Strategies to Overcome Requirements Engineering Challenges in Distributed Scrum Teams

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Thesis submitted in partial fulfilment of the requirement for the degree of Master of Business Administration in Information Technology

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DECLARATION

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ABSTRACT

Requirements are the needs and want of a customer and or a user group, expressed in a formal set-up. They are inevitable in any software and should be managed extensively, to prevent product/project being failed. Requirement management in scrum projects has a significant difference to that of the traditional approach.

This research discusses Requirement Engineering challenges seamlessly occur in Scrum offshore teams. An initial survey was carried out to identify the most challenging factors affecting the Requirement engineering process and it was followed by a survey reaching the software professionals. The challenges identified in the literature review and the pre-survey are same. Therefore, the study was designed to further investigate the matter with three factors that are affecting the success of the business analysis function.

The methodology used for the survey is an online based questionnaire. The population considered for the survey is software professionals in distributed Scrum teams. Sri Lanka is becoming an offshore development destination. Over 30,000 software professionals are employed in Sri Lanka, and the majority are engaged in offshore development. Therefore, a sample of 376 is drawn from the population for further proceedings.

The present study revealed that Scrum requirement process and the soft skills are statistically related to the entire requirement management process in a team. This emphasizes that the method adopted in the team has a direct impact on the requirement analysis. Soft skills produced by the team members are highly contributing to the effectiveness and the productivity of the requirement management.

This research highlights important factors to consider in formulating requirement management plans. Requirements have to balance two extremes of expectations; expectations of the fellow team members on receiving comprehensive clear documentation and the expectations imposed by the development method. Organizations should incorporate suggested changes to the requirement management process depending on the suitability of the organizational culture and standards.

Keywords: Requirement engineering, Scrum, documentation, offshore development, business analysis

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LIST OF ABBREVIATIONS

Abbreviation	Description
IT	Information Technology
RE	Requirements Engineering
XP	Extreme Programming
BABOK	Business Analysis Body of Knowledge
LR	Literature Review

1 INTRODUCTION

1.1 Overview

The trends in the Information Technology (IT) industry regarding software development change over time. The first widely accepted model for software development life cycle was Waterfall. The requirement stage is the initial phase of the waterfall model (Gavrilova et al, 2006) and the model moves from one phase to the other after completing the preceding step. Waterfall Model avoids iterations and overlaps of the phases. The model is capable of creating a standardized process for software development. The waterfall model invented in the 1970s' brought structure to software development that relied highly on unstructured development approaches before the introduction of the model (Hasan, 2011).

Waterfall Model best suited when the requirements are finite and the entire scope can be developed at once. The massive upfront design, comprehensive documentation, and incapability to handle dynamic requirements are highlighted as the major disadvantages in the waterfall model (Larman & Basil, 2003). The incorporation of changes to the scope is limited in the Waterfall model after the confirmation of requirements. The later iterations of the Waterfall model increased the ability to change requirements after the confirmation but still does not allow significant changes to the requirements (Gavrilova et al, 2006). The complexities in software development have increased over the years due to technological improvements. Waterfall Model did not respond to the demanded changes in the software life cycle as a result of it.

Agile Software Development emerged as a result of an application development crisis caused by the time gap between the project's commencement and delivery. The time lag between development commencement and customer delivery was estimated to be three years on average. The need for the software has changed massively to the extent of rejecting the project halfway during this long delivery time. The impact of the time gap has further increased with the development of the World Wide Web. The go-to-market timing needed to be reduced due to increased competitiveness in the commercial market (Schmidt, 2016).

The Agile Manifesto was the resulting outcome of expert discussions carried out in 2001. The focus was a lightweight software development process over a rigid, documentation driven, heavyweight software process. Agile Manifesto was an alternative to the software development challenges during the era. This was based on 12 principles to support four values. The four values were expressed in the format of X over Y (Ambler & Lines, 2012). The twelve principles in the manifesto promote close collaboration with customers, late requirement changes, deliver working software frequently, etc. (Martin, 2014).

The Agile framework has gained popularity among the industry, and methodologies inheriting agile principles, Scrum, Lean, and Kanban Software Development, Extreme Programming, Feature - Driven Development, etc. emerged as a result of it. Scrum is the widely used agile development methodology, with 94% of agile practitioners using Scrum. 78% of the agile practitioners that follow Scrum use it with other methodologies like Kanban and Waterfall. Only 16% uses Scrum exclusively. Scrum is widely accepted due to its ability to increase customer value. The high responsiveness, flexibility and continuous improvement to work life are the key factors considered when adopting Scrum for a software project (Scrum Alliance, 2018). However, according to the 12th annual report of VersionOne, Scrum is the widely accepted and used agile methodology representing 56% of the agile practitioners across the globe (VERSIONONE, 2018). Therefore, RE must align with scrum practices, to experience the best outcome of scrum and RE.

The prime challenge in software projects is the distance between the development team and the client. Requirements Engineering (RE) and requirement management become even more difficult due to lack of communication with clients and other stakeholders that occurs as a result of it (Wagner, Méndez Fernández, Felderer, & Kalinowski, 2017). Agile Manifesto suggests working closely with the client to achieve a common objective and to produce quality software. The close collaboration with the client and the development team allowed by Agile is a significant factor for choosing it as the software development framework. Requirement errors due to miscommunication are resolved in agile projects (Omair & Carlsson, 2008).

The poor project management and lower customer satisfaction that lead to project failures are a result of poor RE. According to the report of PMI 2017, 39% of the projects fail due to inaccurate requirements (PMI 2017 Pulse of the Profession In-Depth Reports: Organizational Agility Increases Project Success Rates, 2017). Accurate requirements facilitate accurate project planning, on-time delivery, accurate test planning, and overall project management. The requirement sources and managing requirements during the project life cycle contributes to the success or the failure of a project (Lehtinen, Mäntylä, Vanhanen, Itkonen, & Lassenius, 2014).

1.2 Motivation

Every software has requirements that are either documented or undocumented, but still, all the requirements have to be captured in a non-systematic approach. RE is the systematic process of determining user expectations for a new product or an existing product that requires modifications. The process of RE varies according to the company, project, team, and soft skills of the personnel involved in the process.

RE process needs frequent communication with clients and system users to identify expectations for each feature, objectives, and purpose of using the feature, and to resolve conflicts of requirements' changes among various user groups that arise due to changes in priority. The uncontrolled extension to the product or the project without adjusting the time, cost, and resources are referred to as the Scope Creep (PMBOK®Guide, 2017). Scope creep increases the project volume with uncontrolled requirement changes. The delivery time and the project direction are affected by the scope creep. Reasons for scope creep varies from project management inefficiencies to shortcoming in communication among parties involved with the project. The scope creep should be effectively managed to avoid delays and unexpected costs in projects. As a remedy for the scope creep, documentation of all aspects of the project from start to the end is a vital aspect to conforming to the client needs (Jamal, 2014). Out of scope components required to be explicitly stated to avoid negative impacts from the scope creep (PMBOK®Guide, 2017).

All agile methodologies including Scrum encourage lean documentation and attempt to avoid descriptive functional documents as much as possible. The drawbacks of lean requirement documents include (Bartlett.J, 2017);

1. The assumptions made during the developments will be inaccurate
2. No evidence of customers' consent and approval on requirements
3. Testers have less supportive documents to test, they do not know what to test
4. Lack of traceability in later stages, deteriorating document quality, etc.

Business analysts (BAs) are often challenged to strike a balance between scrum principles and documentation needed to develop the project. User stories, the popular documentation method in scrum is not providing expected outcomes. Challenges of user stories include the following aspects according to (Majchrzak & Madeyski, 2016), and (Gilson & Irwin, 2018)

1. Acceptance criteria are not precise
2. Fewer details, business rules are not included leading to underestimations
3. Only the user perspective is captured, and information is missing in user stories, etc

Over the years, researches and practitioners were trying to come up with a framework/methodology to overcome challenges in the evolving IT environment, but the industry experiences gap in their established processes compared to the expected outcomes of scrum requirement engineering. The attempt of this research is to look into the challenges in a BA's perspective together with insights from project managers to ease the management of the overall project.

1.3 Objectives

The research has four objectives.

1. To identify prevailing key challenges in RE in offshoring scrum teams.
2. To analyze existing techniques, tools and processes to overcome challenges in scrum RE.
3. To identify failure factors in the RE process of offshoring scrum teams that have a direct impact on the project failures and are practically existing in the current context.
4. To provide recommendations to reduce challenges in requirement aspects of offshoring scrum teams.

Objective 1: To Identify key challenges in RE in offshoring scrum teams.

The main objective of the research is to identify the key challenges that create limitations in the requirement analysis process. Offshoring teams operate in remote locations and the team doesn’t meet the customer regularly. Thus, offshoring and On shoring teams have own specific challenges with respect to the requirement management process. The challenges in offshoring emerge since the customer does not reside in close proximity to the development team, communication problems due to time differences and lack of domain expertise in Sri Lanka (or the development country), etc. (Sauer, 2006). Existing knowledge provided by worldwide researches will be used in achieving the objective 1.

Objective 2: To analyze existing techniques, tools and processes to overcome challenges in scrum RE

The industry is blessed with many open and closed source tools to reduce the challenges in requirement management. Despite the positive outcomes generated by new tools and techniques, there are limitations too. These limitations cannot be eliminated completely, but can be managed by better planning of alternatives (Aguilar et al., 2015). Researches have been carried out in the direction of existing tools analysis, and prevailing studies will be used in achieving the objective 2.

Objective 3: To identify failure factors in the RE process of offshoring scrum teams.

Failures in the RE affect project delivery, budget, and resource utilization. Project success depends on accuracy (Lehtinen, Mäntylä, Vanhanen, Itkonen, & Lassenius, 2014). Each software project has unique problems associated with requirements, therefore the third objective is to identify the most relevant and common problems in the industry. The factors identified in objective 1 would be prioritized based on the hands-on challenges identified in objective 3.

Objective 4: To provide recommendations to reduce challenges in requirement aspects of offshoring scrum teams.

The ultimate objective of the research is to propose strategies to overcome RE challenged that can be easily adopted within scrum teams. The proposed strategies should not be threatening the practices existing today. Proposed strategies should not be a burden nor should be complex to understand. The challenges identified in this research have to be addressed by a strategic plan and they would enhance the traceability, validity, and unambiguity of requirements.

1.4 Research Significance

The software development industry is growing exponentially with new technologies, tools, and methods. Development teams are expected to work with customers in close collaboration. Unlike in traditional development processes, Agile emphasizes lean documentation and iterative development. In many IT companies, the Business Analyst role is assigned and shared among non-BA members in the team thus, developers, and testers are entrusted with requirement gathering and elicitation. In such contexts, a Business Analyst can be any person in a team who performs the business analysis tasks, despite the job title (International Institute of Business Analysis, 2015). Scrum teams need high caliber persons to join with their development teams as SCRUM avoids complex documentation, but the backlog has to be maintained and followed thoroughly.

This study will evaluate the challenges in SCRUM RE associated with off-shore development. Off-shore development has the key risk of the customer being in a separate geographical area, which in turn creates communication barriers. As the challenges were identified a few years ago, the tools should have been emerged to address problems. However, still the companies have not been able to completely eliminate their RE problems.

The knowledge gathered during this study will add value to the existing research pool with regard to RE. The main benefit is that BAs, Project Managers, and any other relevant party can consider adopting strategies proposed to overcome challenges encounter in requirement management.

1.5 Research Challenges

RE is a vastly distributed area, starting from collecting information from users and business owners until the product being handed on to customer's hands. Well captured and documented requirements assist the software companies in the long run but agile methodologies promote fewer documents. The agile manifesto is focusing on "Working Software Over Comprehensive Documentation" (Larry, 2015). To gather data from relevant parties either involved or interested in requirements and those who are associated with SCRUM needs to identify companies using SCRUM as the development methodology. Companies having alliances with SCRUM are difficult to identify, as many companies use hybrid approaches in their projects.

Identifying the correct sample size is another constraint as a clear demarcation should be determined to differentiate software professionals with a scrum experience. Even though the study provides guidelines and a framework to operate in a SCRUM environment and manage requirements, it's doubtful whether the results can be generalized into every software project. Due to the complexities and the scale, the framework might not be appropriate to use in a few contexts. The success of the current study depends on the benefits that the industry would be gaining with the research findings and the strategies proposed. Software professionals are reluctant to read research papers and therefore the final outcome should be published in any other way, to reach the interested parties.

2 LITERATURE REVIEW

2.1 Overview of the chapter

The literature review chapter discusses the current knowledge and findings related to the Scrum requirement engineering practices and challenges.

2.2 Agile Software Development Process

The software development process can be defined as a set of interconnected activities that produce a software product, which may be different from one product to another based on the nature, domain, technology, and stakeholders of the software. Activities of software development can be granule into three; Requirement definition, the implementation that includes design, coding and testing, and modifications for the delivered product(Schmidt, 2016).

In delivering software, various practices have been used in the industry and during 2000, the time taken to go-to-market has been the priority in software development. According to (Schmidt, 2016), the new start-ups were shown up in the industry and the pressure on delivery time had been increasing along the way. Responding to the demand in the industry and also in addressing various issues faced by the project teams with the use of traditional practices have been led to the emergence of Agile. Agile is not a development practice itself but the term serves as the “umbrella” for many methods. Key methods in agile are;

1. Scrum: Scrum is an iterative approach based on ‘Sprints’ which would be having a shorter time span. The average length of a sprint is 2.4 weeks (Scrum Alliance, 2017). According to (Permana, 2015), there are three key roles in the Scrum practices: Product owner who is responsible for managing requirements, Scrum master ensuring the project is in line with scrum methodology and the Team; consisted of developers, business and system analysts’ designers etc.
2. Xtreme Programming: XP tends to achieve higher quality software and higher quality in the lives of the development team. However, XP is difficult to incorporate into a complex environment (Dybå & Dingsøyr, 2008). In XP programming, the customer is considered as a team member and if the

customer sits with the development team it is considered to be the best art, (Winter, 2014).

3. Lean software development: Lean is a term referred to Toyota manufacturing processes, and those are incorporated into software development. The concept is built based on eliminating waste, respect people, fast and flexible, focus on time etc. (Poppendieck & Poppendieck, 2013).
4. Feature driven development: FDD is a "client-centric, architecture-centric, and pragmatic software process", which considers the 'feature' to be the most important aspect of the project.
5. Dynamic software development method: DSDM focusses on delivering the right business solutions at the right time. Atern is the current version of DSDM and is more concerned about project management and delivery (Craddok, Richards, Tudor, Roberts, & Godwin, 2008).
6. Crystal methodologies: which is introduced by Alistair Cockburn, is a set of methodologies that places people and their interaction with the system at the core.

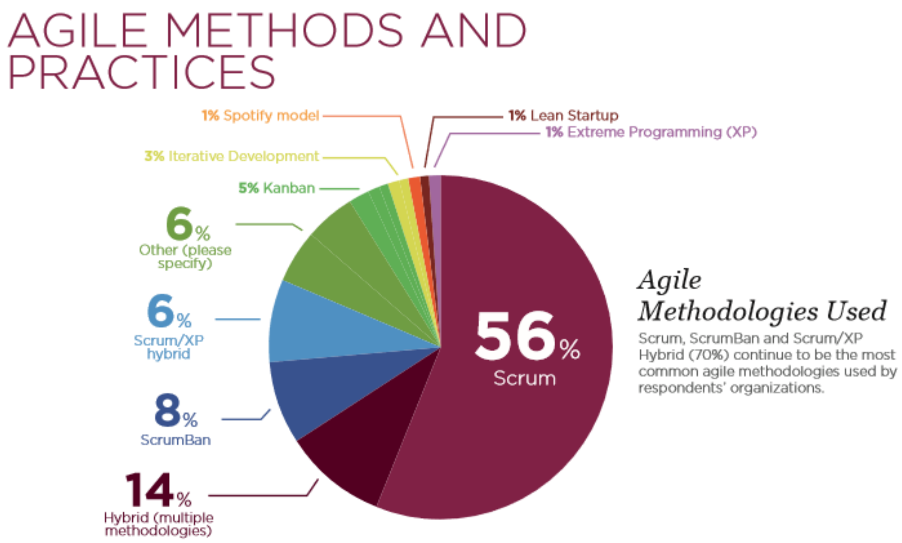

Figure 2-1: Mostly used agile processes, Source: (VersionOne® Releases 12th Annual State of Agile Report., 2017.)

Among the widespread processes practiced by many IT companies, SCRUM ranks number one. SCRUM is the most widely used agile methodology with over 70% uses scrum alone or mix with other methodologies (refer Figure 2-1: Mostly used agile processes, Source: (VersionOne® Releases 12th Annual State of Agile Report., 2017.).

2.3 Requirements engineering

The BABOK definition of requirements engineering is "a process that establishes a structured approach for requirements development and management and is used in predictive, adaptive, and agile environments." (International Institute of Business Analysis, 2015). Requirements engineering is also viewed as the process of eliciting stakeholder requests and develop them into detailed requirements that are used in software development activities (Jin, 2018).

2.4 Importance of requirements engineering

Effective management of requirements is a competitive advantage that saves money, time, and effort. The organizations that embrace requirements engineering as a part of the software development process are benefitted by less reworking, reductions in the testing period, and improved traceability. (Coventry, 2015), published the importance of requirements engineering as quality improvements, cost minimization, decrease the delivery time, low risk, and enhanced scope management.

