy with it.

4.3.2 Standardized software process improvement

This second category emerged from the two second-order themes explained below which summarizes how standardized software process improvement i.e. ISO, CMMI, RUP, IEC etc. increases the innovation performance of a software firm and the overall influence of these on getting customers. However, some participants without these certifications were of the view that these certifications do not affect their performance and they are doing fine without SPI.

Customer attraction. All the participants agreed on the fact that customer is not concerned with what happens at the back or the process used, their primary focus is on the final product released or the beta version released earlier. However, as for as the SPI is concerned, Firm P participant explained that relevant certifications allow them to compete on international level. Another representative from with ISO and CMMI certification stated:

> *We are both ISO and CMMI certified, this increases customers satisfaction and we do mention it in our ads. Currently our business model is B2B, so we are mostly hitting telecom and banking sector. We are client focused than customer focused. In multinational companies or enterprise level or like for B2B, it matters how much is your company certified like when you compete in performance or in bidding of project then the potential clients prefer the certified companies* (Firm E, interview).

Similarly, another participant from a well-established firm acknowledged:

> *We have applied for ISO 9000, and we are working to achieve for CMMI but it needs more improvement for us to get it. Maybe in software we are not that mature to reach CMMI level because we are involved in hardware and cyber security too. These give competitive edge over others 100%. Client is looking for trademark always to decide whether to choose a certified company or the one without SPI models* (Firm H, interview).

Another participant from a software technology park shared:

> *Of course, without these certifications we will not be able to get projects from international clients* (Firm P1, interview).

As far as the companies without these certifications also managed to provide and justify their stance. Most of these were involved in general application development and thus did not feel the need of certifications as the user will download the mobile application without looking for any information about the developer. Firm A's CEO continued:

> *No we don't have any certification yet, we might go for one of ISO but it is as such not a bottleneck because work we are a medium enterprise and we have clients in Finland and their main requirement is how we would follow process and how GDPR is not violated and how data sharing is done, not concerned with certifications* (Firm A, interview).

Another Firm A2 also mentioned the GDPR and Azure compliance as the main requirement of the domain they are working in.

> *CMMI and ISO is important for service-based companies. We are product based so our product gives us competitive edge. We are not making apps we deal in APIs,*

and we generate libraries. Our customers are not concerned with what is happening at the back. Anybody in SAAS industry is more concerned with when the software is delivered. Our clients are only concerned with fast process, and we are giving service to their product we have AZURE and GDPR compliance (Firm A2, interview).

Product and process innovation. CMMI and other relevant certifications bring continuous high-level certifications and streamline the processes. However, these are costly and require a management and continuous compliance to advance to its next level.

Standardized process increases throughput, innovation performance and efficiency of employees like we don't have testing environment, so we go to other people and ask for stuff so standardized process saves this hassle (Firm A1, interview).

CMMI requires more R&D and a streamline process where both go side by side. One reason of some firms not going for CMMI was the high-end requirements of CMMI which could slow down their processes:

We have not applied for CMMI because there is extensive documentation. It will slow down our operations because more time will be done on documentation, we need to code and deliver product as quickly as possible (Firm H, interview).

Similarly Firm S participant declared:

Software Standardization is any case either it's the UI or the development process make things easy for the development organization as well as the clients. We often need to allocate new programmers to the software development process and thus having standard format help the new developer to understand the code better. Even the naming convention must be standardized it will help in long run (Firm S,

interview).

Companies in application development almost stated the same thing:

> *We have apps so downloading app would not matter about certification like customer would not go check if we have any certification. These certifications are nonetheless best practices, and they are tried and tested so they do make difference* (Firm A, interview).

Hence these two second-order themes finalised the second category for the thematic analysis i.e. SPI frameworks nonetheless are effective and firms having those are performing better and attracting more clients which is further discussed in section 4.5.

4.3.3 High level innovation and R&D

The last category derived from two second-order themes made the importance of SPI on R&D and Innovation performance of the software firms.

R&D involved with or without SPI. upon interviewing a mix of software firms in which some have the certain certifications while others do not. However, some of the certifications are the ones needed for security compliance and data sharing purposes. As far as SPI frameworks are concerned it was discovered that the software firms not having compliance with them are still involved in R&D. They are involved in figuring out and generating new AI filters and machine learning techniques to keep their technology evolving.

> *For general apps both research and development are catered all at once. R&D is required to know what AI algorithms to use to make it competitive to improve filters and overall organization's procedures. It involves Innovation of course* (Firm P3, interview).

This also indicates that the companies involved in general application development that

mainly are B2C, the do R&D for improvement of their application. According to one respondent:

> *We search on higher management level, and we encourage every field to stay updated not really the literature, the machine learning squad does literature review, but others just go and check the latest trends and how to incorporate them. Like not making something that is already done what is the point then, so we research on that. Without research you will not be effective in making products* (Firm V, interview).

Similarly, other respondents also ensured that they do R&D and that it is continuous process specially the ones which are involved in more than one domain ranging from mobile application to AI to web applications. One respondent said:

> *Our product is all about R&D. We do not have competitors we are first movers, so we need ourselves to retain the edge* (Firm P, interview).

Research and Development in term of project requirements and its functional definition is always done before start of any project in Requirement Gathering/Elicitation stage. R&D however in terms of new technology development is limited as some companies are bound to the project scope. To keep the development team aware of latest tech stack and trends, companies hold session on technology trends. Hence, developing new tech is costly and only performed by tech giants. Small and medium tech companies just extend their functionality.

Competitive edge over the others. The last second-order themes finalize the research objective which was to discover whether SPI frameworks make difference, and the answer is Yes. All the companies with SPI compliance had a separate department, offices or even branches that were solely dedicated to R&D – bringing continuous innovation rather than just

extending functionality of their products.