2.5 Factors affecting agile requirements engineering

Agile is based on 12 key assumptions and some are not compatible with offshore development. (Turk, 2005) identified assumptions that are affecting the requirement engineering process that affects agile development.

Assumption 1: Customers are co-located with the development team and are readily available when needed.

Agile development relies on face to face communication with the customer and therefore the customer has to be located in close proximity to the development team. (Turk, France, & Rumpe, 2014) Communication through Skype, emails and other distant communication methods are not entertained by the agile development as the potential risk of miscommunication and misunderstandings are higher than face to face communication. Since the agile concept is developed based on this assumption, offshore development companies have challenges in encouraging face to face communication due to the distance of the customer and the team.

However, requirement accuracy and reliability improves by frequent communication with the client. Communication effectiveness depends on the writing styles, technology and time zones. Offshoring teams are disturbed by the time differences of the client location and team. Thus, a delay in communication occurs by the emails and waiting for other communication channels to exchange ideas in cross-site team members (Damian & Zowghi, 2014). This lead to increased waiting time for clarifications of unclear requirements, feedbacks, and approval.

Some offshore development companies send their entire or partial development team to the client site to bridge the gap between communications. This incurs a higher cost to the development company. Some companies address the issue by encouraging video conferencing, periodic Skype video calls and client meet-ups at the development premises as often as possible.

Assumption 2: Software requirements change during the time of software is being developed.

One of the agile principles requires the development teams to welcome changes even in the last stages of the development. Whereas conventional approaches, requirement changes are discouraged until the current development phase is completed (Boehm, 1981; Royce, 1970; Petersen & Wohlin, 2010). The emphasis is to enhance customer satisfaction by addressing their needs as they emerge. However, development teams must be adaptive and supportive in delivering the changes and should demonstrate the willingness to re-engineer the code.

This approach is not best suited for projects with a fixed price. The time spent on developing a requirement goes in vain when the new changes are adopted without any further revision of pricing and may be resulting in major code changes in other functionalities too. As a result, team members are frustrated and demotivated by reworking on the same areas developed before.

Assumption 3: Creating extensive and complete documents and models are less productive.

The main assumption in Agile is that the code has built on the requirements and by reading the code everyone can understand the current requirement. However, the assumption is made without considering that everybody cannot read the code and understand, and it consumes a considerable time to read and understand what is written in the code compared to a document.

Large complex projects with a long-life span might require proper documentation to track the changes and reduce the cost and timing needed to determine the impact of the project. Lack of documentation will bring long term effects, as documents are widely used for knowledge sharing purposes. (Paetsch, Eberlein, & Maurer, 2003)

According to (Paetsch et al., 2003) documentation prevents the knowledge loss and enhance the knowledge sharing when a new team member joins with the team, as a good document provides a detailed description of the work. However, it is assumed in agile principles that fellow team members can share their knowledge whenever needed but knowledge sharing has an impact on the time constraint.

2.6 Agile Requirement Engineering Challenges

Requirement Engineering in Agile is dependent on customer availability and involvement. However, budget limitations, time, and distance limit frequent meet-ups with customers (Heikkil, Paasivaara, Lassenius, & Damian, 2015). Internal teams are expected to work in collaboration, but many teams complain of open dialogues between team members and cross-operational teams. Communication gaps between internal teams and the client cause a rush in requirement completion without being considerate of the real needs of the requirement (Wagner et al., 2017).

Requirements privatization in agile teams is an important factor to succeed in the development and on-time delivery of the deliverables. Clients provide conflicting prioritizations over the time period (Wagner et al., 2017). The prioritized requirements should fit into the development stream in term of time, cost, and effort. Thus, prioritization has to be firmly negotiated with the client.

Simple user stories for requirement documentation for complex systems are not scalable enough. However requirements are considered to be precise when agile methods are used, due to scope for requirements are reduced in an iteration(Petersen, 2012). Employee turnover is a limitation in agile requirement engineering as most requirements knowledge is tacit.

Software architecture is dependent on the quality of requirements analysis. Faulty architecture is a result of understated requirements. Scrum teams often encourage in short time spans which is also applicable for requirements analysis and grooming. Thus non-functional requirements are given less attention, leading to end user dissatisfaction and frustration. The main contributor to non-functional requirements is: relying on the experience and inability to make a solid communication to derive the idea from the client (Wagner et al., 2017). Most of the challenges in Agile can be generalized to SCRUM practices as well.

2.7 Challenges specific to Scrum Requirement Engineering

Major product technologies obsolete in two years, and a development company cannot take a too long time to develop the software. According to (Pries & Quigley, 2011), SCRUM brings a new dimension to software development, where both customer and developer learn new facts about the product during implementations.

Backlogs are key elements in SCRUM practices. All Agile methodologies including SCRUM are reluctant to comprehensive documentation, and thus backlogs are created instead of documentation which will list stakeholder interests and requirements (Mueller & Oyeyipo, 2011). Product backlog, which contains change requests, bugs, and new developments are the basis for SCRUM meetings to allocate tasks in the sprint. (Cristal, Wildt, & Prikladnicki, 2008) highlighted that product backlog is the place that teams can see the entire requirement list that is pending still, and they are sized according to the complexity or number of hours.

Once a sprint is formed, each development team maintains a Development Sprint Backlog, which has all the requirements given to the development team. Requirements in development sprint backlogs are decomposed into smaller requirements (Vlaanderen, Jansen, Brinkkemper, & Jaspers, 2011). In each backlog item, a small sentence describes the requirement, and it doesn't give the full picture of the requirement. This may lead to prioritization errors and delays in deliveries.

These shows, requirements are the first place in any software project management approach, and they have to be clear and concise. Few challenges were identified by (Cristal et al., 2008)with respect to requirement engineering in SCRUM ;

1. Lack of formal document for requirements in the planning phase.

If a trained BA is not utilized to capture the requirement, the development team may not be able to identify the need in a business perspective. Sometimes the requirement documents remain unsigned and unapproved due to the lack of management support in pursuing the requirements sign-off.

2. Communication issues in the development phase

Developers are expected to communicate with clients during the development phase. Most developers are reluctant to speak to a client. Even though the developers communicate with business owners and system users, the ability to explain a problem or a solution in an understandable manner is lacking. The use of technical terms will help neither developers nor clients.

3. Poor business commitment to agree on requirements

If the client resides outside the development team's country, teams experience difficulties in signing-off the requirements. Therefore, teams cannot identify the correct requirements at the development stage and developers have to raise clarifications after commencing the development work.

Scrum teams working in a distributed environment will increase the need for documentation (Fowler, 2012). This is mainly due to customers and the team are not collocated, hence face to face communication rarely takes place.

Unlike in traditional software development processes, the product backlog at the beginning of the project contains only high-level requirements, with little information. As the project progresses, these requirements become precise during sprints. (Düchting, Zimmermann, & Nebe, 2007). Sometimes the product backlog is the only source for requirements. In the development process, the team considers best-understood requirements and later-on the requirements will be more clarified and evolved with changes. Therefore, product backlog does not contain a finite list of requirements and it will be changing throughout the project time. (Bannink, 2014).

Moreover, the usage of the product backlog is not clear in handling requirement changes. Some organizations directly use the product backlog whereas others make changes on the requirement specifications and directly work with the change request without updating the backlog (Wagner et al., 2017).

A development sprint length lasts for 2.4 weeks on average (Scrum Alliance, 2017) and during this limited time capturing and finalizing the entire requirement beforehand development starts is challenging to the development team. The team spends considerable time in the sprint to understand the user experience (Sutherland, 2005). However (Maccormack, Kemerer, & Crandall, 2003) has observed the importance of finalizing functional requirements before the start of the development.

2.8 Generic challenges specific to offshore development

The current trend in Europe and America is to outsource its IT projects to countries like China, India due to the increased cost saving. The number of offshore developments is increasing as companies are now more willing to outsource their IT projects. Few reasons have been identified in the Global Outsource Survey (2016), such as Cloud Computing that enables remote working, innovation, and business enablement that drives the company towards competitive advantage and etc.

Due to the distance between the client and the development team and also due to the conflicts in cultures, the following issues have been identified by Kliem.R (2004), (Sauer, 2006), (Marambe, 2014)

1. Transforming instinct diversity into synergy is highly challenging resulting in risks such as unclear responsibilities, unmanaged conflicts, and less interacted team members. Considering requirement engineering, it is hardly recognized who is responsible for requirements, as the customer and the development team must collaborate in defining the requirement for the product.
2. Managing communication between two parties, due to differences in the native language, the body language and even ideas may drive miscommunication and misunderstandings. Therefore, the projects involving parties from two or more countries are often at risk of poor information sharing leading into incorrect decisions. This has a high impact on RE activities, as it relies on effective communication.
3. The goal of SCRUM practices is to find solutions with the support and participation with the client and his team. Offshore development challenges this goal because finding a collaborative solution is even more difficult due to "differences in values and perceptions"
4. "Slow learning curve and inability to agree on priorities" due to cultural differences form a prevailing barrier to the requirement engineering process. Cultural differences are leading to misinterpretations of the requirement as the development team would not understand the context in which the business and the practicality of the customer needs.
5. Reduced motivation in the development team, as the business (customers), is located in another country and therefore relationship building at the personal level is not as strong as inshore development.

Offshore development has specific risks and limitations, especially when the teams are located in different time zones. Therefore, offshoring teams are challenged with requirements analysis across continents. However, developing requirements in the formulation phase narrow down the risks, but this is against SCRUM practices.

2.9 Existing and Proposed Methodologies/tools and frameworks

The requirement analysis process has consisted of techniques and tools to facilitate traceability. This section will provide a brief description of the tools and techniques available in the current context and the associated risks, advantages and disadvantages.

2.9.1 Requirement Elicitation techniques

The process of collecting expectations and needs for an anticipated system from end users, customers and other various stakeholders is called as the requirement elicitation or mostly known as requirements gathering. Brainstorming, Document Analysis, Focus Groups, Interface Analysis, Interviews, Observation, Prototyping, Requirements Workshops, Survey, and Questionnaire are the few approaches identified by BABOK 3.0 for BAs to follow in requirement elicitation process (International Institute of Business Analysis, 2015).

During the process of requirements elicitation, the team is expected to identify domain requirements which will be comprised of, the environment that the system is expected to operate, services that system should provide and the limitations, government regulations or business rules prevailing for the domain.

However, there are 5 main categories of requirement engineering (Nuseibeh & Easterbrook, 2000). Traditional Techniques use conventional elicitations such as interviews, surveys, domain analysis and etc. Cognitive techniques include Repertory grids, card sorting, and laddering and protocol analysis. Modern and Group Elicitation Techniques uses many of the BABOK approaches. Contextual Analysis considers personal goals and contexts, with the effect of time on personal requirements. It uses techniques such as ethnography and observation. Observation is not compatible with every company when its customers are in another country.

Table 2-1: Use of elicitation techniques (Source: Aguilar,2015)

Method	Interviews	Questionnaire	Observation	Prototyping	Brainstorming
NDT	✓	X	x	x	✓
UWE	✓	✓	x	✓	x
WebML	✓	X	x	x	x

Requirements are unrevealed due to misconceptions and assumptions made by the team. Thus, the end output could be missing important features and also could be limiting the usage of the system. Thus, misconceptions and assumptions should be avoided in the requirement elicitation level, therefore requirement elicitation is an important step in requirement analysis. The elicitation techniques differ according to the method employed in the project. In model-driven web engineering (MDWE), techniques such as UML Web Engineering (UWE), Web-Based Modeling Language (WebML), and Navigational Development Testing (NDT) allows to use the interview in all three methods but questionnaires are compatible with UWE only. (Aguilar et al., 2015) tabulated the elicitation methods used in MDWE. According to Table 2-1, interviews are the mostly used elicitation technique and observations are not used.

2.9.2 Requirement Prioritization

Software projects have consisted of an elaborated and non-elaborated set of requirements. Time constraints, budget, market readiness and urgency are some of the factors that limit the ability to develop all the requirements (Qaddoura, Abu-srhan, Qasem, & Hudaib, 2017). Scrum teams are following an iterative approach and a sprint can only contain requirements that will fit into the time box. Thus, requirement prioritization is a major activity in the requirements engineering process thriving for excellence. Over the years, prioritization has been discussed significantly. The approaches that are currently used by the software companies are AHP: Analytical hierarchical process, Bubble sort, Binary search tree, Minimal spanning tree, Priority groups, Moscow, Win-win, and Quality functional deployment.

The existing techniques were measured in the means of scalability, complexity and granularity by (Berander & Andrews, 2005) and are presented in Table 2-2: Analysis of a few techniques (Source: Andrews, 2005).

Table 2-2: Analysis of a few techniques (Source: Andrews, 2005)

Technique	Scale	Granularity	Easiness to use
AHP	Ratio	Fine	Very Complex
Hundred-dollar test	Ration	Fine	Complex
Ranking	Ordinal	Medium	Easy
Numerical Assignment	Ordinal	Coarse	Very easy
Top - Ten	-	Extremely Coarse	Extremely easy

According to (Achimugu, Selamat, Ibrahim, & Mahrin, 2014), AHP is the most cited requirement prioritization technique. AHP compares hierarchically organized requirement pairs and determines the highest priority. If the number of requirements is n, there will be n * (n-1)/2 comparisons. AHP is not scalable when the number of comparisons increases due to the project complexity (Berander & Andrews, 2005). The prioritized result will not be productive if the number of requirements is more than ten (Lehtola & Kauppinen, 2004).

(Asghar, Tabassum, Bhatti, & Jadi, 2017) proposed a requirement prioritization methodology based on cost, value, risk, time to market, functional and non-functional requirements. The methodology proposed is a 7-step approach starting with cumulative voting from each stakeholder for each requirement. Second step groups the requirement based on factors such as value, risk, complexity etc. Next, the groups are prioritized based on the number of points according to requirements and applying the analytical hierarchical process (AHP) the requirements are identified as top 10 priorities. This technique has certain limitations including, getting stakeholders to vote for the requirements according to the importance, and the time and effort consumed to complete the entire methodology.

Relative weighting is another approach for prioritization (Cohn, 2006) describes the relative weighting process as an approach that asses the user story in two aspects; assessing the impact of having the user story, and assessing the impact of not having the user story in a scale of 1-9. Relative weighting calculates the value of the story relative to the entire product backlog and the estimated cost of developing each story. However, all the stakeholders do not participate in the value generating process, therefore the team would be inconsiderate of a very important story due to lack of business sense in the respective domain.

2.9.3 Requirement Specification: Tools, Models and Techniques

A software requirement specification (SRS) is a description of a system that needs to be built. The SRS enlists all the elements needed in delivering the software including both functional and non- functional requirements. The SRS is expected to contain a rigorous assessment and clear statements of system deliverables and non-deliverables. SRS acts as an agreement between the project team and the customer about the way that the system will be built.

MS Word serves as the basis for specifying details gathered in Requirement Elicitation phase. However, due to the changing nature of requirements, MS Word is not the optimal solution for SRS. Word is unable to capture and trace requirement changes and thus needs more manual work when a requirement change is needed.

The market now provides many solutions to overcome the problems mentioned above, featured with automatic tracking of changes and requirement smells. Such commercial tools are Process Street, CASE Spec and Abacus.

Following practices have been identified by researches to reduce ambiguity, inconsistency and misunderstandings of requirements.

1. Structured Natural Language documentation: The requirement is written in natural language that can be read and understood by anyone but in a more structured and standardized form. (Cooper & Ito, 2002) has identified a formalized notation for structured natural language specifications. This has been helpful in reducing common requirement problems.
2. Use of requirement management tools that helps acquiring, specifying, grouping, and attribution of newly captured raw requirement. Requirement management tools support traceability to a greater extent and also supports changes of specifications in the meantime(Hoffmann & Kuhn, 2004).

Documentation is the vital aspect in the requirement specification, which could be cumbersome in larger complex projects as requirement changes are more likely to occur during the implementation stage and after the project delivery. According to (Hoffmann & Kuhn, 2004), following are the key attributes that a requirement management tool must provide for documentation.

1. A track of all changes made to the requirement
2. Versioning of objects
3. Automatic increment of version numbers when changes are made
4. Availability of changes and old requirements
5. Reversing of a changed requirement to a previous requirement at any given time

The market offers many requirement management tools but their usability depends on a few factors such as price, features provided and the scalability of the available features with the current requirement management process. (Wieringa & Ebert, 2004) have identified widely used tools, features that are ranked from the most relevant, and a comparison of their primary costs and are reflected in Table 2-3.