> *This company's office here is basically dedicated to R&D because we are working on product related things. In the other office, there are scheduled audits of CMMI. Which means more R&D to fulfil the standard requirements.*
>
> *Product-wise we are making some that are different than competitors like local market. Most of our clients are international ones, similarly some of our R&D things are different than the market. Currently our business model is B2B so we are mostly hitting telecom and banking sector. So, we are client focused than customer focused. Like Jazz app is ours. Before that we had EasyPaisa contract, like KPK Zama KP system is ours* (Firm E, interview).

Similarly, another firm with SPI compliance, that was involved in Urban planning and mega projects of digitizing the property stated the same. Their R&D lead to creating something that was not initiated before in Pakistan. According to their respondent:

> *We have for past 4 years been working on R&D. This is how we started reverse engineering and have 75 offices in whole Pakistan. Our entire system is based on R&D. Our system is result of reverse engineering of UK 2020 lane registry system. We have copied but enriched it. It's more diverse with online property verification handling urban planning and real estate.*
>
> *We make feasibility study of international clients and have surpassed companies in Dubai to attract their audience. We are now making banking system for home financing. We resolve bank inquiry and verify person's details and short the timespan from one month to one week* (Firm P, interview).

Hence, compared to the R&D conducted by firms without SPI, the ones following SPI are automatically gaining competitive edge in their business, generating greater revenue, and attracting clients and working on Mega projects. This summarizes and answers the research objectives very evidently.

4.4 SPI and Software Entrepreneurship Framework

The categories and themes derived from thematic analysis led to making of conceptual framework (see **Error! Reference source not found.**.2). This framework demonstrates the relationship of SPI frameworks to firm growth. The SPI and software entrepreneurship framework aims to find out whether the software firms make revenue and progress by simply following the basic steps or if a standardized model is used for development which further introduces innovation and R&D, how it plays its role on firm's growth. For example, use of CMMI, Six Sigma and CMMI blended model, ISO 9000, SCRUM, SPICE and RUP etc.

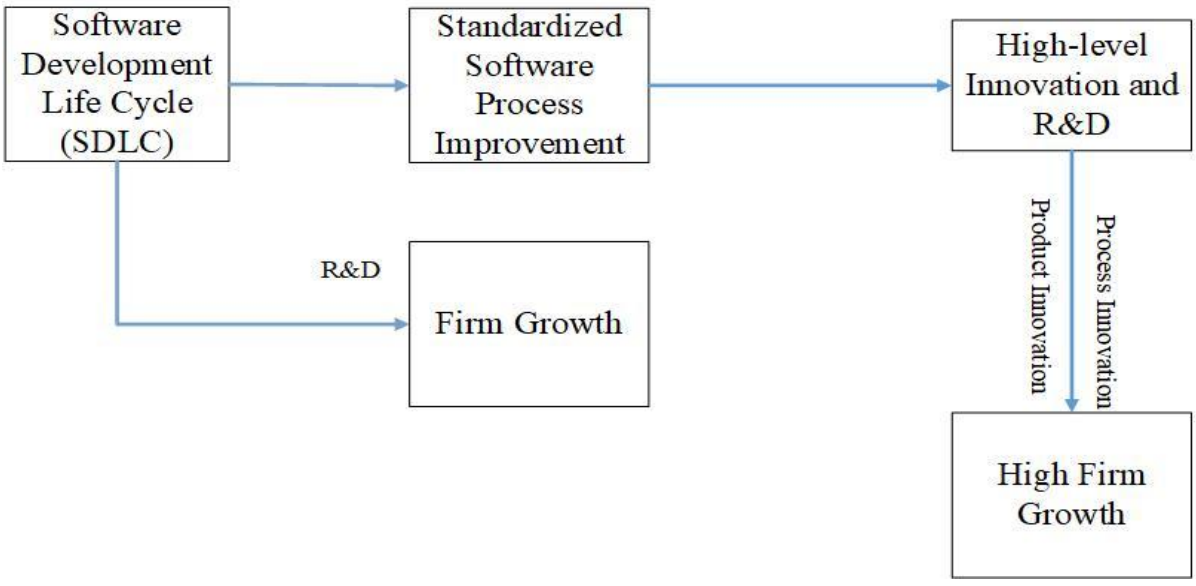

Figure 4.2: SPI and software entrepreneurship framework

It is discovered that if the firms use any standardized software process model and work on gradually achieving the maturity levels of SPI mainly CMMI – their likelihood of getting innovative overtime, increased efficiency, and quality will improve leading to high growth and increased revenue – although the process to get there will be costly and will involve a lot of audits and reports.

Hence, as it could be seen the firms that have not been following any SPI frameworks are still involved in R&D which leads to their firm growth but compared to that the ones complying to any SPI framework are indulged in high-end R&D. Those firms are more innovative, their firm performance and revenue generation is better than the ones without certifications.

Compliance to CMMI let firms strive to reach higher levels of CMMI which improves the process they use and there is innovation in the service and products they deploy over time. In short, the main idea behind the framework is to propose that the use of any standardized software process model will increase firm's performance which is apparently not practiced in majority of software firms in Pakistan when compared to global software market.

4.5 Discussion and Recommendations

The results show that firms having certain certifications and following their requirements are nonetheless performing better than the one without SPI frameworks. If we go according to the research questions (see Table 3.2), it starts off with finding the difference between traditional entrepreneurship and software entrepreneurship. According to the responses gathered it can be deduced that software business is cheaper than traditional business when it comes to establishing a business as it does not require raw data, labor or even brick and mortar at some cases compared to traditional businesses. A software business could be run at remote locations. However, skilled resources are required that are capable of

performing necessary operations for development of a software.