Table 2-3: Comparison of tools (Source: Wieringa, 2004)

Tool	**Supplier**	**Key features and the tools ranked from the most relevant**	**Entry-level cost**
Caliber-RM www.borland.com	Borland	Lifecycle-oriented, large systems, traceability TestDirector, Borland Star Team, MS Project	High
CARE(Computer-AidedRE) (www.sophist.de)	Sophist Technologies	Database-like view, requirements-centric UML tools, MS Office, Lotus Notes	Low
DOORS (www.telelogic.com)	Telelogic	Integrated management, large projects, API available, XML support PLM, UML tools, MS Project	High
IRqA (Integral Requisite Analyzer) (www.tcpsi.es/irqa/ingles/irqa.htm)	TCP Sistemas & Ingeniería	Requirements classification, OO analysis and entity relationship method for database design, traceability, test support, XML support, MS Office	Medium
Reqtify (www.tni-valiosys.com)	TNI-Valiosys	Traceability and impact analysis, text processing, office tools, Simulink	Low
Requisite Pro (www.rational.com)	IBM Rational	Change management, traceability, XML support, MS Word, Rational Rose, TeamTest, MS Project	High
RM Trak (www.rmtrak.com)	RM Trak	Entry-level requirements management MS Office, SQL interface	Low
RTM Workshop (www.chipware.com)	Integrated Chipware	Multiuser distributed projects, modelling, API available, information modelling UML tools, test tools, SQL	High
Truereq (www.truereq.com)	Truereq	Lifecycle-oriented, team-centric, entry level, XML support Web browser forms	Low
Vital Link (www.complianceautomation.com)	Compliance Automation	Database-centric, large projects, SQL, API available , Adobe Framemaker	Medium

2.9.4 Requirements Verification and Validation

Requirement verification and validation are two different processes carried out by the business analyst. Verifying requirements ensure the requirement specification and the design conforms to the standards and they can be used for future work. Even though the elicitation and communication processes were performed perfectly ambiguous, inconsistent requirement specifications may not provide expected benefits of the requirement process (International Institute of Business Analysis, 2015). Thus verification will check “Are we building the right system”. Differences in the two processes are discussed in Table 2-4.

Once requirement specification is completed and verified, the validation process ensures the specified requirements are consistent and meet the customer needs (Anas, Ilyas, Tariq, & Hummayun, 2016). The requirements should be traced back to business needs, objectives and goals. The business analyst should possess a high-level understanding of the future state of the business that the system is catering to. Thus, requirement validation is an ongoing process to ensure “Are we building the right system” (International Institute of Business Analysis, 2015), (Schibi & Lee, 2015).

Table 2-4: Differences of validation and verification (Source: International Institute of Business Analysis, 2015)

Verification	Validation
Answers the question “were the requirements stated right”	Answers the question “were the right requirements stated”
No code executions	Code executions may involve
Ensure all stakeholders understand the requirement	Ensure requirements deliver the expected benefits to the client
Activities: walkthrough, review, inspections, adding examples for further clarifications	Activities: document analysis, item tracking, evaluate alignment with scope, financial analysis

Tools available today are capable of both eliciting and verification. However, the most capable tools for requirement verification/validation and traceability are CASE Spec, Cognition Cockpit, Cradle, GMARC, and Reqtify. (Carrillo de Gea et al., 2011). Most of the requirement engineering tools exist in the industry are not supporting the requirements validation process to ensure consistency, correctness, and completeness of the implemented functionalities (Dauad.N et al, 2014).

2.10 Limitations in existing work and new challenges

The basis of SCRUM is the facilitation of requirement changes during any phase of development. There is not enough evidence to demonstrate the impact of higher and severe changes on to the project management process and the final delivery. Changes have an impact on the project on a technical and management level, but employee motivation and their capacity to handle changes, control the project and its deliverable. Thus, human factors such as motivation, satisfaction, and mental stability against SCRUM RE practices have to be evaluated.

Requirement Engineering tools and techniques cannot be used alone and cannot be generalized into all companies and project that are seeking requirement analysis. Requirement gathering is more of an art than being a science, which depends on interpersonal skills, experience, and problem domain. Thus, a structured framework will not suit the requirement analysis process, but to support the process, a framework that minimizing the risk of requirement failure is a timely need.

Even though requirement prioritization is a key success factor to keep customers continuously satisfied, there are only a few empirical studies that have analyzed the scalability of existing requirements and their usage in different environments. Every company cannot use the same technique due to differences in the requirements analysis process. The customer base; stakeholders, domain, company size, the complexity of the project and etc have a significant impact on the tool/method that has to be used. There are new techniques that are used successfully in the industry, but they are not been evaluated by an empirical study.

Since Requirement Engineering is a chain of many activities that creates a bond between client and the team, the RE process has to be clear, concise and fast enough to cater communication gaps, documentation loopholes and solution development. Today, the BA should be a solution designer, who bridges the peace and harmony with two parties. Therefore, a specific framework should cover all the aspects concerning RE, to ease BA work. Current researchers have identified many tools, but they are not interconnected. Thus, one tool may be contradicting to another, or may not support basic requirements to use the next tool/methodology available.

2.11 Discussion

Requirement Engineering is not only about writing specifications. "It is the ability of writing requirements that could be understood and trace by many others in need, which eventually will help the evolution over time" Nuseibeh, B & Easterbrook, S (2000).

Recent researches have focused on prioritization mechanisms, and many methodologies have been identified to overcome challenges in prioritization. Validity and usability of these methodologies have not been assessed. According to Table 2-5, many types of research have highlighted the problem of lean documents, incomplete documentation, prioritization limitations and problems with Scrum requirement management. Table 2-6, provides the summarized view of related literature aligned with the factors affecting the requirement engineering process. The impact created by the new techniques used in requirements management has not been widely researched. Business analysts' understating of the overall scope is rarely investigated.

Requirement elicitation has not been a popular topic in research papers, but few papers discussed, problems related to elicitation. Elicitation depends on interpersonal skills that a person possesses, but the documentation needs to be guided with guidelines. Every project will not be able to strict the guidelines provided, based on the nature of the project and stakeholders the approaches might crave changes. Being the first step to RE, elicitation is an important attribute not only in RE but also considering the entire Software Project Management. Therefore, elicitation has to be handled with care in any project whether it is offshore or onshore.

Starting with elicitation, a RE framework should address the majority of the problems in each stage of RE process, and it should also cover the handling of maintenance related issues, change requests, and other project management problems.

2.11.1 Comparison of related work

Table 2-5: Comparison of related work

Related work	Factors considered	Advantages	Disadvantages
Assumptions Underlying Agile Software Development Processes (2005)	Lean documentation problems, Problems with Agile assumptions and inability to exercise face to face communication	A comprehensive analysis of challenges in assumptions of agile methodology, specifically related to distributed development.	The paper was mainly based on developer comments. The study should have revealed perspectives of customer and PMs to bring a better picture.
The Agile Requirements Refinery: Applying SCRUM Principles to Software Product Management (2009)	Scrum doesn't provide adequate guidelines for managing large amounts of requirements.	A new method for software products that apply SCRUM principal. Enables project managers to deal with complex requirements. The study serves the existing gap of software product management	Only software product management was considered.
Transition to Agile Development Rediscovery of Important Requirements Engineering Practices (2010)	Lean documentation problems Problems in using the product backlog as a requirement source Inefficiencies of user stories	Discusses challenges in. lean documentation and proposes requirement triage select requirements for the sprint. Preserving key practices and traditional approaches to requirement engineering are mentioned	Requirement triage is not explained but stated as an approach to overcome selection problems. Doesn't discuss the additional benefits a team could have due to requirement triage. Benefits of a hybrid approach are not evaluated.
Impact and challenges of requirements elicitation & prioritization in quality to agile	Requirement elicitation is difficult in SCRUM, as the product owner has to list all requirements in the system. Product Owners commonly use techniques such as Kano	Reveals RE techniques and requirement prioritization methods. Proposes a model for requirement prioritization to overcome challenges in selecting requirements into sprints.	The proposed model has 7 steps, and usage of the model could take a considerable time for sprint planning. When the project size is increased, the adaptability of the proposed model is not yet evaluated.

process: Scrum as a case scenario. (2017)	Analysis, Moscow, Relative Weighting	A hybrid of all the existing prioritization techniques, designed for SCRUM teams	
A systematic literature review of software requirements prioritization research (2014)	Four categories of prioritization techniques exist with over 49 techniques.	49 prioritization techniques were evaluated Identified the importance of elicited requirements and precise requirements	Improvements to existing prioritization techniques are not discussed. Only English medium studies were considered and thus have missed important studies on other languages.
Requirements Prioritization. Engineering and Managing Software Requirements (2005)	The prioritization techniques were analyzed based on complexity, scale and granularity.	Several factors were considered such as importance, penalty, cost, time and risk. Discusses how the above factors contribute towards trade-offs between different stakeholders.	Analyses 15 requirements. Thus the scalability of the prioritization method for large complex projects is not addressed. Interdependencies of requirements are not considered in the techniques used.
An Analysis of Techniques and Tools for Requirements Elicitation in Model-Driven Web Engineering Methods. (2015)	Not every elicitation technique can be used in every environment	MDD is close to agile and could be coupled easily. Thus the paper doesn't being related to agile/SCRUM is not a major problem.	More work has to be carried out to generalize results for agile/SCRUM Paper is silent about tools that can be used in requirement elicitation.
Requirement engineering tools (2005)	The tools availability of different aspects	Identify mostly used tools in the requirement process	Does not specify challenges specific to each tool.

2.11.2 Summary of Related Work

Table 2-6: Summary of related work

Related Study	Lean documents	Over all view	Tools	New techniques	Customer responsiveness	Communication
Assumptions Underlying Agile Software Development Processes (2005)			X		X	
The Agile Requirements Refinery: Applying SCRUM Principles to Software Product Management (2009)		X				
Transition to Agile Development: Rediscovery of Important Requirements Engineering Practices (2010)	X					
An Analysis of Techniques and Tools for Requirements Elicitation in Model-Driven Web Engineering Methods. Computational Science and Its Applications (2015)				X		
Practical Requirements Engineering Solutions (2004)			X			
Requirements for requirements management tools (2004)			X			
Requirements Management in an Agile-Scrum (2011)	X					
Requirements Engineering Tools (2011)			X			
Agile Practices in Offshore Outsourcing – An Analysis of Published Experiences (2006)					X	X
The agile requirements refinery: Applying SCRUM principles to software product management (2011)	X					
Usage of SCRUM practices within a global company (2008)	X				X	X
Requirements Engineering Practice and Problems in Agile Projects: Results from an International Survey (2017)	X					
Challenges in the Transition from Waterfall to Scrum–a Case study at Port base (2014)	X					

3 METHODOLOGY

3.1 Chapter Overview

Business analysis is the starting point of any project in the software industry. Failure to provide quality requirements lead to failures in project milestones. The utmost objective of this research is to identify challenges and blockers in requirement engineering when scrum has been adopted in offshore development. As per the National ICT Workforce Survey (2013), Sri Lanka has 30,661 professionals. This is the target population for the research.

This chapter presents the conceptual framework, hypothesis development, data collection process and theoretical sampling discussion.

3.2 Research design

A research design is a series of decisions leading to form a strategy for answering the research questions and testing the hypotheses. Research design can also be described as a structured set of rational decision-making and guidelines assist in generating valid, reliable research results. Research design decides the selection of data collection methods, measurement and scaling procedures, instruments, samples, and data analysis (Cavana, L. Delahaye, & Sekeran, 2001).

In conclusion, the research design ensures the evidence collected from various sources will guide to resolve the research problem logically and unambiguously. The most commonly classified research designs of exploratory, descriptive or causal research

3.3 Population and sampling

The targeted population of the present study is offshoring scrum team members who are engaged in requirement analysis or affected by the requirement management process in IT companies. Therefore, targeted job roles are project managers, software developers, quality assurance engineers, architects, and business analysts.

3.3.1 Population

The ICT workforce survey 2013 claims that a total number of ICT employees in Sri Lanka is 30661. Experience in the IT industry is important to find out key compelling challenges in the requirement management process as junior resources could have extreme opinions to that of experienced persons in the industry. They might either think that the requirement engineering process in the company is matured and complete enough to cater the development process, or they might think the RE process doesn't fit the expectations of the development process. In order to avoid these extreme opinions, the targeted population is further narrowed down to software professionals with more than three years of experience.

The ICT workforce survey also concludes that 43% of the total ICT workers do not have experience in the IT industry for more than 3 years (refer Figure 3-1: ICT workforce Experience level. (Source: National ICT Workforce Survey 2013).

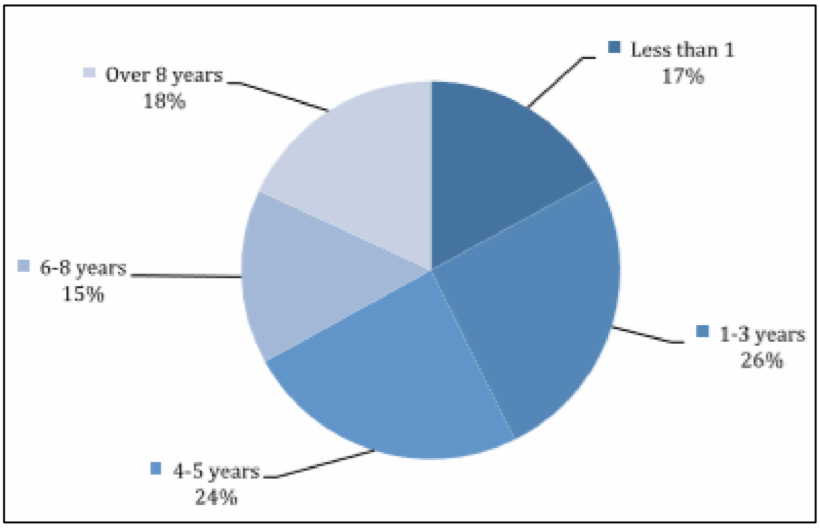

Figure 3-1: ICT workforce Experience level. (Source: National ICT Workforce Survey 2013)

The workforce with more than 3-year experience includes a 57% of the total population (Information and Communication Technology Agency of Sri Lanka, 2013). Therefore, the targeted population is 17477 software professionals.

3.3.2 Sample size and technique

Sampling is the process of selecting a group to represent the total population of a study. The present survey includes a targeted population of 17477 software professionals, which is infeasible to reach out to all the individuals representing the population.

Therefore, a sampling technique has been used to calculate the sample size for the present study.

The research uses simple random sampling, as all the software professionals in the targeted population have an equal chance of selecting in the questionnaire distribution. At a 95% confidence interval and at a 5 % margin of error is 376.

3.4 Data collection methods

Data collection is the process of collecting data to solve the research problem. The collected data are analyzed further to obtain the outcome of the research. Two methods of data collection are primary data and secondary data.

3.4.1 Primary data

The current research is quantitative research and quantitative data collection methods applied for the primary data collection which is based on mathematical calculations. The questionnaire serves as the main source of data collection for the research and the questionnaire distribution is further described in 3.6.4 Distribution method.

3.4.2 Secondary data

Secondary data considered for the research are the already published sources of data and information with respect to the research areas of requirement engineering in offshore development, requirement engineering in scrum teams, requirement engineering in agile etc. These information sources were research papers, books, reports and journals. Secondary data were included in the Literature Review and was greater assistance in understanding the background, work already done by the researches and prevailing limitations of conducting research in the problem area.

3.5 Conceptual Research Framework

The literature reviews highlighted factors that directly and moderately affecting the success of requirement management process. Factors identified by the related previous work had been further validated and prioritized by interviewing industry professionals. The factors identified in the literature review and the factors highlighted by the industry professionals are similar, but two new subfactors were identified after the pre-survey. The conceptual model for the present research is depicted in Figure 3-2:

Conceptual Framework, which is developed after considering both the literature review and the pre-survey. The factors are grouped into three main categories with nine subcategories.