Similarly, initial cost for starting a software business is also relatively less than the cost incurred for traditional business setup. The firms interviewed had clients in other countries and even some were based in remote location in other parts of the world but were functioning in capital city as well. For the software deployment, even physical presence is not necessary as everything is shared over the internet and services are provided to other companies without having the need to be physically present. Likewise, the cost effectiveness comes with the process followed by software companies.

Compared to traditional business where a product is delivered after being completed, a software firms gets to release beta version of its product which is cost effective. During the process, client gets to see the progress at each stage of software development cycle. It allows flexibility to the firms and even last-minute changes can be accommodated without any hassle. During the entire agile process. Agile projects are lost cost per unit of value produced, the particular reason to this circumstance is that the people performing work can perform same activities with an elevated degree of effectiveness – hence increased productive work gets done per hour designated time period.

However, software business is not cheap when it gets to hiring skilled developers for development of software products as these generate high revenue and are considered high income skills. In a low-income developing country like Pakistan, establishing a software business from scratch would for sure be cheaper than any other businesses considering the hourly wages of freelancers or even the software developers/engineers looking for employment. However, this will if successful, lead to generation of high revenue if the firm is to take projects from international and other giants in the industry to develop their products like websites, mobile or web applications or entire software systems. Skilled resources are

required that are capable of performing necessary operations for development of a software. Skill intensity still remains an important factor in software entrepreneurship.

Based on the responses, it was discovered almost all the firms are developing software based on agile methodology and even traditional waterfall model is adopted, it is in combination with agile which is relatively saving time and cost for these software firms. Moving forward to next objective which focused on performance of software firms based on the standardized software process improvement (SPI) used and their comparison with the ones without the SPI frameworks. The research questions also centered on inquiring from firms about the products or service they performed i.e. how horizontal or vertical their products are.

This allowed assessing the intensity and scale of products and services provided by firms that have SPI compliance. It is discovered the firms which are following and trying to achieve CMMI levels or other certifications are involved in delivering B2B services and products. Their products are implemented and used on large-scale. They have many branches all over the country and are expanding and innovating their business. Hence, their revenue is also greater than others without SPI frameworks. These firms are leading in gaining international clients and bid among other giants of software industry.

Firms without the CMMI, ISO or any other improvement process are performing well in their domain too. Most of such firms were involved in B2C services i.e. mobile or web applications or AI. Some of these are also working with international clients and are complying with the GDPR or Azure to retain their clients. It was discovered that application development and general products generating companies did not feel the need to have any SPI certifications as their applications are used by public which do not require any background information of a company.

The information gathered from interviews in the light of past literature comes to a conclusion that the software firms in pursuit of entry level success of SPI, shall work on creating process asset libraries – for example SW-CMM[4] which is an asset library having a compilation of entities to be utilized by projects in creating, customizing, maintaining and executing their software processes. Similarly, use of product component library and already existing tools for sharing and the use of social media platforms can also allow firms to nurture an explicit knowledge sharing culture i.e. Use of Google docs, SharePoint, or wiki etc. These assist organizations in exploitation of knowledge.

On the other hand, Exploration of knowledge as mentioned above comes at the later or higher stages of SPI success when the improvement focus is on technological expertise and tailored standardization of processes. At this stage, firms shall emphasize and promote visionary leadership and the Quality Assurance Groups (QAG) or the Software Engineering Process Groups (SPEGs) – in charge of the Quality Initiative and accountable for product and project development by exploring and employing shared patterns or the Application Programming Interfaces (APIs).

Thus, when the focus is on the process adopted by software firms, SPI comes in picture. Thus for lightweights approaches such as Lean, Scrum, XP, Kanban, or Agile – SPI can be endorsed. For example, in achieving different maturities levels of CMMI, agile procedures can be equipped with. Hence, allowing software firms to nurture and capitalize in particular knowledge mechanisms while practicing agile software process for development. As apparently most firms even if they do not possess any SPI model, are still practicing agile software development in their firms.

[4] Software Capability Maturity Model

If software firms work on getting certain certifications they can improve their processes, performance and generate higher revenue and also client's satisfaction as the client looks for some trademark to trust. For example, a firm that follows CMMI has extensive and pre-defined processes to follow that cannot be challenged or altered. These standardized software process improvement models are best practices which have been tried and tested and then deployed hence their authenticity and methods cannot be challenged; compliance to those will automatically give firms edge over the other.

CHAPTER 6: CONTRIBUTIONS AND FUTURE RESEARCH

In conclusion, this chapters the concluding remarks about the research and summarizes the findings. It highlights the research limitations and contribution to literature based on practical, theoretical, and methodological inferences. Lasty, it suggests directions for the future work.

6.1 Conclusions and Summary of the Research

In this research, previous literature and studies done in SPI and software entrepreneurship are extended and consolidated for additional pursuit on comparing firms' functionality when they are progressively executing SPI specially achieving CMMI levels. CMMI with resource and knowledge-based perspective in entrepreneurship can allow firms into amalgamating new discovered knowledge gathered from R&D to existing practices to lead to CMMI maturities and firms' success.

Success on different levels of SPI in a firm is reliant on the knowledge-processing tools that a firm utilises. Hence, software firms may implement and capitalise in particular knowledge mechanisms that suit them while practising discrete levels of CMMI or other SPI frameworks.