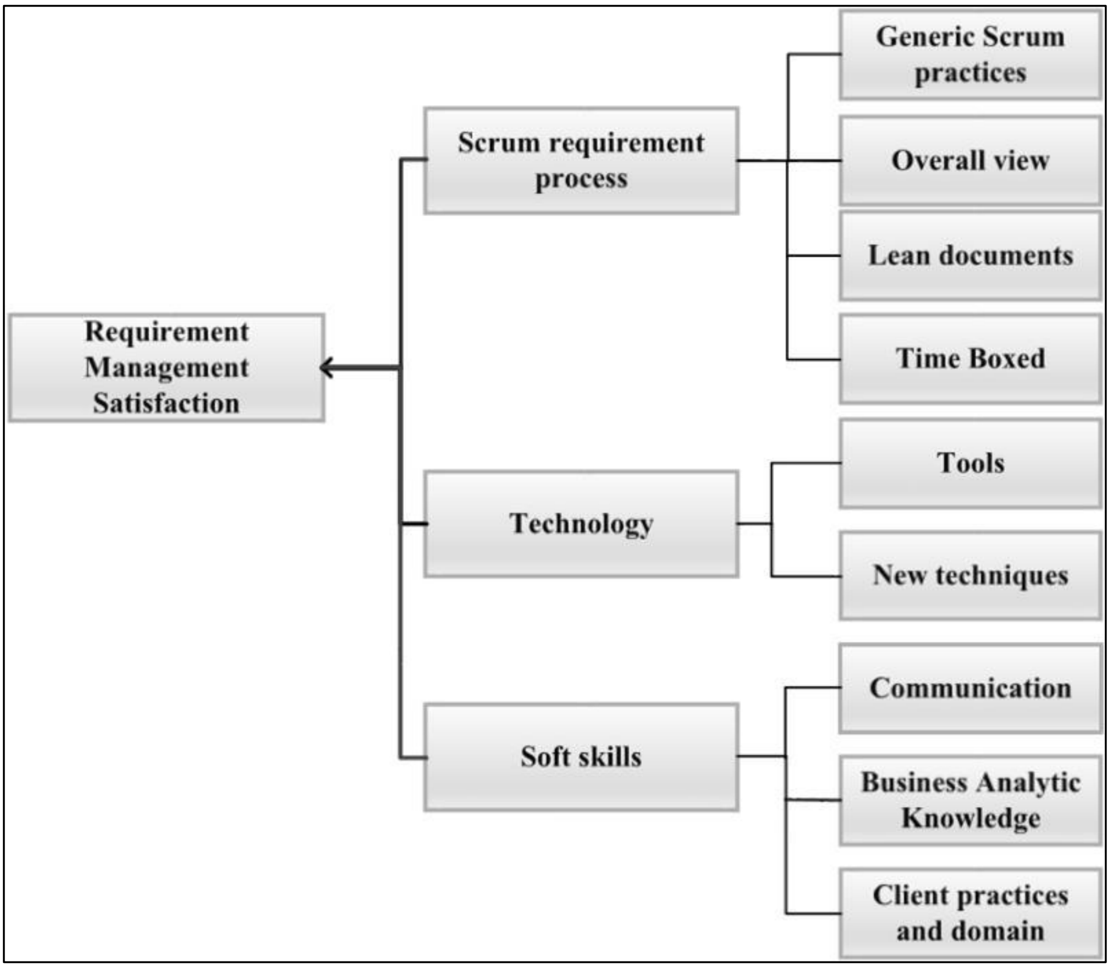

Figure 3-2: Conceptual Framework

1. Scrum requirement process
    a. Generic Scrum process: Generic Scrum process includes practices adopted for requirement engineering in scrum teams. These are general attributes that are practiced by any scrum team. The product owner is responsible for deciding the specifications needed in terms of the business perspective (Permana, 2015).
    b. Lean documents: Scrum is an agile methodology that focuses on workable product over complex documentation. Thus, "just enough' documentation have been the emphasis on scrum teams. 'Just enough' has not been clearly

defined and teams follow a lean approach for documentation (Marshall, 2012).

c. Time-boxed: Sprints have a limited time span varying according to the needs of the team and the project (Cristal et al., 2008). The average is 2.4 weeks (Scrum Alliance, 2017). Ability to produce quality requirement elaboration within a shorter time span is challenging.

d. Overall view: Components of a software project cannot stand alone. Every story has a link with other stories of a project. If the analyst is unaware of the linkage between components, the requirement could lead to rework.

2. Technology

a. Tools: Tools used in the industry ease the requirement engineering process. They have few drawbacks with regard to communication.

b. New techniques: Techniques used in requirement engineering changes over time. The user story is a documentation technique used in scrum projects.

3. Soft skills

a. Communication: Communication is the topmost challenge as offshoring teams cannot have the client on the same premises. As agile practices suggest, effective communication can minimize documentation.

b. Business analytic knowledge in the team: Some teams use technical experts to elaborate requirements. The narrow vision of technical experts leads to conflicts and gaps in the requirement. This was not being identified in the literature review but the pre-survey highlighted the importance of businesses knowledge of a BA in the requirements elicitation process.

c. Client practices and the domain: Domain is a sphere of knowledge around the business that the software is catering to. Client practices refer to specific user behaviors and user experiences of using the software.

3.5.1 Factors and relationships

The prefigured factors through the literature review have been categorized based on their relevance to each other. Factor categorization was facilitated by the pre-survey conducted involving various software professionals in the industry.

3.5.1.1 Dependent Variable

The dependent variable is "Successful requirement management process" which is directly affected by the independent factors of this study. A successful requirement engineering process will ease the upfront planning of a sprint, will reduce reworking and team members will be confident about the requirements. Communication, technology, and requirement process in a company directly affects the success or the failure of requirement management.

3.5.1.2 Independent Variables

The dependent variable, "Successful requirement management process" depends on factors such as Soft Skills of both customer and development team, Scrum requirement process adopted by the team, and new technologies and techniques in use. These main factors are further analyzed using subfactors identified.

Table 3-1: Independent variables and sub variables

Factor	Sub factor	Description
Soft Skills	Communication	Communication is an act that will be delivered to a recipient as intended by the sender. Communication skills can be related to oral, written and listening skills.
	Business analytic skills	The level of business-related knowledge of a BA is a significant factor to deliver a successful requirement.
	User behavior	Certain user behaviors are hard to capture unless they have been clearly demonstrated.
Scrum Requirement Process	Lean documentation	Scrum is encouraging to have fewer documents as much as possible. Therefore, a number of documents, the complexity is kept at a minimum level in scrum practice.
	Time-boxed	Within a limited time period, the requirements have to be completed. Before the start of a sprint, BAs should ensure that the requirement is clear, has no loop-holes and understandable to all the stakeholders.

	Overall view	Understanding of the entire product scope is critical in any business context so that business rules are not violated in any feature being developed.
Technolog y	Tools	The requirement engineering process is enriched with online tools to support requirement management.
	New techniques	Techniques to elicit requirements have been changed over time.

3.5.2 Hypothesis development

Hypothesis provides the research with a focus and a scope for the research problem. In order to find out the relationships theorized in the conceptual research framework, five hypotheses have been developed. The developed hypothesis used in prioritizations for data collection and hypothesis testing for the current research verified the research outcome. Let; H_a: Alternate Hypothesis and H_0: Null Hypothesis.

Hypothesis 1

H_{1a}: Requirement management process satisfaction and the scrum requirement process are positively correlated.

H_{10}: Scrum requirement process and requirements management process satisfaction are not correlated.

Hypothesis 2

H_{2a}: Requirement management process satisfaction and technology are positively correlated.

H_{20}: Requirement management process satisfaction and technology are not correlated.

Hypothesis 3

H_{3a}: Requirement management process satisfaction soft skills of a business analyst are positively correlated.

H_{30}: Requirement management process satisfaction soft skills of a business analyst are not correlated.

Hypothesis 4

H_{4a}: Satisfaction level of the requirement management process and the job role are positively correlated.

H_{40}: Job role has no relationship with the requirement management process.

Hypothesis 5

H_{5a}: The set of independent variables significantly explain the satisfaction of the requirement engineering process

H_{50}: The set of independent variables do not significantly explain the satisfaction of the requirement engineering process

3.6 Data gathering

The target population for the study is software professionals with over 3 years of experience working in an offshoring scrum team. The research is analyzing current practices in requirement engineering and challenges incorporated with the practices. The survey collects opinions and trends in the requirement management process. The quantitative research approach, is better applicable in analyzing opinions and concluding results using highly structured tools as it uses objective facts, numerical data, and statistics.

As the research questions internal practices and their success rate, employees will be reluctant to respond in a face to face interview. Since questionnaires support user anonymity, more responses can be obtained, and the responses are generous due to user anonymity. Moreover, the questionnaire gathers a considerable amount of information in less time span. A questionnaire can be used to reach a large sample within a short time span. Thus, the questionnaire has been selected as the main instrument of data gathering. A five-point Likert scale model was used for open-ended questions. Likert scales provides the opportunity for the respondents to select the option that will best support their opinion.

3.6.1 Pre-survey

The Literature review highlighted a few factors affecting the requirement engineering process in offshoring scrum teams. Factors discussed in each article were converging to the same set of challenges, however, some researches have been published 1-2 two years ago. These finding may not be compatible with the current state of the industry as software related processes are frequently updated faster than other industries. Thus the findings from the LR needed to be further validated with industry practices and processes. LR findings were not fitting to the scope of the research due to a number of factors identified in the LR was more than 10. These factors need to be prioritized, in order to form the research design. Hence, a pre-survey was carried out to find out the most compelling factors that can be affecting the requirement engineering process of an offshoring scrum team.

3.6.2 Pre-survey participants

23 Software professionals with offshoring scrum experience and representing architects, project managers and business analyst curriculum participated in the pre-survey. Pre-survey participants were interviewed through Skype calls, meetings, and phone calls. They were questioned on practical requirement engineering challenges that arise specifically due to the adoption of Scrum. The result of pre-survey is described in DATA ANALYSIS. The chapter provides a detailed analysis of data and observations obtained for the present survey.

3.6.3 Questionnaire Design

Questions for the questionnaire was constructed based on three aspects.

1. Insights received in the pre-survey: Common problems and concerns were identified which also highlighted in the literature review.
2. Literature review: Literature review opened a vast variety of factors that needs to be further validated in a survey. Therefore, the pre-survey was used to identify valid factors for the target audience.

3. Personal Experience: Challenges and limitations associated with the requirements analysis have been observed during the 7 years' experience as a Business Analyst.

Base on the above three aspects, questions were formed to cater to the research problem. The questionnaire consists of five sections with 35 total questions. Section 1 is about demographic information such as age, experience level, gender etc. with six questions. Section 2 is based on the independent variable to identify the success rate of the current process using four questions. Section 3-5 are based on the main factors of the research. Section 3 was designed for the Scrum Requirement Process with 13 Likert scale questions. Section 4 was testing the technology factor with four Likert scale questions. Finally, section 5 was created for soft skills (refer to Table 3-2: Question distribution per factor). The section had eight Likert scale questions. The entire questionnaire needs five to seven minutes to answer all the questions. Time varies according to the awareness of the terminologies used, therefore terms that tend to be unfamiliar to participants were introduced at the beginning of each section.

Table 3-2: Question distribution per factor

Main factor	Subfactors	Questions
Scrum requirement process	Scrum practices	11,12,13,14
	Lean documents	15,16,17
	Time-boxed	21,22,23
	Overall view	18,19,20
Technology	Tools	24,25
	New techniques	26,27
Soft skills	Communication skills	28,29,30
	Business analytic knowledge	31,32
	Client practices and domain	33,34,35

3.6.4 Distribution method

The questionnaire is a widely used research instrument (Wilkinson & Bermingham, 2003). Despite the difficult nature of designing and analyzing questionnaires, they provide the ability to collect vast quantities of responses from a variety of respondents. Questionnaires can provide rich data to analyze if managed properly. The questionnaire used in the current survey was published on social media, especially Linked in and professional Linkedin groups. Questionnaire URL was disseminated through emails. Emailing was considered to be a better option as software professionals responds online forms. Collecting responses from software professionals was challenging than expected as the industry is filled with busy schedules.

Google forms provide the ability to collect email addresses of the respondents. Since the questionnaire is designed to collect information on an internal process the answers were made confidential, reiterating that the completed questionnaire is only be used for the academic purpose. As to ensure the confidentiality, respondent identity, including name, email and the workplace was not collected. Therefore, sending reminders for those who have not filled was another challenge in this survey as respondents who have filled the survey remained unknown. However, potential respondents were reminded frequently to get immediate responses.

3.7 Data Processing

Data processing refers to the conversion of raw data into a desirable and a usable form, thus data are prepared for the analysis after the data collection. The reliability of the result depends on the quality of data being used. Therefore, data processing engaged in data editing, coding, classifying, tabulating - charting and diagramming.

3.7.1 Data editing

Editing is a manual process of examining the data collected in questionnaires to detect errors and omissions and to see that they are corrected, and the schedules are ready for tabulation. Data editing starts with questionnaire checking after data is collected through the questionnaire. Data has been rejected when all the questions are not answered, and if the respondent’s working background does not match with scrum.

3.7.2 Data Coding

The questionnaire of the present survey includes Likert scale questions and single answer multiple choice questions. Likert scale questions linked with the dependent variable or independent variables were numerically coded to facilitate data comparison for measures and data conversion. The questionnaire consisted of both negative and positive questions, thus positive questions are coded as 5- Strongly agree, 4- Agree, 3- Neutral, 2- Disagree, and 1- Strongly disagree. The negative questions are coded as 5- Strongly disagree, 4- Disagree, 3- Neutral, 2- Agree, and 1- Strongly agree.

4 DATA ANALYSIS

4.1 Chapter Overview

The Data Analysis chapter provides a detailed analysis of data gathered from the survey and a discussion on the statistical results of the data and observation analysis. The data set was analyzed using Cronbach alpha, Pearson's Correlation Matrix, Regression analysis, and One Way ANOVA according to the need and data structure.

4.2 Data Collection

The survey was sent to 600+ professionals with offshoring scrum experience. 392 responses were received and only 376 could be used for further analysis due to the erroneous data provided with the responses. The questionnaire was available online for a period of one and a half months since the day it was first circulated on 19.01.2019 until 06.03.2019. Responses over the time period are illustrated in Figure 4-1: Response rate.

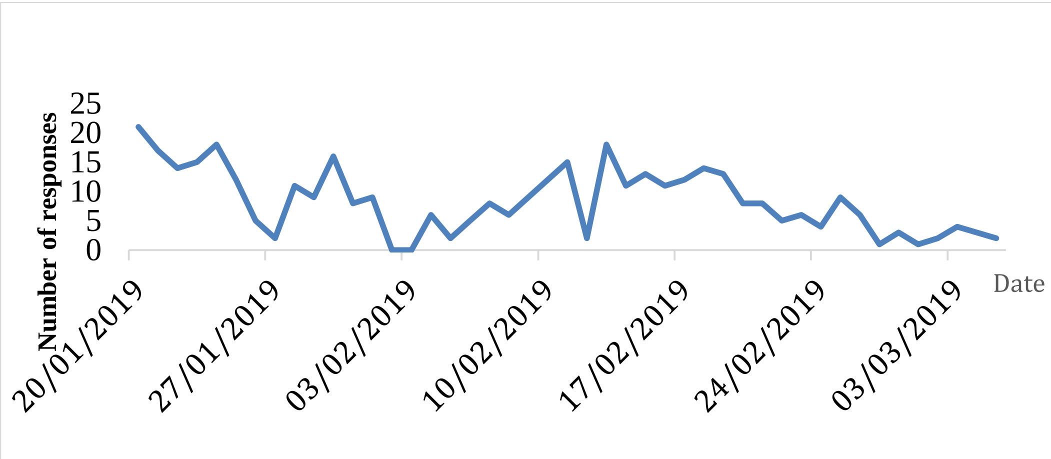

Figure 4-1: Response rate

All missing data were replaced by the column average of the respective item. Experience in Scrum practice is a vital aspect of this survey. The 379 responses comprised of scrum practitioners with an 84% response rate (320) and 10% hybrid (38). The hybrid versions are used in the industry customizing the scrum - waterfall or scrum – Kanban. Thus hybrid practitioners considered for the study as they could provide better feedback on the scrum process. 2% DevOps users (6) and 3% Kanban users (10) were also included in the study. Respondents only practicing the waterfall method were disregarded from the study and the total responses are 376. The sample is complying with the survey problem with a 94% response rate generated from scrum practitioners and hybrid practitioners.

The cleaned data set was analyzed for the reliability using Cronbach's alpha. The hypothesis was tested using Pearson Correlation Matrix and One-way ANOVA. A full regression model was carried out for all the variables. Moreover, descriptive statistics were used to find the frequencies of the responses. SPSS version 18 was used in data analysis for the present study.

4.3 Reliability Analysis

A research survey should provide high-quality data and analysis. Before the data analysis, the results need to be verified for reliability and internal consistency. Reliability refers to the extent to which the measurement constitutes a consistent measure of the given concept. Cronbach's alpha is one method to measure the consistency or the reliability of a data set.

4.3.1 Cronbach's Alpha analysis

Cronbach alpha measures the internal consistency between two tests (Tavakol & Dennick, 2011). This could be viewed as the expected relationship between tests that are in consideration. The alpha is a value between 0 and 1. The Coefficient increases as the number of items increases and when the relationship is higher. However, a higher value of Cronbach alpha does not indicate a higher degree of internal consistency or the measure is unidimensional. The alpha is also dependent on the length of the tests being performed. If the alpha value is greater than 0.7, the test items are considered as interrelated.

The reliability test was carried out for the entire survey sample of 376 respondents. The calculation has been constructed based on the factors used in the survey. The research survey included 29 items, categorized under independent variables and the dependent variable.

4.3.1.1 Cronbach’s alpha analysis for requirement process satisfaction (dependent variable)

The dependent variable was tested by four questions in the questionnaire. These questions were Question 7: I feel comfortable with the requirement management process in my company, Question 8: My team spend a considerable time in reworking due to requirement errors, Question 9: Initial time estimations were proven to be wrong due to poor requirements, Question 10: Final delivery gets delayed due to frequent changes within a sprint.

Data obtained for the above four questions were tested using the SPSS. The result generated a coefficient of 0.750 for the four items tested, which is displayed in Table 4-1: Reliability test for the dependent variable (Source: SPSS).

Table 4-1: Reliability test for the dependent variable (Source: SPSS)

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.750	0.776	4

4.3.1.2 Cronbach’s alpha analysis for independent variables

4.3.1.2.1 Cronbach’s alpha analysis for Scrum requirement process (Independent Variable)

Scrum requirement process is associated with four subfactors; generic Scrum practices, lean documentation, overall view and Time-boxed. Each subfactor consisted of at least two Likert scale items. The reliability test was applied to all independent variables individually.

Generic Scrum Practices is tested by four items in the survey and the responses generated an alpha of 0.757. Lean documentation is associated with three items and the result for Cronbach’s alpha is 0.768 Overall view had 3 items focusing on the impact of knowledge level in the overall view of the project. The overall view variable passed the test with a Cronbach’s alpha of 0.777. Time-boxed had three questions, but only two were on the Likert scale. These two items generated an alpha of 0.706 and passed the test. All the subfactors linked to Scrum Requirement Process passed the Cronbach's alpha test. Test results are displayed in Table 4-2: Reliability test for the factor - Scrum requirement process.

Table 4-2: Reliability test for the factor - Scrum requirement process

Variable	**Subfactor**	**No of items**	**Cronbach's alpha**
Scrum requirement process	Generic Scrum Practices	04	0.757
	Lean documentation	03	0.768
	Overall view	03	0.777
	Time-boxed	02	0.706
Cronbach's Alpha Coefficient value for the variable of **Scrum requirement process**			0.760

4.3.1.2.2 Cronbach's alpha analysis for technology (Independent Variable)

Technology sector had two subfactors, tools and new techniques. Tools were tested by two items, and new techniques were also tested by two items. Both subfactors passed the Cronbach's alpha with over 0.7 coefficient. Tools produced an alpha of 0.735 and new techniques generated an alpha of 0.742.

Table 4-3: Reliability test for Technology factor

Variable	**Subfactor**	**No of items**	**Cronbach's alpha**
Technology	Tools	2	0.735
	New Techniques	2	0.742
Cronbach's Alpha value for the variable of **Technology**	0.713		

Thus, Cronbach's alpha value for both subfactors was sufficient to pass the reliability test. However, the Technology factor as a whole produced an alpha of 0.713. Cronbach's alpha for each subfactor and the main factor is depicted in Table 4-3: Reliability test for Technology factor.

4.3.1.2.3 Cronbach's alpha analysis for Soft skills (Independent Variable)

Soft skills included three subfactors communication, business analytic knowledge and client practices and domain. Business analytic knowledge has consisted of two items, and the other two subfactors have consisted of three items.

Subfactors were tested for the reliability on an individual basis. All the subfactors were able to pass the reliability test with over 0.70 value. The Cronbach's alpha coefficient was 0.785, 0.756, 0.819 for the subfactors communication, business analytic knowledge, client practices, and domain respectively. All the eight items considered for the Soft Skills variable passed the reliability test by obtaining a Cronbach's alpha of 0.821. The summary of the test result is depicted in Table 4-4: Reliability test for the independent factor - Soft skills.

Table 4-4: Reliability test for the independent factor - Soft skills

Variable	**Subfactor**	**No of items**	**Cronbach's alpha**
Soft Skills	Communication	03	0.785
	Business analytic knowledge	02	0.756
	Client practices and domain	03	0.819
Cronbach's Alpha Coefficient value for the variable of **Soft skills**			0.821

In conclusion, all the variables passed the reliability test with over 0.700 Cronbach's alpha. Therefore, the internal consistency of the items considered in the survey is at an acceptable level as coefficients are closer to 1.0.

4.4 Demographic analysis

4.4.1 Gender profile

The data set is consisted of 376 responses after cleaning data. Respondent gender profile was 241 (64%) male and 135 (36%) female. The gender distribution in the survey is represented in Figure 4-2: Respondent Gender Profile.

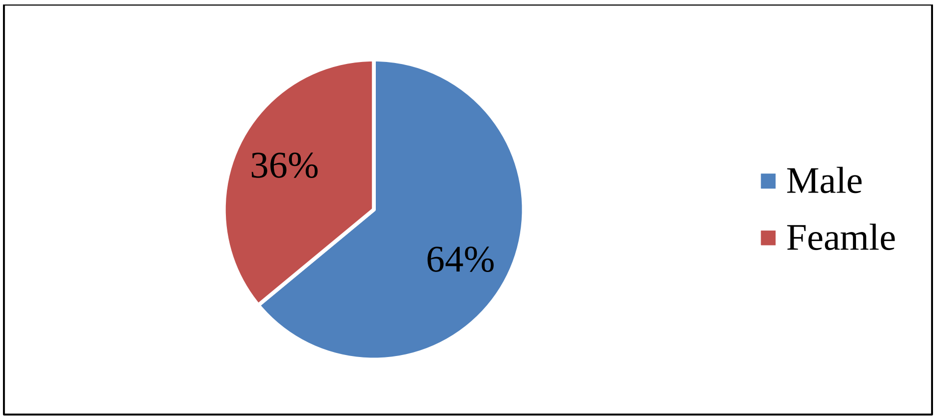

Figure 4-2: Respondent Gender Profile

4.4.2 Job profile

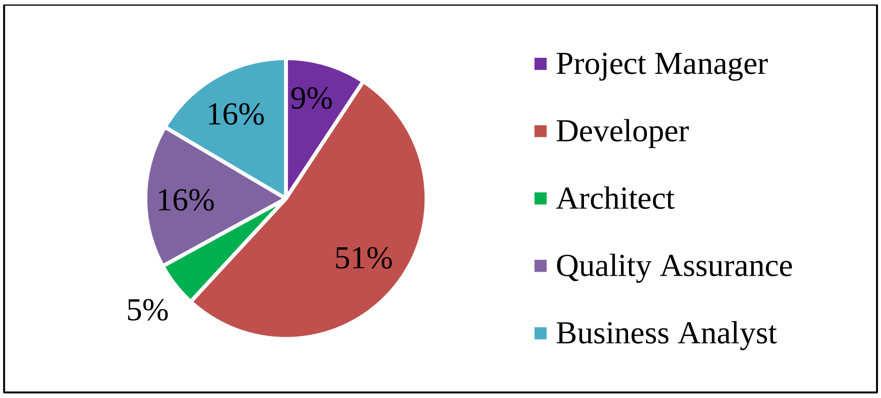

Figure 4-3: Job role and response rate

Participants in the survey hold different job roles and they were classified into four major areas; Architect, Project Manager, Business analyst, Quality assurance engineer. The leftovers were considered as ‘Others’. The respondent profile consisted of 17 architects (4.5%), 62 business analysts (16.48%), 193 developers (51.3%), 33project managers (9%), 60 quality assurance engineers (15.95%), 11 (3%) others representing job roles such as tech leads, product owners, and delivery managers etc. The respondent job profile is depicted in Table 4-3.

4.4.3 Industry experience

Industry experience of the respondents was from different experience levels. The level of experience respondents hold is depicted in Figure 4-4: The Response rate of the experience. Most of the respondents were having five to seven years of experience totaling 129 (34.31%). Respondents holding three to five years of experience were 113 (30.05%) and 98 (25.8%) had seven to 10 years of experience. Only 9.84% of the respondents were having more than 10 years of experience.

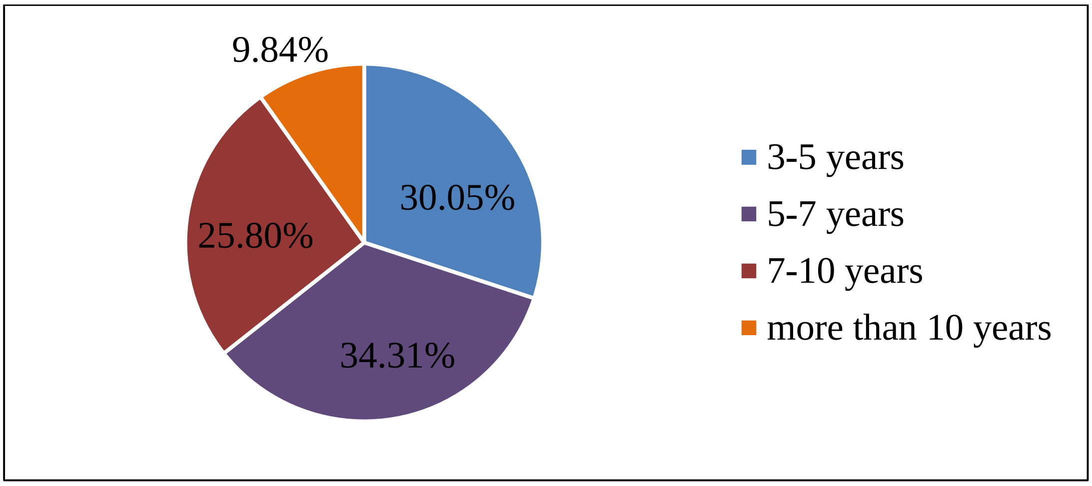

Figure 4-4: The Response rate of the experience

4.5 Descriptive Statistics Analysis

Descriptive statistics are a quantitative summary of the data set which is representing the sample. The present research study considers the central tendency measurements and frequency constructs to evaluate the data set obtained in the survey.

4.5.1 Central tendency measurements and frequency statistics for constructs

Individual perception towards current requirement management process in the respondent's company was tested, and the result yielded a mean of 4.11 with a mode of 4. According to Figure 4-5: Requirement process satisfaction, 80% of the respondents were not satisfied with the current requirement process. The majority of participants are not satisfied with the current requirement management process in their companies and it is a timely need to identify the factors causing dissatisfaction.

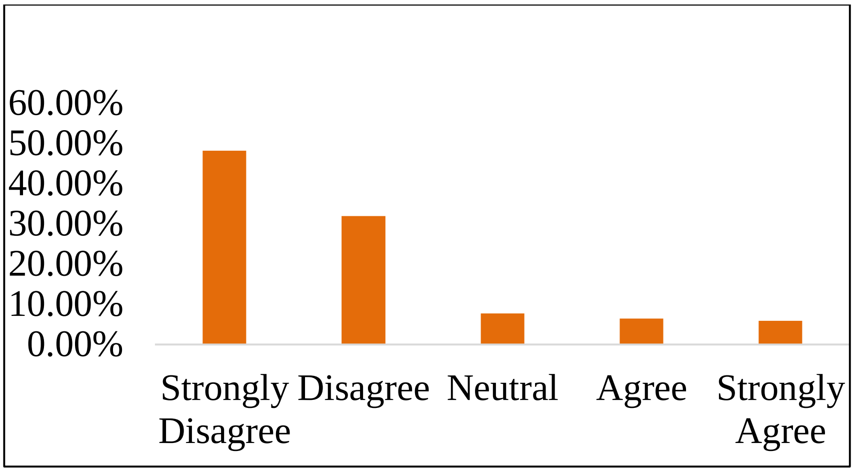

Figure 4-5: Requirement process satisfaction

The reworking of development can be due to various reasons, and requirement errors is a basic factor leading to reworking. The mean was calculated to be 3.82. However, the standard deviation of the result is 0.76, which indicates the responses are close to the mean. According to Figure 4-6: Response rates for the dependent variable item no: 02, a total of 77% agreed with the fact of reworking effort due to requirement errors. The disagree percentage is 5% which emphasize that reworking is a common challenge experienced by many of the development teams.

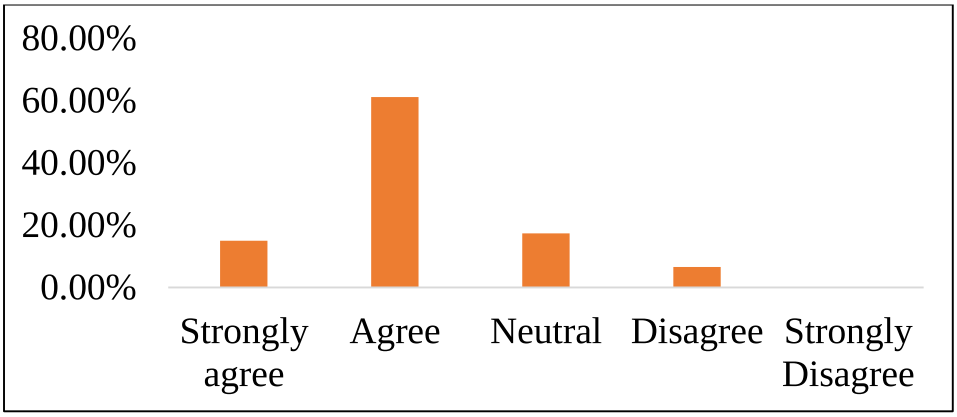

Figure 4-6: Response rates for the dependent variable item no: 02

Time estimation deviation at the end of the sprint was accepted by a majority of 84.31%. According to Table 4-5, the response profile consists of 32.9% of strongly agreed responses. A total of 6.65% have disagreed that the initial time estimation was not sufficient to deliver the feature. The mean is 4.09, with a standard deviation of

0.86. The respondents admit that poor requirement management has led to inaccurate time estimates as the disagreements with the statement is at a low rate, as visible in Figure 4-7: Responses for dependent variable item no 03. The graph visualizes the decreasing tendency of the response rates after the agreed responses.

Table 4-5: Statistics: Requirement Management Process Satisfaction – Item No. 3

Variable Name		**Subfactor**	
Requirement process satisfaction		N/A	
Variable Type		**Item No**	
Dependent		3	
Question : Initial time estimation, proven to be not sufficient at the end of a sprint, due to poor requirement management.			
	Frequency	**Percentage**	**Cumulative %**
Strongly agree	124	32,98 %	32,98 %
Agree	193	51,33 %	84,31 %
Neutral	34	9,04 %	93,35 %
Disagree	20	5,32 %	98,67 %
Strongly Disagree	5	1,33 %	100,00 %
Total	376	100,00 %	
Mean	**Mode**	**Std.Deviation**	**Skewness**
4.05	4	0.90438	-1.094

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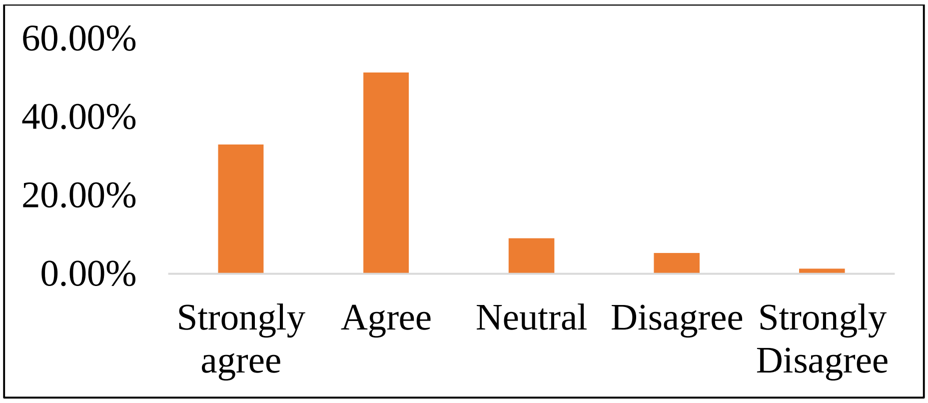

Figure 4-7: Responses for dependent variable item no 03

The mean for question 10 is 4.16 with a standard deviation of 0.81. The result implies that the majority accepts the fact of delivery delays arising due to frequent requirement changes within a sprint. A cumulative of 86.17% (Figure 4-8: Response rates for dependent variable item no 04) has either agreed or strongly agreed with the statement.

The respondents were not comfortable with the current process of managing requirements utilized in the company

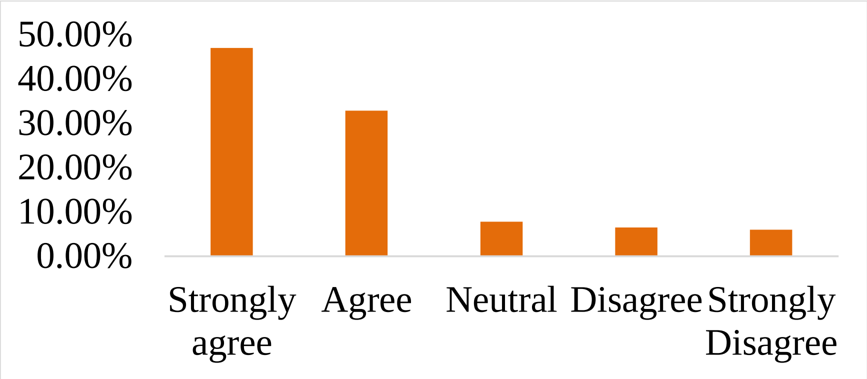

Figure 4-8: Response rates for dependent variable item no. 4

Figure 4-9: Histogram of Requirement Process Satisfaction, displays the summary of the software requirement process satisfaction. This summary is obtained using the standard mean of four items included in the dependent variable. The requirement management process is contributing to optimizing other processes such as planning, estimations, delivery management and quality assurance.