This study was done on micro-level in capital city of Pakistan which gathered interviews from 15 software firms. All the respondents are well positioned to prompt responses on software entrepreneurship. The research focused on discovering whether software entrepreneurship is cheaper than traditional entrepreneurship and if the SPI helps an organization to gain competitive edge or become more innovative. For this purpose, qualitative analysis was done using the semi-structured interview technique and later the results were analyzed using computer-assisted qualitative data analysis software. Based on

analysis technique previously used by Pollock et al. (2022), codes were generated, themes were identified from the quotes of respondents.

Software process improvement models are significant for the firms involved in software development to effectively re-organize their practices and processes. As far as software entrepreneurship is concerned, firms creating their own software are either subcontracting or hiring their own people. Sometimes a firm would need skills to develop software for a short period of time. It is low cost in the initial stages and can generate profits quickly compared to other businesses.

However, the studies do bolster the function of human capital and absorptive capability in the perspective of software business in general. It is discovered that for software industry there is a skill biasness, and the firms look for skilled individuals. With the increase in digitization and involvement of computers in every business, the demand for human capital has increased and firms are willing to invest in human resources and even give high salaries. Additionally, this study offers insights about the firms with SPI i.e. CMMI, and ISO and other compliances but mainly focusing on CMMI as this is the model widely used when it comes to software industry and with regard to our resources based view CMMI fit in. The study compares how software firms with the compliance of any SPI and how they are performing better than others.

It also demonstrates the agile methodology and other software development approaches adopted by firms to maximize profit and minimize cost and damages. Through thorough evaluation of present literature and the qualitative study conducted on the software firms of capital city Islamabad, it is discovered that trend for software firms to go for SPI is relatively low. The reason behind is the poor economic structure of the country. However, it was discovered that firms that engage in software process improvement and follow certain

models report advanced levels of innovation productivity and feature a grander segment of their sales to innovation.

Software development benefits from SPI when the emphasis is on the process. In process-oriented development methodologies including heavyweight approaches like waterfall, spiral, iterative, or lightweight approaches – SPI can be implemented. The knowledge perspective and the SPI's in-depth understanding in this study offers direction for firms implementing SPI to attain superior development performance and looking to incorporate the notion of process maturity in their development techniques. CMMI provides firms an intrinsic roadmap for process improvement; with the maturity levels achieved–it is uncomplicated for the firms to go for expansion.

Henceforth, for the small firms which believe that CMMI is expensive and not much practical for their business – differing to widespread belief – the compliance will undeniably aid them in preparing enhancements as they get bigger and plan to expand their business and wish to get bigger projects in future. Similarly, ISO assist in legislative structure of organization, the practices, and resources essential to execute the planning, controlling and improvement of quality.

6.2 Research Limitations

The sample size on which the thematic analysis was carried out is evidently a limitation of research although quality was preferred over the quantity. The respondents of this research were involved in urban planning, analytics software development, mobile and web application development, cyber security, telecom, and banking sector. However, the research is only focused on the software firms of Islamabad which puts a limitation as fewer firms were found to be following/practising the SPI frameworks and firms in other cities of Pakistan i.e. Lahore and Karachi would have generated more responses from firms that are

involved in software process improvement.

This research explored the performance of software firms based on the process they follow and the SPI conformance focusing on CMMI and ISO. It has not taken under consideration other factors like software firm's capability or desire to engage SPI as this stage thoroughly as the focus was on innovation performance. Similarly, company's maturity i.e. for how long it has been functioning, was not taken into account. A small software firm may get involved in process development that would demonstrate CMMI maturity level while not increasing its employees. Hence not consideration of this factor is a limitation to this research.

However, as far as consistency and credibility is concerned – the research is reliable and will generate similar outcomes if replicated over time. The research is however limited to software industry only and the results are software business based. Hence compared to other businesses, only software entrepreneurship is being addressed in the research which cannot be applied to other small and medium enterprises.

6.3 Contributions to Literature

Firstly, the research will fill a gap in the literature by qualitatively exploring SPI's involvement and its connection to resultantly better performance of software firms. The results of research can be useful and applicable to other similar contexts as the general trend observed in capital city is likely to be the same in other cities of Pakistan.

Secondly, this research is aiming at software firms' performance regarding the process and improvement model they use in the development of software and its association to the quality production, user satisfaction and performance of the organizations. Moreover, studies conducted have been quantitative in nature which lack in-depth knowledge. Either they have been purely related to software development or to

business solely.

Thirdly and very notably, preceding literature centers on either labor throughput of software firms in Islamabad or the firm's growth driver where the SPI is not considered, and their role in firm growth was not measured. One prominent theoretic contribution that is provided by this research is that it merges the literature of software process models, improvement processes, resource and knowledge-based perspective of entrepreneurship into one context. The knowledge exploitation and exploration perspective aligned with the SPI in this study offers direction for firms implementing SPI to attain superior development performance and looking to incorporate the notion of process maturity in their development techniques.

By exploring these constructs collectively, the characteristics that surfaced as the result of research can be regarded as vital concepts that can be antecedents of effective involvement of SPI in software entrepreneurship. Based on SPI and software entrepreneurship framework that has highlighted a comprehensive and novel viewpoint on the subject matter, significant concerns involving SPI in software entrepreneurship could be uncovered that might have been overlooked earlier.

Moreover, the findings associate and confirm the past literature done worldwide on various disciplines. The results will assist the software firms conducting R&D regarding SPI involvement in the manufacturing of premium quality software to discover the lacking areas where the improvement is required. Lastly, research will be adding value to the literature of both engineering and entrepreneurial innovation, opening means for future research and applying the framework to other cities of Pakistan.

6.5 Future Directions

The results of this research can be utilized by software firms that plan to go for software process improvement as they expand their business and human resource. As the research only targets the software firms of Islamabad, further work could be done on other cities of Pakistan to see the trend. The framework can be applied to other firms of developing countries. Even though the companies included in the research have been operational from between 3 to 15 years or more, yet further research is needed to assess if the company size and maturity could make it more prone to conform with SPI frameworks or not. Similarly, future research can focus on dynamic capabilities of firms using the SPI with the organizational learning types i.e. single loop, double loop or deutero learning.

APPENDICES

Appendix 1.

INTERVIEW QUESTIONS

Date: _____
Designation: _____ Company: _____
Experience in software lifecycle: _____
Age/ Qualification (Optional) _____
Customized or general software production_____

Steps to be followed:

- *Introduction about the research*
- *Informing about all the terms and conditions*
- *Getting the consent form signed*
- *Asking for permission for recording the interview*
- *Ensuring that anonymity and confidentiality will be strictly observed*
- *Explaining about the interview structure*

Interview Questions:

1. How do you think software business is easier and cheaper than traditional business? Share your success failure stories and client's satisfaction about software quality?

2. What software development process your firm follows? Does the use of process give your firm competitive edge, do customers care about process?

3. What is the role of software process in advertisement? Do you use it in ads? Why?

4. Do you think use of standardized process effects the organization's innovation performance and attracts clients? Local international? Does big data, prototyping or simulation help in innovation? Is innovation risky?

5. How often do you conduct R&D? What do you think of role of R&D and how often your firm follows it?

6. How horizontal and vertical is the product created by you? How are they created in software industry and how is it created in your industry?

Appendix 2.

"Participant Information Sheet"

Name of PI Name of Organization	Ridaa Fatima NUST Business School, NUST Islamabad
Name of Co-PI Name of Organization	Dr. Owais Golra NUST Business School, NUST Islamabad

Introduction

As a student of MS Innovation & Entrepreneurship and having background of Software engineering, I am conducting this research that combines both disciplines of Engineering and entrepreneurship. The aim of this research is to explore the effect of software engineering process on performance of software entrepreneurship. In order to explore more about software entrepreneurship, standardized software engineering process used in the development of software and its role in the overall performance of the firm – a qualitative research is carried out.

Before you decide to take part, we would like to let you know about the study and what it involves. This leaflet provides the information you may require before giving your consent.

Purpose of the Study

Conducting interviews of various software firms in the capital city to see the inclination towards use of standardized software engineering process (CMMI, SIX SIGMA etc) and if that bring more innovation and revenue to the firm, also to find out how much of part research development play in the regard. There hasn't been any recent research conducted that will be aiming at software firms' performance regarding the process they use in the development of software and its linkage to the quality production, user satisfaction and performance of the organizations.

Why have I been invited to take part?

You are being invited to take part in this research because we feel that your experience can contribute much to our understanding and knowledge of use of standardize processes and the innovation performance.

Voluntary Participation

Your participation in this research is entirely voluntary. It is your choice whether to participate or not. The choice that you make will have no bearing on your job or on any work-related evaluations or reports. You can change your mind later and ask to discontinue the participation, despite having agreed before.

Reimbursement

You will not be provided any incentive or payment to take part in the research.

How much time and effort is required?

The interview/discussion is anticipated to take 20-30 minutes, maximum an hour.

Benefit

There will be no direct benefit to you, but your participation is likely to help us find out more about the health information infrastructure of Pakistan.

Risks
No risks are involved except using your time for the interview.

Confidentiality
Your name will not be shared with the other participants in the study and your data will be protected by removing names and identifiers from the transcripts and ensuring that only the researcher has access to your data. The interview recordings will not be heard by anyone other than the researcher and will be kept secure. Any information about you will have a number on it instead of your name.
Only the researcher will know what your number is, and your data will be stored in a locked filing cabinet or in password protected computer. In our reports, I may quote you, writing down what you said in your own words, but I will not use any information which could identify you (like your name, where you work etc.). The recordings and data will be destroyed after 3 years of this research.

Who to Contact?
If you have any questions, please ask now or later. You may contact any of the following:

Researcher
Ridaa Fatima
Email:ridaa.msie20nbs@student.nust.edu.pk

Appendix 3.

"Participant Consent Form"

Please read and complete this form carefully. Please initial the following statements if you are happy with them and leave blank any that you are not happy with. If you do not understand anything and would like more information, please ask.

	Initials
The research has been explained to me in a way I can easily understand (written or verbal)	
I have had the opportunity to ask questions about the study and understand what is involved.	
I understand that my interview will last no more than one hour and will be recorded by using digital equipment.	
I understand that it will not be possible to identify me when using direct quotations from me in future publications.	
I understand that I may withdraw from this study at any time without having to give an explanation. This will not affect me in any way.	
I am willing for my anonymized data to be archived and used for this research project and I understand that all data will be destroyed at the end of the project.	

I freely give my consent to participate in this research study and have been given a copy of this form for my own information.

Participant Name:	Date:
Signature:	
Name of the Person taking Consent:	Date:
Signature	

Appendix 4.