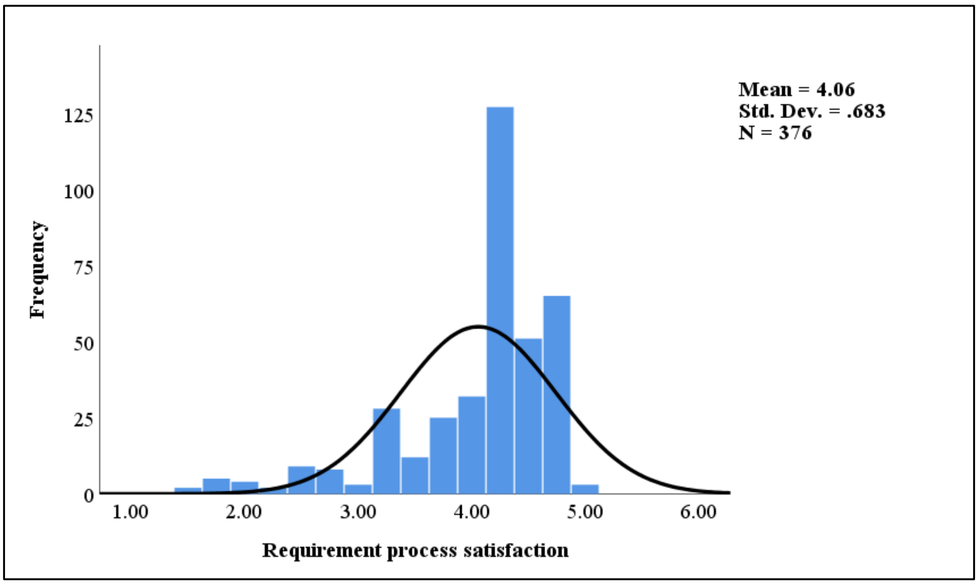

Figure 4-9: Histogram of Requirement Process Satisfaction

4.5.1.1 Analyze the Scrum Requirement Process factor

Scrum practitioners highlight the fact that the required knowledge can be shared among a team without a document. However, respondents do not believe in sharing requirement knowledge without a proper document. According to mean generated for the “Requirement knowledge sharing among the scrum team can be done without a requirement document” is 4.12 with a standard deviation of .631. Mode for the particular question was 4, indicating the majority disagree with the statement.

In the lean concept, user stories have been a popular document among the scrum teams. However, user stories have inherited problems concerning requirement management. Thus the sample was asked for their perception regarding technical aspect coverage in user stories. A majority agreed on the fact that user stories are likely to ignore technical aspects. The mode for the particular question is 4, with a mean of 4.00. An 81.9% of the total sample have responded with either “Strongly agree” or “Agree” for item 2 of the Lean documents subfactor. Descriptive statistics are illustrated in Table 4-6.

Table 4-6: Statistics: Scrum Requirement Process – Item No. 2

Question: User stories focus only on the business & functional requirements. Technical aspects are ignored.			
	Frequency	**Percentage**	**Cumulative %**
Strongly agree	84	22.3%	22.3%
Agree	224	59.6%	81.9%
Neutral	56	14.9%	96.8%
Disagree	10	2.7%	99.5%
Strongly Disagree	2	.5%	100.0%
Total	376	100,00 %	
Mean	**Mode**	**Std.Deviation**	**Skewness**
4.0053	4	0.72662	-0.763

Visual items such as wireframes, prototypes and flow charts are helpful resources in requirement communication. Including these items in the requirement, documents can enhance the usability of documents. 85.9% of the sample agreed that visual items would improve the understandability of requirements. The mean for the question is 4.32. 37.8% of the sample had agreed and 48.1% of the sample had strongly agreed. The mode for the sample is 5 which indicates the majority “Strongly agrees” with including visual items in requirement documents as depicted in Table 4-7.

Table 4-7: Statistics: Scrum Requirement Process – Item No. 3

Question: Offshoring teams should encourage wireframes, prototyping and flow charts to ensure all stakeholders understand the requirement.			
	Frequency	**Percentage**	**Cumulative %**
Strongly agree	181	48.1%	48.1%
Agree	142	37.8%	85.9%
Neutral	47	12.5%	98.4%
Disagree	6	1.6%	100.0%
Strongly Disagree	0	0%	
Total	376	100,00 %	
Mean	**Mode**	**Std.Deviation**	**Skewness**
4.3245	5	0.7562	0.840

The overall view reflects the business analyst's knowledge related to the scope of the project. The overall view leads to a better understanding of inter-relationships with various business rules. All three items in this section scored a mean closer to 4 which indicates that the majority of respondents agree on the importance of overall view. **Error! Not a valid bookmark self-reference.**. Business Analyst's knowledge gap in the entire scope of the project or product leads to, requirement overlaps with another sprint backlog item, created a mean of 3.98 and requirements will not be compatible with existing business rules if the BA has a limited understanding of the entire scope of the project or product generated a mean of 4.06. The relationship between functionality coverage and lack of overall picture had a mean of 4.11.

Table 4-8: Scrum Requirement Process – Item No. 4

Question: Business Analyst's knowledge gap in the entire scope of the project/product leads to, requirement overlaps with another sprint backlog.			
	Frequency	**Percentage**	**Cumulative %**
Strongly agree	69	18.4%	18.4%
Agree	242	64.4%	82.7%
Neutral	56	14.9%	97.6%
Disagree	7	1.9%	99.5%
Strongly Disagree	2	.5%	100.0%
Total	376	100,00 %	
Mean	**Mode**	**Std.Deviation**	**Skewness**
3.9814	4	0.6750	0.762

Time allocated for the requirements analysis process should not be less than 10% of the total time. Only 12.5% had agreed to allocate less than 10% and all others expect the time allocation to be more than 10%%. In fact, according to **Error! Not a valid bookmark self-reference.**, 58.78% expects an allocation between 11%-30%. However, 28.73% of the total sample suggests allocating more than 31% for the requirement process.

Table 4-9: Statistics for allocation time in requirement management

	Frequency	**Percentage**	**Cumulative %**
<=10% of total time	47	12.50 %	12.50 %
11-30% of total time	221	58.78 %	71.28 %
31-50% of total time	97	25.80 %	97.07 %
>= 50% of total time	11	2.93 %	100.00 %
Total	376		

A sprint time span varies from 2 weeks to 4 weeks. The increased effort in shortening the sprint time spans has an effect on the requirements analysis and specification process due to the increased pressure for business analysts to complete the requirement within a shorter time period. As per descriptive statistics illustrated in Table 4-10, 63.9 % of the sample agrees that the time span of a sprint is not sufficient to a detail requirement elicitation. Only a total of 10.1% disagrees that the time span of a sprint is not sufficient for a detailed requirement elicitation process.

Table 4-10: Scrum Requirement Process – Item No. 7

Question: Time span of a sprint is not sufficient for a detailed requirement elicitation process			
	Frequency	**Percentage**	**Cumulative %**
Strongly agree	51	13.6%	13.6%
Agree	189	50.3%	63.8%
Neutral	98	26.1%	89.9%
Disagree	28	7.4%	97.3%
Strongly Disagree	10	2.7%	100.0%
Total	376	100,00 %	
***Mean**	**Mode**	**Std.Deviation**	**Skewness**
3.643	4	0.90030	-0.741

An 83.5 % agreed or strongly agreed to start requirement detailing before two sprints. Only 5.6% was against the statement and a 10.9% were neutral about starting requirement detailing before the development sprint. The mean for the particular question had been 4.02, with a standard deviation of 0.86.

4.5.1.2 Analyzing the Soft Skills factor

Customer interaction with the team to communicate the requirement is vital in the requirements engineering process. A cumulative of 59.3% disagreed with the statement Customers frequently interact with the development team to assist in a better understanding of the problem and domain. Only 20.8% of respondents agree that customers are interacting with the team frequently.

Requirement delays due to poor feedback from customers have been responded with a mean of 3.85 and a standard deviation of 0.94. The importance of business analysts' presentation and communication capabilities have been accepted by the sample with an average of 4.23. According to statistical evidence, the majority of the sample strongly agree with the fact that communication and presentation skills of the BA lead to success in requirements engineering.

The importance of having the business analytic knowledge had been agreed by a majority of the sample. The means generated for the two items related to business analytic knowledge are 4.13 and 4.30. Both items had a positive response rate of 79.8% and 84.6% which represent 'Agree' and 'Strongly agree' responses. This reinforces the business analytic knowledge in a business analyst is a critical factor to consider in requirement management and planning activities.

The business domain could be better understood by the teams located onsite. This has been reinforcing by the sample response as they responded by agreeing with the statement. 68% of the sample has either agreed or strongly agreed with the statement. Responses with strongly disagree or disagree are only 10.9% of the total sample. However, the opinion on the question is versatile as the mean of 3.8 is having a standard deviation of 1.01, and the respondents with a neutral view are 21.1%.

The domain expertise is an important factor in eliciting requirements as it leads to better understanding. 72.1% have accepted the fact that domain expertise enhances the capability of requirement gathering. The mode is 5, mean is 4.06 with a standard deviation of 1.26. The answers deviate from the mean as another 27.9% are either neutral or disagrees with the statement.

The time differences between the development team and the client's location have a severe impact on the requirement process. Only 54.3% either agree or strongly agree. Response mean is 3.56 and the standard deviation is calculated to be 1.06. Though the majority response is 4, the responses have a quite spread across disagree to strongly agree.

4.5.1.3 Analysis of the technology factor

Table 4-11 presents the summary of Technology factor. Technology factor has consisted of two subfactors Tools and Techniques. 76.9% of the sample has agreed that unfamiliarity of the tools used in requirement engineering has an adverse effect on customer interaction with the team. The mode is 4 for the question and the mean is calculated to be 3.85.

The results confirm that the tools used to communicate with the client have an influence on customer interaction. The new introductions of tools have replaced documents in Scrum teams. Thus, the requirement for a particular feature is dispersed inside the tool without proper linkages. Only 42.8% have agreed that tools cause for the lack of single requirement documents and the item cannot be clearly assessed as 25.8% of the total sample is neutral and 31.4% of the sample either disagree or strongly disagree. Business analysts use new techniques in eliciting requirements to improve efficiency. 63.6% accepts that prototyping is the best technique to use in requirement management. The average response is 3.6915 with a standard deviation of .9936. 62.5% of the respondents agree that joint application development is infeasible in offshoring teams as the support provided by the customer is not satisfactory. The mean for the item is 3.51 with a standard deviation of 0.9322. Considering the four items in the technology factor, the majority of the respondents agree that offshoring teams have a limitation due to the technology in use.

Table 4-11: Descriptive statistics for the technology factor

Subfactor: Tools			
Question 24: Client interaction with the team is affected due to the unfamiliarity of the communication tools used **Mean**: 3.8537 **Mode**: 4 Std. **Deviation** : 1.05698 **Skewness**: -.292			
	Frequency	**Percentage**	**Cumulative %**
Strongly agree	100	26.6%	26.6
Agree	189	50.3%	76.9
Neutral	37	9.8%	86.7
Disagree	32	8.5%	95.2
Strongly Disagree	18	4.8%	100.0
Total	376	100.00 %	
Question 25: Scrum teams cannot find a single document describing the entire requirement as they are maintained in tools. **Mean**: 3.0878 **Mode**: 4 **Std. Deviation** :1.11008 **Skewness**: -.126			
	Frequency	**Percentage**	**Cumulative %**
Strongly agree	26	6.9%	6.9
Agree	135	35.9%	42.8
Neutral	97	25.8%	68.6
Disagree	82	21.8%	90.4
Strongly Disagree	36	9.6%	100.0
Total	376	100.00 %	
Subfactor – New Technique			
Question 26: Prototyping is the best technique that an offshore team can use to demonstrate the requirements captured. **Mean**: 3.6915 **Mode**: 4 Std. **Deviation** : .99360 **Skewness**: -.662			
	Frequency	**Percentage**	**Cumulative %**
Strongly agree	77	20.5%	20.5
Agree	162	43.1%	63.6
Neutral	93	24.7%	88.3
Disagree	32	8.5%	96.8
Strongly Disagree	12	3.2%	100.0
Total	376	100.00 %	
Question 27: Joint application design is limited with offshore scrum teams due to the low support and fewer interactions from the customers. **Mean**: 3.516 **Mode**: 4 Std. **Deviation** : .93224 **Skewness**: -.960			
	Frequency	**Percentage**	**Cumulative %**
Strongly agree	29	7.7%	7.7
Agree	206	54.8%	62.5
Neutral	88	23.4%	85.9
Disagree	36	9.6%	95.5
Strongly Disagree	17	4.5%	100.0
Total	376	100.00 %	

4.6 Inferential Statistics - Pearson's Correlation Analysis

Inferences about the population were made using Pearson's Correlation Analysis. Pearson's correlation matrix was used to analyze all the three hypotheses associated with identifying the linear relationships between the independent variable and the dependent variables. Standard averaging has been used to measure the dependent variable and independent variables when the variables contained more than one item.

4.6.1 Hypothesis 1

The relationship between the Requirement Management Satisfaction and the Scrum Requirement process is tested by Hypothesis 1.

Table 4-12: Pearson Correlation - Requirement Management Satisfaction and Scrum Requirement Process

		Requirement management satisfaction	**Scrum Requirement Process**
Requirement Management Satisfaction	Pearson Correlation	1	0.570
	Sig. (2-tailed)		0.000
	N	376	376

As illustrated in Table 4-12: Pearson Correlation - Requirement Management Satisfaction and Scrum Requirement Process, the relationship between Requirement Management Satisfaction and Scrum Requirement Process is significant at the 0.01 level. Therefore, the alternate hypothesis (H_{1a}) is accepted and the null hypothesis (H_{10}) is rejected. Thus, Scrum Requirement Management Process in a company has a significant relationship towards the Requirement Management Satisfaction.

4.6.2 Hypothesis 2

The relationship between the Requirement Management Satisfaction and Technology is depicted below Table 4-13. As illustrated in the table, the relationship between Requirement Management Satisfaction and technology is not significant at the 0.01 level. Therefore, the alternate hypothesis (H_{2A}) is rejected. Thus, it is concluded that tools and advanced techniques associated with requirements management process in a software development company have no significant relationship towards the Requirement Management Satisfaction.

Table 4-13: Pearson Correlation - Requirement Management Satisfaction and Technology

		Requirement management satisfaction	**Technology**
Requirement Management Satisfaction	Pearson Correlation	1	0.067
	Sig. (2-tailed)		0.197
	N	376	376

4.6.3 Hypothesis 3

The relationship between Requirement Management Satisfaction and Soft skills is depicted in Table 4-14. As illustrated in Table 4-14 the relationship between Requirement Management Satisfaction and Soft Skills is significant at the 0.01 level. Therefore, the null hypothesis (H_{30}) is rejected and the alternate hypothesis (H_{3a}) is accepted. Thus, Soft Skills inherited by the business analyst has a strong relationship towards the independent variable: Requirements Management Satisfaction.

Table 4-14: Pearson Correlation - Scrum Requirement Management Satisfaction and Soft Skills

		Requirement management satisfaction	**Soft skills**
Requirement Management Satisfaction	Pearson Correlation	1	0.775
	Sig. (2-tailed)		0.000
	N	376	376

4.7 Inter-item correlation analysis

The correlation statistics generated by Pearson's Correlation Matrix is used to test the correlation among the items included in a variable. The present study has three variables, and therefore inter-item correlations are assessed for all three variables individually. Computed inter-item correlations are discussed in the sections below.

4.7.1.1 Inter-item correlation – Requirement management satisfaction

The dependent variable in the present study is requirement management satisfaction. It has been tested by four items in the questionnaire. An inter-item correlation analysis was carried out to test the correlation within the dependent variable.

Table 4-15: Inter-item correlation for the dependent variable

		1	2	3	4
I feel comfortable with the requirement management process in my company (1)	Pearson Correlation	1	.544	.515	.495
	Sig. (2-tailed)		.000	.000	.000
	N	376	376	376	376
My team spends a considerable time in reworking due to requirement errors (2)	Pearson Correlation	.544	1	.607	.496
	Sig. (2-tailed)	.000		.000	.000
	N	376	376	376	376
Initial time estimation, proven to be not sufficient at the end of a sprint, due to poor requirement management. (3)	Pearson Correlation	.515	.607	1	.633
	Sig. (2-tailed)	.000	.000		.000
	N	376	376	376	376
Final delivery gets delayed due to the frequent changes in the requirement when the sprint is started (4)	Pearson Correlation	.495	.496	.633	1
	Sig. (2-tailed)	.000	.000	.000	
	N	376	376	376	376

The four items possess a positive correlation among each other as displayed in Table 4-15: Inter-item correlation for the dependent variable. Time estimation deficiencies and delays in the final delivery are having a significantly positive relationship. Time spent in reworking of a feature and the time estimation inefficiencies are having a significant relationship. The time utilized for reworking has a direct impact on delivery delays and it is a reason for the initial time estimation is proven to be incorrect.

4.7.1.2 Inter-item correlation – Scrum requirement process

Scrum requirement process was split into four sub-factors Time-boxed, lean documents, scrum practices and overall view. The characteristics of each subfactor are considerably different to each other and therefore the inter-item correlation generated by the Pearson Correlation matrix is highlighted according to the subfactor. All the items included in the variable are positively correlated and is illustrated in Table 4-16: Inter-Item Correlation of Scrum Requirement Process.

"In my scrum team, user stories are always written by the product owner or end users" and "Requirements can be gathered correctly when all the scrum members contact the customer" are sustaining a coefficient of 0.536. Problem domain can be well-explained using scenario-based specification than user stories or use cases and Our company facilitates additional conversations between the product owner/end users and the scrum team before accepting the user story into a sprint generated a coefficient of 0.522. Other items are not significant, but all the items are positively correlated.

One item in the Lean documents subfactor has a significant relationship with the other two items. “Requirement knowledge sharing among the scrum team can be done without a requirement document” and “User stories focus only on the business & functional requirements, technical aspects are ignored” are positively correlated with “Offshoring teams should encourage wire-frames, prototyping and flow charts to ensure all stakeholders understand the requirement”. Inter-item correlations of these items are 0.524 and 0.645 respectively which emphasize a significant relationship.