Table 3.2: Interview questions

Question No.	Main Questions
1	How do you think software business is easier and cheaper than traditional business?
2	What software development process your firm follows? Does the use of process give your firm competitive edge?
3	How do you think use of standardized process effects the organization's innovation performance and attracts clients?
4	How often do you conduct R&D? What do you think of role of R&D and how often your firm follows it?
5	How horizontal and vertical is the product created by you? How are they created in software industry and how is it created in your firm?
6	What is your opinion on the role of standardized software process in advertisement? How often do you mention process or certifications in your ads?
	Sub-question 1 (Breaking Down)
Share your success and failure stories in this regard?	
How is client's satisfaction about software quality?	
	Sub-question 2 (Breaking Down)
What do you think are customers concerned about the process followed during development of software?	
What type of clients do you have? Local? international?	
	Sub-question 3 (Breaking Down)
What implications a standardized process can have on firm who have it and who do not? What is your opinion?	
Why do think standardized process is not necessary for your organization?	
How do you think certifications and standardized processes require more R&D?	
Do you think the use of process increase the firm's revenue? How?	
	Sub-question 4 (Breaking Down)
What do you think about R&D being effective, expensive? Is it time consuming or saving in long term?	
Does big data, prototyping or simulation help in innovation?	
Does innovation in software products risks the quality of those products?	
How do think innovation could be risky?	
	Sub-question 5 (Breaking Down)
How customized are you products or general, explain the products you have made or currently working on?	
	Sub-question 6 (Breaking Down)
What do you think about the followers?	
Do you consider yourself a follower (who develops products based on already existing technologies)?	
What do you think of role of a leader as an innovator?	

REFERENCES

Almeida, F., Amaral, M. J. I. J. o. K., Innovation, & Entrepreneurship. (2019). Conceptual Framework for Assessment Entrepreneurial Education. *7*(3), 5-25.

Almomani, M. A. T., Basri, S., Mahamad, S., & Bajeh, A. O. (2014). *"Software process improvement initiatives in small and medium firms: a systematic review.*"

Alonso, A. D., & Kok, S. J. L. E. (2018). A resource-based view and dynamic capabilities approach in the context of a region's international attractiveness: The recent case of Western Australia. *33*(3), 307-328.

Andersson, M., Kusetogullari, A., Wernberg, J. J. T. F., & Change, S. (2021). Software development and innovation: Exploring the software shift in innovation in Swedish firms. *167*, 120695.

Archibald, M., & Munce, S. (2015). Challenges and strategies in the recruitment of participants for qualitative research. *University of Alberta Health Sciences Journal, 11*(1), 34-37.

Arif, A., Mehmood, B., & Siddiqi, M. W. (2011). Traits of Software Developing Industry in Pakistan: An Exploratory Account. *IJCRB*, 2023.

Aronson, J. J. T. q. r. (1995). A pragmatic view of thematic analysis. *2*(1), 1-3.

Backlund, P. J. A. P. (2002). Identifying situational factors for IS development processes: applying the method-in-action framework. 189.

Barney, J. B. J. J. o. M. (2021). The Emergence of resource-based theory: A personal journey. *47*(7), 1663-1676.

Batjargal, B. (2005). Software entrepreneurship: Knowledge Networks and Performance of software ventures in China and Russia.

Behm, A. (2019). The antecedents of big data analytics: integrating resource-based theory and knowledge management perspective.

Belitski, M., Caiazza, R., & Lehmann, E. E. J. S. B. E. (2021). Knowledge frontiers and boundaries in entrepreneurship research. *56*(2), 521-531.

Bell, E., Harley, B., & Bryman, A. (2022). *Business research methods*: Oxford university press.

Bessen, J., Hunt, R. M. J. J. o. E., & Strategy, M. (2007). An empirical look at software patents. *16*(1), 157-189.

Bhattacharjee, S., & Chakrabarti, D. (2017). The congruence of entrepreneurship and India's excellence in information technology. *Journal of Global Operations and Strategic Sourcing*.

Blohm, I., Bretschneider, U., Leimeister, J. M., Krcmar, H. J. I. J. o. N., & Organisations, V. (2011). Does collaboration among participants lead to better ideas in IT-based idea competitions? An empirical investigation. *9*(2), 106-122.

Boltz, L. O., Henriksen, D., & Mishra, P. J. T. (2015). Rethinking technology & creativity in the 21st century: Empathy through gaming-perspective taking in a complex world. *59*(6), 3-8.

Branstetter, L. G., Drev, M., & Kwon, N. J. M. S. (2019). Get with the program: Software-driven innovation in traditional manufacturing. *65*(2), 541-558.

Braun, V., & Clarke, V. (2013). *Successful qualitative research: A practical guide for beginners*: sage.

Braun, V., & Clarke, V. J. Q. r. i. p. (2006). Using thematic analysis in psychology. *3*(2), 77-101.

Budhwar, P. S., & Mathew, J. (2007). The relationship of organisational culture with productivity and quality. *Employee Relations*.

Caiazza, R., Belitski, M., & Audretsch, D. B. J. T. J. o. T. T. (2020). From latent to emergent entrepreneurship: the knowledge spillover construction circle. *45*(3), 694-704.

Chen, C.-Y., Lee, J.-C. J. C. S., & Interfaces. (2022). Comparative effects of knowledge-based antecedents in different realms of CMMI-based software process improvement success. *81*, 103599.

Choi, S., & McNamara, G. J. S. M. J. (2018). Repeating a familiar pattern in a new way: T he effect of exploitation and exploration on knowledge leverage behaviors in technology acquisitions. *39*(2), 356-378.

Chung, S., Animesh, A., Han, K., & Pinsonneault, A. J. I. S. R. (2019). Software patents and firm value: A real options perspective on the role of innovation orientation and environmental uncertainty. *30*(3), 1073-1097.

Cusumano, M. A. (2004). *The business of software: What every manager, programmer, and entrepreneur must know to thrive and survive in good times and bad*: Simon and Schuster.

Devadiga, N. M. (2017). *Software engineering education: Converging with the startup industry*. Paper presented at the 2017 IEEE 30th Conference on Software Engineering Education and Training (CSEE&T).

Diebold, P., Scherr, S. A. J. J. o. S. E., & Process. (2017). Software process models vs descriptions: What do practitioners use and need? , *29*(11), e1879.

Dyba, T. J. I. t. o. S. E. (2005). An empirical investigation of the key factors for success in software process improvement. *31*(5), 410-424.