Considering the Overall view, Requirements will not be compatible with existing business rules if the BA has limited understanding about the entire scope of the project/product has significant correlations with Business Analyst’s knowledge gap in entire scope of the project/product leads to, requirement overlaps with another sprint backlog and Important functionalities may not be covered in requirement analysis due to Business Analyst’s poor understanding of the overall picture. The correlation between them is 0.619 and 0.549.

Table 4-16: Inter-Item Correlation of Scrum Requirement Process

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
In my scrum team, user stories are always written by the product owner or end users. (1)	**1**	**.536**	**.434**	**.359**	.048	.167	.132	.161	.119	.106	.112	.116
Requirements can be gathered correctly, when all the scrum members contact the customer. (2)	**.536**	**1**	**.485**	**.344**	.092	.175	.165	.124	.106	.151	.113	.066
Problem domain can be well-explained using scenario-based specification than user stories or use cases (3)	**.434**	**.485**	**1**	**.522**	.038	.213	.130	.111	.147	.143	.226	.103
Our company facilitates additional conversations between the product owner/end users and the scrum team before accepting the user story into a sprint. (4)	**.359**	**.344**	**.522**	**1**	.064	.162	.145	.158	.134	.235	.188	.114
Requirement knowledge sharing among the scrum team can be done without a requirement document.(5)	.048	.092	.038	.064	**1**	**.394**	**.524**	.349	.310	.231	.061	.126
User stories focus only on the business & functional requirements. Technical aspects are ignored.(6)	.167	.175	.213	.162	**.394**	**1**	**.645**	.283	.288	.301	.121	.143
Offshoring teams should encourage wire-frames, prototyping and flow charts to ensure all stakeholders understand the requirement.(7)	.132	.165	.130	.145	**.524**	**.645**	**1**	.280	.287	.262	.079	.131
Business Analyst’s knowledge gap in entire scope of the project/product leads to, requirement overlaps with another sprint backlog. (8)	.161	.124	.111	.158	.349	.283	.280	**1**	**.619**	**.467**	.160	.183
Requirements will not be compatible with existing business rules if the BA has limited understanding about the entire scope of the project/product.(9)	.119	.106	.147	.134	.310	.288	.287	**.619**	**1**	**.549**	.155	.166
Important functionalities may not be covered in requirement analysis due to Business Analyst’s poor understanding of the overall picture.(10)	.106	.151	.143	.235	.231	.301	.262	**.467**	**.549**	**1**	.180	.142
Time span of a sprint is not sufficient for a detailed requirement elicitation process(11)	.112	.113	.226	.188	.061	.121	.079	.160	.155	.180	**1**	**.546**
Requirement detailing should start at-least before two sprints(12)	.116	.066	.103	.114	.126	.143	.131	.183	.166	.142	**.546**	**1**

Business Analyst's knowledge gap in the entire scope of the project/product leads to, requirement overlaps with another sprint backlog and Important functionalities may not be covered in requirement analysis due to Business Analyst's poor understanding of the overall picture depicts a correlation coefficient of 0.467 and thus these two items are positively correlated.

Time-boxed is an attribute in Scrum practices, which promotes a fixed time frame for a development sprint. The effect of time boxed attribute is tested by two items in the questionnaire and they are positively correlated with a coefficient of 0.546. Therefore, "Time span of a sprint is not sufficient for a detailed requirement elicitation process" and "Requirement detailing should start at-least before two sprints are having a significant relationship with each other".

4.7.1.3 Inter-item correlation – Technology

Technology variable has two subfactors, Tools and New Technology. The coefficients related to Pearson's Correlation Matrix are illustrated in Table 4-17: Inter-Item Correlation of Technology. Each subfactor of the technology variable had two items and the inter-item correlation for the subfactor have a significant positive relationship. Interaction with clients can be improved by familiarizing them with communication tool and Scrum teams cannot find a single document describing the entire requirement as they are maintained in tools are related to each other with a correlation coefficient of 0.581.

Table 4-17: Inter-Item Correlation of Technology

	1	**2**	**3**	**4**
Interaction with clients can be improved by familiarizing them with communication tool (1)	**1**	**.581**	.262	.193
Scrum teams cannot find a single document describing the entire requirement as they are maintained in tools. (2)	**.581**	**1**	.259	.193
Prototyping is the best technique that an offshore team can use to demonstrate the requirements captured. (3)	.262	.259	**1**	**.558**
Joint application design is limited with offshore scrum teams due to the low support and fewer interactions from the customers. (4)	.193	.193	**.558**	**1**

Prototyping is the best technique that an offshore team can use to demonstrate the requirements captured and Joint application design is limited with offshore scrum teams due to the low support and fewer interactions from the customers are having a correlation coefficient of 0.558.

4.7.1.4 Inter-item correlation – Soft Skills

Soft skills included three subfactors and all the items are positively correlated, as per the Pearson's correlation matrix depicted in Table 4-18: Inter-Item Correlation of Soft Skills. Two items constructed a significant positive relationship among each other for communication subfactor.

Table 4-18: Inter-Item Correlation of Soft Skills

	1	2	3	4	5	6	7	8
Customers frequently interact with the development team to assist in better understanding of the problem and domain.(1)	**1**	**.542**	**.480**	.334	.219	.256	.263	.226
Requirement completion delays occur due to lack of swift feedback from the customer.(2)	**.542**	**1**	**.630**	.317	.262	.334	.319	.261
Business analysts should have good presentational and communication skills to understand requirement, negotiate with customers and to propose alternatives.(3)	**.480**	**.630**	**1**	.312	.218	.342	.292	.235
Sound knowledge about business management, helps a Business Analyst to understand customer requirement.(4)	.334	.317	.312	**1**	**.609**	.418	.473	.317
Business analysts should be encouraged to carry out intensive background research of a project/product domain.(5)	.219	.262	.218	**.609**	**1**	.265	.327	.206
On-site teams of an offshoring scrum team can identify end user expectations on User Experience better than off-site teams.(6)	.256	.334	.342	.418	.265	**1**	**.705**	**.574**
Having domain expertise can capture the requirement easily within a short time frame.(7)	.263	.319	.292	.473	.327	**.705**	**1**	**.532**
The time differences between the development team and the client's location, has a severe impact in requirement process.(8)	.226	.261	.235	.317	.206	**.574**	**.532**	**1**

Customers frequently interact with the development team to assist in better understanding of the problem and domain and Requirement completion delays occur due to lack of swift feedback from the customer demonstrated a significant relationship of 0.542. The coefficient of 0.630 generated for Requirement completion delays occur due to lack of swift feedback from the customer and Business analysts should have good presentational and communication skills to understand the requirement, negotiate with customers and to propose alternatives emphasizes the correlation between the two items are significant.

Business analytic knowledge has only two items and they are having a significant correlation of 0.609. Sound knowledge about business management, helps a Business Analyst to understand customer requirement and Business analysts should be encouraged to carry out an intensive background research of a project/product domain demonstrates a significant relationship among each item.

On-site teams of an offshoring scrum team can identify end-user expectations on User Experience better than off-site teams and Having domain expertise can capture the requirement easily within a short time frame are having a strong relationship with each other according to the correlation coefficient of 0.705. Having domain expertise can capture the requirement easily within a short time frame and The time differences between the development team and the client's location, has a severe impact in requirement process are positively correlated with a coefficient of 0.532. On-site teams of an offshoring scrum team can identify end-user expectations on User Experience better than off-site teams and The time differences between the development team and the client's location, has a severe impact in requirement process are related to each other as the correlation coefficient is 0.574.

4.8 ANOVA

Analysis of variance (ANOVA) is a popular statistical technique used to test the influence of different groups on the dependent variable (Smalheiser, 2017). The present survey used One-way ANOVA and Two-way ANOVA to test the hypothesis.

4.8.1 One – way ANOVA for job role and requirement process satisfaction

One-way ANOVA testing is used to compare three or more groups on one variable. The present study intended to use One-way ANOVA to test the Hypothesis 4. Job roles are categorized into five segments, Business analysts, Developers, Architect, Project Managers, and Quality assurance engineers. However, Levene's test was performed on the dependent variable and the professional job role to test the assumption of homogeneity of variances.

According to (Brown & Forsythe Alan B., 1974), the median could be used in skewed distributions. As illustrated in Table 4-19: Levene's test for Job role and Requirement Process Satisfaction, the p = 0.065 > significance level (0.05) and the null hypothesis of equal variances can be sustained. Therefore, according to the test results of Levene's test, it can be assumed that the ANOVA test can be performed on job role and requirement process satisfaction.

Table 4-19: Levene's test for Job role and Requirement Process Satisfaction

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Requirement process satisfaction	Based on Mean	9.410	4	371	.000
	Based on Median	2.228	4	371	.065
	Based on Median and with adjusted df	2.228	4	265.508	.066
	Based on trimmed mean	6.666	4	371	.000

Table 4-20: One way ANOVA table

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.042	4	1.260	2.751	.028
Within Groups	169.979	371	.458		
Total	175.021	375			

As depicted in Table 4-20: One way ANOVA table, the significance value is 0.028 (p=0.028) which is less than 0.05. Thus the null hypothesis (H_{40}) is rejected and the alternate hypothesis (H_{4a}) is accepted. The result implies that a significant difference exists among different job roles towards Requirement process satisfaction. 206 of the sample is represented by developers and their perceptions towards the requirement the engineering process has a diverse response rate. Some of the respondents in this category have claimed the requirement process is not satisfactory, while others have responded that they are satisfied with the requirement management process.

4.8.2 Two - way ANOVA

Two-way ANOVA is calculated to find interactions between two independent variables on the dependent variable.

4.8.2.1 Scrum requirement process and technology towards requirement management satisfaction

Levene’s test for the scrum requirement process, technology towards the requirements process satisfaction is summarized in Table 4-21. The interpretation of the result is that the sigma value greater than 0.05, which indicates the ANOVA test for the considered variables can be used and the test output will be reliable.

Table 4-21: Levene's, Scrum requirement process and technology towards requirement management satisfaction

Levene's Test of Equality of Error Variances[a,b]					
		Levene Statistic	df1	df2	Sig.
Requirement process satisfaction	Based on Mean	1.526	90	182	.009
	Based on Median	.792	90	182	.892
	Based on Median and with adjusted df	.792	90	48.030	.830
	Based on trimmed mean	1.355	90	182	.043
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.					
a. Dependent variable: Requirement process satisfaction					
b. Design: Intercept + Scrum process + Technology + Scrum process * Technology					

Two-way ANOVA test has been applied to the technology factor and the Scrum process. As illustrated in Table 4-22, the significant value (0.243) is greater than 0.05. Therefore, the alternate hypothesis is accepted. In conclusion, the scrum requirement process and the technology do not interact towards requirement process satisfaction.

Table 4-22: ANOVA, Scrum requirement process and technology towards requirement process satisfaction

Tests of Between-Subjects Effects					
Dependent Variable: Requirement process satisfaction					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	137.920[a]	193	.715	3.506	.000
Intercept	1495.245	1	1495.245	7334.960	.000
Scrum process	93.699	31	3.023	14.827	.000
Technology	1.625	15	.108	.531	.921
Scrum process * Technology	33.401	147	.227	1.115	**.243**
Error	37.101	182	.204		
Total	6364.250	376			
Corrected Total	175.021	375			
a. R Squared = .788 (Adjusted R Squared = .563)					

4.8.2.2 Scrum requirement process and soft skills towards requirement management satisfaction

Levene’s test Table 4-23, interprets the sigma value (0.317) greater than 0.05 based on the median. This indicates that the ANOVA test for considered variables can be used and the output will be reliable. Thus, the ANOVA test applied to Scrum requirement process factor and Soft skills factor, and the results are depicted in Table 4-24.

Table 4-23: Levene's, Scrum requirement process and soft skills

Levene's Test of Equality of Error Variances[a,b]					
		Levene Statistic	df1	df2	Sig.
Requirement process satisfaction	Based on Mean	3.044	91	161	.000
	Based on Median	1.089	91	161	.317
	Based on Median and with adjusted df	1.089	91	45.834	.382
	Based on trimmed mean	2.824	91	161	.000
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.					
a. Dependent variable: Requirement process satisfaction					
b. Design: Intercept + Scrum process + Soft skills + Scrum process * Soft skills					

Table 4-24: ANOVA, Scrum requirement process and soft skills towards requirement process satisfaction

Tests of Between-Subjects Effects					
Dependent Variable: Requirement process satisfaction					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	151.798[a]	214	.709	4.918	.000
Intercept	1616.569	1	1616.569	11207.361	.000
Scrum process	14.010	30	.467	3.238	.000
Soft skills	27.303	25	1.092	7.572	.000
Scrum process * Soft skills	19.708	158	.125	.865	.820
Error	23.223	161	.144		
Total	6364.250	376			
Corrected Total	175.021	375			
a. R Squared = .867 (Adjusted R Squared = .691)					

The significant value from the ANOVA test is 0.820 and it is greater than 0.05. Therefore, the null hypothesis is accepted and the alternate hypothesis is rejected. In conclusion, the scrum requirement process and soft skills have no interaction towards requirement process satisfaction

4.8.2.3 Technology and soft skills towards requirement management satisfaction

Levene's test Table 4-25, interprets the sigma value (0.902) greater than 0.05 based on the median. This indicates that the ANOVA test for the considered variables can be used and the output will be reliable.

Table 4-25: Levene's, Technology and soft skills towards requirement management satisfaction

Levene's Test of Equality of Error Variances[a,b]					
		Levene Statistic	df1	df2	Sig.
Requirement process satisfaction	Based on Mean	1.692	75	208	.002
	Based on Median	.773	75	208	.902
	Based on Median and with adjusted df	.773	75	103.153	.881
	Based on trimmed mean	1.558	75	208	.008
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.					
a. Dependent variable: Requirement process satisfaction					
b. Design: Intercept + Soft skills + Technology + Soft skills * Technology					

According to the Levene's test results, the ANOVA test is applied to Technology factor and Soft skills factor. The ANOVA test results are depicted in Table 4-26. The significant value from the ANOVA test is 0.108 and it is greater than 0.05. Therefore, the null hypothesis is accepted and the alternate hypothesis is rejected. In conclusion, technology and soft skills have no interaction with requirement process satisfaction, thus the relationship with one factor and the dependent variable is not influenced by the second independent variable.

Table 4-26: ANOVA, Technology and soft skills towards requirement process satisfaction

Tests of Between-Subjects Effects					
Dependent Variable : Requirement Process Satisfaction					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	144.039[a]	167	.863	5.791	.000
Intercept	1244.242	1	1244.242	8353.503	.000
Soft skills	106.499	26	4.096	27.500	.000
Technology	2.207	15	.147	.988	.469
Soft skills * Technology	22.786	126	.181	1.214	.108
Error	30.981	208	.149		
Total	6364.250	376			
Corrected Total	175.021	375			
a. R Squared = .823 (Adjusted R Squared = .681)					

4.9 Regression Analysis

In order to test hypothesis 5: Independent variables significantly explains the dependent variable, a multiple regression analysis has been performed with all the independent variables. Tables Table 4-27: Full regression model - Model Summary, Table 4-28:Full regression model - ANOVA, Table 4-29: Full regression model - coefficients presents the output of the full regression model. According to Table 4-27: Full regression model - Model Summary, a high degree of correlation 0.804, can be observed and a 64.6% of the total variation in the dependent variable can be explained by all three variables in the conceptual model. Table 4-28:Full regression model - ANOVA indicates that the regression model predicts the dependent variable significantly. $P < 0.05$ indicates that the regression model statistically significantly predicts the dependent variable. According to Table 4-29: Full regression model -

coefficients, all P values are less than 0.05, indicating that the contribution of all three variables in the conceptual model is statistically significant to the regression model. Therefore, the alternate hypothesis is accepted and the null hypothesis is rejected. Thus, the set of independent variables significantly explain the satisfaction of the requirement engineering process.

Table 4-27: Full regression model - Model Summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. The error of the Estimate
1	.804[a]	.646	.644	.40787
a. Predictors: (Constant). Soft skills. Technology. Scrum Requirement Process				

Table 4-28:Full regression model - ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	113.134	3	37.711	226.685	.000[b]
	Residual	61.886	372	.166		
	Total	175.021	375			
a. Dependent Variable: Requirement process satisfaction						
b. Predictors: (Constant). Soft skills. Technology. Scrum Requirement Process						

Table 4-29: Full regression model - coefficients

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.436	.182		2.396	.017
	Scrum Requirement Process	.303	.049	.225	6.222	.000
	Technology	-.091	.030	-.097	-3.082	.002
	Soft skills	.721	.039	.677	18.394	.000
a. Dependent Variable: Requirement process satisfaction						

4.10 Other significant relationships

This section focusses on finding relationships and significant results that are not linked with a hypothesis.

4.10.1 Subfactors contributing to Requirement Management Satisfaction

According to the present study, requirement management satisfaction was deteriorating due to lean documentation and lack of overall view. The relationship between the independent variable and subfactors are illustrated in Table 4-30. Two subfactors of Scrum requirement process are having a significant relationship towards satisfaction of the requirement process. Lean documents are influential on the entire requirement process and problems of lean documentation lead to dissatisfaction on the requirement management process.