Edison, H., Smørsgård, N. M., Wang, X., Abrahamsson, P. J. J. o. S., & Software. (2018). Lean internal startups for software product innovation in large companies: enablers and inhibitors. *135*, 69-87.

Emam, K. E., Melo, W., & Drouin, J.-N. (1997). *SPICE: The theory and practice of software process improvement and capability determination*: IEEE Computer Society Press.

Fontana, R. M., Meyer Jr, V., Reinehr, S., Malucelli, A. J. J. o. S., & Software. (2015). Progressive Outcomes: A framework for maturing in agile software development. *102*, 88-108.

Garratt, B. (1990). *Creating a learning organisation: A guide to leadership, learning and development*: Director Books.

Giones, F., & Brem, A. (2017). Digital technology entrepreneurship: A definition and research agenda. *Technology Innovation Management Review*, *7*(5).

Grant, R. M. (1996). *Toward a knowledge-based theory of the firm*, *17*, 109-122.

Habib, M., Ahmed, S., Rehmat, A., Khan, M. J., & Shamail, S. (2008). *Blending six sigma and CMMI-an approach to accelerate process improvement in SMEs.* Paper presented at the 2008 IEEE International Multitopic Conference.

Hall, B. H., & MacGarvie, M. J. R. P. (2010). The private value of software patents. *39*(7), 994-1009.

Heitmeyer, C., Jeffords, R., Bharadwaj, R., & Archer, M. (2007). *Re theory meets software practice: Lessons from the software development trenches.* Paper presented at the 15th IEEE International Requirements Engineering Conference (RE 2007).

Horwitz, P., von Davier, A., Chamberlain, J., Koon, A., Andrews, J., & McIntyre, C. (2017). Teaching teamwork: Electronics instruction in a collaborative environment. *Community College Journal of Research and Practice*, *41*(6), 341-343.

Iqbal, J., Ahmad, R. B., Nasir, M. H. N. M., Niazi, M., Shamshirband, S., & Noor, M. A. J. S. Q. J. (2016). Software SMEs' unofficial readiness for CMMI®-based software process improvement. *24*(4), 997-1023.

Kang, Y., Lee, K. J. E., & Technologies, I. (2020). Designing technology entrepreneurship education using computational thinking. *25*(6), 5357-5377.

Kerdpitak, C., & Jermsittiparsert, K. (2020). Influence of Engineering Education and Integrated Quality & Environmental Management on Quality, Firm and Environmental Performance. *Test Engineering and Management, 82*, 3452-3463.

Kim, K., & Lee, J. (2018). Soft but strong: Software-based innovation, product market competition, and value creation in the IT hardware industry.

Kong, S.-C., & Abelson, H. (2019). *Computational thinking education*: Springer Nature.

Kostere, S., & Kostere, K. (2021). *The generic qualitative approach to a dissertation in the social sciences: A step by step guide*: Routledge.

Kurnia, R., Ferdiana, R., & Wibirama, S. (2018). *Software metrics classification for agile scrum process: a literature review.* Paper presented at the 2018 International Seminar on Research of Information Technology and Intelligent Systems (ISRITI).

Lee, J.-F., & Wu, M.-J. J. J. o. t. C. I. o. I. E. (2007). Organizational capabilities building through CMMI: the case of Taiwan software industry. *24*(4), 327-339.

Lester, N., Wilkie, F. G., McFall, D., & Ware, M. (2010). Investigating the role of CMMI with expanding company size for small- to medium- sized enterprises. *Journal of Software Maintenance and Evolution: Research and Practice, 22*(1), 17-31.

Lincoln, Y., & Guba, E. G. (1985). Naturalistic inquiry. Newbury Park, CA: Sage.

López, J., García, J., Cano, C.-J., & Casado, M.-d.-P. (2012). Anthropocentrism and ecocentrism in potential technology-based entrepreneurs. *Psyecology, 3*(2), 229-237.

Machado, E. M. M., Mexas, M. P., Meza, L. A., de Oliveira, I. A. M. J. E., & Proceedings, S. D. B. o. (2022). `29-38.

Martins, P. V., & da Silva, A. R. (2010). *PIT-ProcessM: a software process improvement meta-model.* Paper presented at the 2010 Seventh International Conference on the Quality of Information and Communications Technology.

Mathiassen, L., & Pourkomeylian, P. J. J. o. K. M. (2003). Managing knowledge in a software organization.

Mehmood, B., & Siddiqi, M. W. (2011). Software Firm Growth and Associated Factors in Pakistan Software Developing Industry: Some Preliminary Findings. *IJCRB*, 2012.

Melegati, J., Guerra, E., Knop, I., & Wang, X. (2019). *A Board Game to Teach Team Composition in Software Startups.* Paper presented at the International Conference on Software Business.

Mishra, D., & Mishra, A. (2008). A study of software process improvement in small and medium organizations. In *Software Process Improvement for Small and Medium Enterprises: Techniques and Case Studies* (pp. 140-157): IGI Global.

Mosey, S., Guerrero, M., & Greenman, A. (2017). Technology entrepreneurship research opportunities: insights from across Europe. *The Journal of Technology Transfer, 42*(1), 1-9.

Nuar, A. N. A., & Abd Rozan, M. Z. (2019). *Benefits of computational thinking in entrepreneurship.* Paper presented at the 2019 6th International Conference on Research and Innovation in Information Systems (ICRIIS).

O. Nyumba, T., Wilson, K., Derrick, C. J., & Mukherjee, N. (2018). The use of focus group discussion methodology: Insights from two decades of application in conservation. *Methods in Ecology and evolution, 9*(1), 20-32.

O'Neill, D. J. C. (2012). Extending the Range of Value of the CMMI To a New Normal. 25.

Packard, M. D. J. J. o. B. V. (2017). Where did interpretivism go in the theory of entrepreneurship? *, 32*(5), 536-549.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., Hoagwood, K. J. A., . . . research, m. h. s. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *42*(5), 533-544.

Paternoster, N., Giardino, C., Unterkalmsteiner, M., Gorschek, T., & Abrahamsson, P. (2014). Software development in startup companies: A systematic mapping study. *Information and Software Technology, 56*(10), 1200-1218.

Peterson, J. S. J. G. C. Q. (2019). Presenting a qualitative study: A reviewer's perspective. *63*(3), 147-158.

Patton, M. (1990). Qualitative evaluation and research methods (pp. 169-186). Beverly Hills, CA: Sage.

Pollock, N., Chapple, D., Chen, S., & D'Adderrio, L. J. J. o. M. S. (2022). The Valorising Pitch: How Digital Start- ups Leverage Intermediary Coverage.

Porter, M. E., & Heppelmann, J. E. J. H. b. r. (2015). How smart, connected products are transforming companies. *93*(10), 96-114.

Quezada-Sarmiento, P.-A., Enciso, L., & Garbajosa, J. (2016). *Use of body knowledge and cloud computing tools to develop software projects based in innovation.* Paper presented at the 2016 IEEE Global Engineering Education Conference (EDUCON).

Quezada-Sarmiento, P. A., Enciso, L., Mayorga-Diaz, M. P., Mengual-Ándres, S., Hernandez, W., Vivanco-Ochoa, J. V., & Carrión, P. V.-T. (2018). *Promoting innovation and entrepreneurship skills in professionals in software engineering training: An approach to the academy and bodies of knowledge context.* Paper presented at the 2018 IEEE Global Engineering Education Conference (EDUCON).

Quezada, P., Enciso, L., & Garbajosa, J. (2015). Using tools of cloud computing for defining, planning, monitoring innovation projects and knowledge generation [Uso de herramientas de computación en la nube para definir, planificar, controlar proyectos de innovación y generación de conocimiento](2015) XI Jornadas Iberoamericanas de Ingenieria de Software e Ingenieria del Conocimiento. In: JIISIC.

Rehman, N. U. (2012). *Relative performance of SMEs: A case study of software firms in Islamabad/Rawalpindi regions.* University of Glasgow,

Rehman, N. U. (2014). OBSTACLES TO THE GROWTH OF SMALL SOFTWARE FIRMS IN ISLAMABAD. *Indian Journal of Commerce and Management Studies, 5*(2), 47.

Rehman, N. U. (2015). Drivers of firms' growth: a case study of software firms in Islamabad/Rawalpindi regions. *Journal of Management Development*.

Rocha, A. R., Zabeu, A. C., & Machado, C. F. (2018). *MR-MPS-SW: 2016 and CMMI-DEV v2. 0: An initial experience of harmonization.* Paper presented at the Proceedings of the 17th Brazilian Symposium on Software Quality.

Rose, J. (2012). Software Entrepreneurship: course notes, Department of Computer Science, Aalborg University.

Rusu, A., Rusu, A., & Elliott, R. (2006). *Work in progress: Smoothing the border between academic and professional software engineering environment through entrepreneurship.* Paper presented at the Proceedings. Frontiers in Education. 36th Annual Conference.

Saarikko, T., Jonsson, K., & Burström, T. (2019). Software platform establishment: effectuation and entrepreneurial awareness. *Information Technology & People*.

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., . . . Jinks, C. (2018). Saturation in qualitative research: exploring its conceptualization and operationalization. *Quality & quantity, 52*(4), 1893-1907.

Sharma, R., Dadhich, R. J. J. o. D. M. S., & Cryptography. (2020). Analyzing CMMI RSKM with small software industries at level-1. *23*(1), 249-261.

Shylesh, S. (2017). *A study of software development life cycle process models.* Paper presented at the National Conference on Reinventing Opportunities in Management, IT, and Social Sciences.

Siepel, J., Camerani, R., & Masucci, M. J. S. B. E. (2021). Skills combinations and firm performance. *56*(4), 1425-1447.

Sivashankar, M., Kalpana, A., & Jeyakumar, A. E. (2010). *A framework approach using CMMI for SPI to Indian SME'S.* Paper presented at the 2010 International Conference on Innovative Computing Technologies (ICICT).

Smit, B., & Onwuegbuzie, A. J. (2018). Observations in qualitative inquiry: When what you see is not what you see. In: SAGE Publications Sage CA: Los Angeles, CA.

Spiezia, V. J. O. J. E. S. (2011). Are ICT users more innovative?: an analysis of ICT-enabled innovation in OECD firms. *2011*(1), 1-21.

Suominen, A., Hyrynsalmi, S., Aarikka-Stenroos, L., & Seppänen, M. (2017). *Are software start-ups different? An empirical study on performance of Finnish software companies.* Paper presented at the 2017 International Conference on Engineering, Technology and Innovation (ICE/ITMC).

Temizkan, O., & Kumar, R. L. J. J. o. M. I. S. (2015). Exploitation and exploration networks in open source software development: An artifact-level analysis. *32*(1), 116-150.

Theriou, N. G., Aggelidia, V., & Theriou, G. (2009). A theoretical framework contrasting the resource-based perspective and the knowledge-based view.

Vidgen, R., & Wang, X. J. I. S. R. (2009). Coevolving systems and the organization of agile software development. *20*(3), 355-376.

Voskoglou, M., & Buckley, S. J. E. C. S. J. (2012). Problem Solving and Computers in a Learning Environment 2. The PS process: A review. *36*(4), 28-46.