Table 4-30: Pearson Correlation - Subfactors

	Requirement management satisfaction	**Lean documentation**
Pearson Correlation	1	0.618
Sig. (2-tailed)		0.000
N	376	376
	Requirement management satisfaction	**Overall view**
Pearson Correlation	1	0.532
Sig. (2-tailed)		0.000
N	376	376
	Requirement management satisfaction	**Communication**
Pearson Correlation	1	0.542
Sig. (2-tailed)		0.000
N	376	376
	Requirement management satisfaction	**Business analytic knowledge**
Pearson Correlation	1	0.798
Sig. (2-tailed)		0.000
N	376	376
	Requirement management satisfaction	**Client practices and domain**
Pearson Correlation	1	0.572
Sig. (2-tailed)		0.000
N	376	376

The overall view is a consideration on the requirement management process and the lack of overall view of the requirement scope inclined to the diminishing value of the dependent variable. Business analytic knowledge of business analysts which was a subfactor of soft skills has a strong relationship with the dependent variable. Client practices and domain has a moderated relationship with the dependent variable.

4.10.2 Relationship between lean documents and time estimations

The basis for time estimations is provided by the specifications generated during the requirement analysis process. Scrum teams are adhering to lean concept for the specifications and artefacts that are expected to produce during the analysis. Therefore, lesser the details provided in specifications higher the tendency in estimations generating a variance compared to the actual time spent. The Pearson correlation analysis is used to define the relationship between lean documents and time estimations. The illustrated correlation in Table 4-31, ascertains the relationship between the lean document factor and "Initial time estimation, proven to be not sufficient at the end of a sprint, due to poor requirement management."

Table 4-31: Lean documents and time estimations

Correlations			
		1	Lean documents
Initial time estimation, proven to be not sufficient at the end of a sprint, due to poor requirement management. (1)	Pearson Correlation	1	.529**
	Sig. (2-tailed)		.000
	N	376	376
Lean documents	Pearson Correlation	.529**	1
	Sig. (2-tailed)	.000	
	N	376	376
**. Correlation is significant at the 0.01 level (2-tailed).			

4.10.3 Relationship between reworking and business analytic knowledge

Business analytic knowledge spreads across key functional areas like Finance, marketing, strategy, operations and human resource management. The software caters to solve problems and needs in real-world business. Therefore, business analytic knowledge strengthens the business analysis process. Lack of business analytic knowledge leads to errors in requirements captured and thus need reworking to rectify the problems occurred. This fact has been tested in the current dataset with the Pearson Correlation Matrix and the results are displayed in Table 4-32.

Table 4-32: Correlation between reworking and business analytic knowledge

Correlations			
		1	2
Business analytic knowledge	Pearson Correlation	1	.597**
	Sig. (2-tailed)		.000
	N	376	376
My team spends considerable time in reworking due to requirement errors	Pearson Correlation	.597**	1
	Sig. (2-tailed)	.000	
	N	376	376
**. Correlation is significant at the 0.01 level (2-tailed).			

Reworking and business analytic knowledge are significantly correlated as the Pearson correlation coefficient is 0.597. Thus, the study can conclude that business analytic knowledge holds a significant impact on reworking.

4.11 Discussion on results

Internal consistency for the present study was tested using Cronbach's alpha. The dependent variable and three individual variables were tested independently for reliability. All the variables passed the reliability test with a coefficient ranging from 0.7 to 0.85. The generated results indicate that internal consistency is acceptable.

Based on the results of the present study, the satisfaction on requirements management is influenced by Scrum requirement process and soft skills that a business analyst use in the process. The two factors have a significant linear relationship with the dependent variable. The correlation between the technology factor and the requirement process was not significant. Thus, the present research concludes that technology has a low impact on the requirements management process.

The analysis further decomposed to find the relationship between subfactors and the dependent variable. All subfactors under the Soft Skills variable had a linear relationship with the Requirement Process Satisfaction. Therefore, results imply that Business analytic knowledge has a greater influence on the requirement process. Client practice and domain also connected with requirement management process as the Pearson Correlation had yielded a significant positive relationship. Communication and the requirement process are linearly related.

The overall view and lean documents are two subfactors in the scrum requirement process. According to the analysis, lean documents are directly affecting the requirement management process. The business analyst should have in-depth knowledge of the scope of the project. Results imply that the overall view that the business analyst possesses, has a direct impact on the requirement process.

The ANOVA test was used to test the relationship between the job role and requirement management satisfaction. The result of the ANOVA testing confirmed that the requirement management process satisfaction is dependent on the job role. Requirement analysis affects all the job roles in a company that are aligned with a software development process. The perceived level of contribution and perceived level of granular details from the requirement engineering process differs per the job role. A business analyst viewpoint on the requirement process satisfaction can differ from the software architect's or a project manager's viewpoint. Therefore, each group of professionals may hold a different level of means for the dependent variable.

The regression model was developed for all independent variables as a full regression model. In the full model, the satisfaction of the requirement management process is significantly explained by the Scrum requirement process, technology, and soft skills. In other words, 64.6% of the variation is significantly explained by the independent variables considered in the conceptual framework.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Overview of the chapter

This chapter concludes the analysis of the statistical results obtained in the present study and recommends approaches to overcome challenges.

5.2 Research outcome based on demographic analysis

The survey questionnaire included six questions to identify the demographic profile of respondents. The respondents’ gender composition was 64% of male and 36% of female. The National ICT Workforce Survey in 2013 (Information and Communication Technology Agency of Sri Lanka, 2013) has reported a 29.7% of female representation in the ICT industry. Thus the gender composition in the survey is in line with the industry average.

Considering the job role composition among the survey respondents, the majority is software developers accumulating to 51% of the total sample. Generally, software developers have the highest share among the job categories. This has been proved by the National ICT Workforce Survey(Information and Communication Technology Agency of Sri Lanka, 2013). Business analysts and quality assurance engineer had a close sharing of 16% and 15% respectively. The higher rate of business analysts is due to the survey title, as it suggests the questionnaire is focused only on professional business analysts. All the respondents selected to further analysis possessed some experience in requirement engineering.

The sample consisted of professionals with 5-7 years’ experience, 34% of the total sample and 30% had 3-5 years of experience. The IT industry is growing and evolving. The experienced professionals move out from the IT environments and join with other industries to leverage from experience and knowledge acquired in the IT industry. Senior professionals in the industry are not passionate about filling online surveys and thus, the participation of experienced professionals limits to 9%.

5.3 Research implications

The conceptual model for the present study included three independent variables and nine sub-variables. The research analysis has identified two significant factors, that impact on the satisfaction on the requirement management process. These two factors are supported by five subfactors. As depicted in

Figure 5-1, the Scrum requirements process and soft skills are having a significant relationship with the requirements management satisfaction while business analytic knowledge is highly contributing to the requirement management satisfaction.

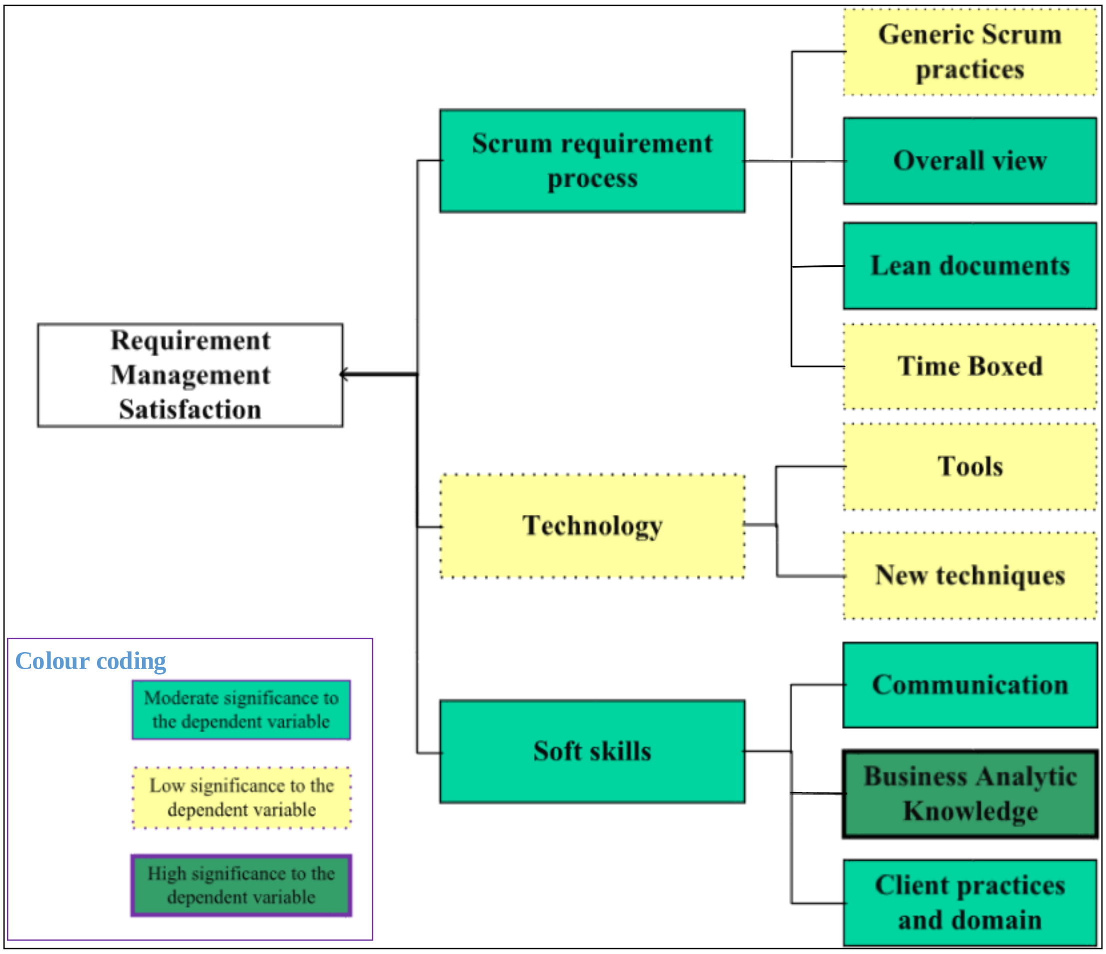

Figure 5-1: The finalized output of the factors affecting RE

Hypothesis 1 tested the relationship between scrum requirement process adopted by software teams and the requirement management process. The research concludes that scrum requirement process and the requirement management process satisfaction has a significant relationship (refer Table 4-12). Scrum requirement process has consisted of four aspects; generic scrum practices, time box, overall view, lean documents.

Lean documentation is a concept practiced by agile teams. Lean documents and requirement management process has a significant positive relationship with the requirement management process (refer Table 4-30). This emphasizes that the continuation of lean document practices would adversely affect the requirements management process. However, traditional document practices cannot be re-implemented for scrum teams, due to the time constraints prevailing in scrum environments. As observed in pre-survey interviews, scrum teams use tools like JIRA to capture the requirement, and they are not incorporated into a single document. Thus, teams spend considerable time in grasping the requirement, as they can be included in the comment sections too. Therefore, scrum teams should adopt a better approach to document the software requirement without violating scrum guidelines.

The overall view and the requirement management process satisfaction are correlated (refer Table 4-30). Overall understanding of the scope is essential in developing solutions, specifically in large projects. Features of a software project have interrelationships with each other, and business rules are linked with the features. A business analyst should have the knowledge in the entire scope of the project to ensure every aspect is captured in the requirement. Lack of minor aspect can decrease the usability level and customers would call off the changes. Missing the big picture expands the product scope and creates an incomplete product. A strategy should exist to expand the knowledge and understanding of the scope. Findings of Scrum requirement process and the requirement management process satisfaction is consistent with the findings of (Käpyaho, 2015) and (Mnkandla & Sebega, 2017).

Scrum requirement process and the satisfaction towards the requirements management process are positively correlated (refer Table 4-12). However, the ‘time box’ subfactor is not significantly correlated with the dependent variable. Since time box is an attribute in the scrum requirement process, the study suggests commencing requirement detailing at least two weeks prior to the development sprint. Thus, requirements should be evaluated and analyzed to the detailed level, before the start of the development sprint.

Hypothesis 2 tested the relationship between technology and the requirements management process satisfaction. According to the results of the survey, technology has no significant relationship with the requirement management process (refer Table 4-13). Thus, the requirement management process has not been affected tools and techniques used to elicit requirements. This could be due to most companies do not use requirements management tools as the cost involved cannot be justified against the benefits. Requirement engineering is more associated with human aspects such as communication abilities, availability of stakeholders, etc. However, a tool or a technique leads to better management provided that the human aspects are controlled in the direction of requirements management plans.

Hypothesis 3 of the present study tested the relationship between Requirement Management Satisfaction and Soft skills. The present study observed a resilient positive relationship as the correlation coefficient was 0. 775 (refer Table 4-14). All the subfactors included in the soft skill factor are significantly correlated with the scrum requirement process. Accordingly, communication is important in requirement analysis. Teams that have demonstrated the high capability of negotiation and communication skills produce useable requirements. Teams with inadequate communication skills are creating errors in the requirement process, thus leading to dissatisfaction among the team members. Communication skills refer to verbal and nonverbal communication, open-mindedness, empathy, and feedback.

Communication is a two-way process. One end delivers and the other end receives the message. In this two-way process, both the client and the team engaged in direct communication should demonstrate a greater extent of empathy, understanding, clarity, and concision. A considerable time of a business analyst is associated with communicating requirements with the customer and delivering requirement briefing to the team. Failure in either aspect (communication with client or communication with the team), cause requirement delays, requirements that are not development ready and even towards reworking the entire functionality.

Soft skill factor consisted of client practices and domain. The domain is a tacit knowledge that a business analyst develops over a period of time. The domain knowledge includes formatting, industry-specific knowledge and regulations. Tacit knowledge is subjected to lost with the employee resignation from the current employment. Moreover, the knowledge in the subject area of the project could be hard to capture due to the unavailability of certain industries in the offshoring country. Client domain is not limited to industry knowledge but also the client practices in using the software. Soft skills directly impact the requirement engineering process during the activities of elicitation, prioritization, negotiation, and validation. A systematic approach should present in every offshoring software company to overcome the challenges caused by the soft skills of the client and employees.

Business analytic knowledge refers to the knowledgeability and the understanding of business contexts in the real world, which is highly significant to the RE process (refer Table 4-30). The pre-survey interviewees highlighted the fact that allowing technically oriented people to contact business customers always cause requirement inefficiencies due to the low understanding of the business aspects. Business understanding could be considered as an individual instinct.

Customer interaction is a subjective norm, and their level of interaction can vary on the urgency and importance of the requirement. If the requirement is potential in generating higher business value, then the customer might interact with the team to collectively solve the problems.

5.4 Recommendations to overcome challenges

Communication is a challenge in every requirement process. In overcoming the challenge of communication, the requirement management process should consider two aspects, client, and business analyst communication, business analyst and internal team communication. Language, methods, exhibits, and any other techniques used for the client is not appealing to the team.

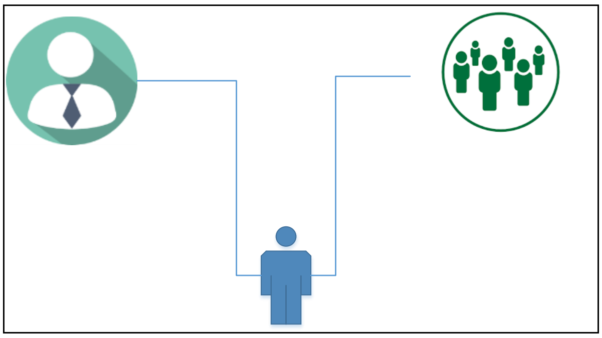

Figure 5-2: Communication considerations

Therefore, if an offshoring company wishes to improve the communication factor to yield better results in requirement engineering, the company should facilitate the improvements in client communication. Client support for effective communication can be affected by the tools used, the priority, clarity, and simplicity etc. In order to avoid the impact of tools, the company can provide training sessions to familiarize the client with the tool. Companies can be reluctant in investing time and effort to arrange a hands-on experience for the tools used. However, the future returns from a better requirement process will compensate for the investment in the long run. The present study has confirmed that client interaction with the team is affected by the level of familiarity in the communication tools used. Priority can be addressed with aligning customer priorities with implementations. Priorities should be pre-agreed for a shorter time period and need to be transparent for both parties. Based on the prior agreement with the importance and sequence of delivery, a business analyst can start elicitation. The client will be more interested in replying queries and clarifications, as he knows that the team is working according to his priorities.

The following steps should be considered as further improvements to the existing practices in customer communication;

1. Consider and agree on the comfort zones of the client. This includes an agreement on the timing for conversations in general.
2. Use of comfortable tools and communication modes. Avoid imposing clients to use tools preferred by the team.

3. A periodic check on the need for scheduled and recurrent status meetings.
4. Organizational-wide acceptance and understating of the steps 1 to 3.

Client practices and the domain is a challenging factor to address in the requirements engineering process. Domain knowledge is always associated with the tacit knowledge and it should be shared among the team members. The following aspects can be considered in developing plans to avoid limitations imposed by the factor.

1. Create a knowledge culture in the organization.
2. Seating arrangements to unite members working for the same area. Close proximity encourages people to communicate freely.
3. Reducing internal completions. Internal competitions result in members being reluctant to share knowledge among team members

Business acumen can be taught. The speedy of developing a strong business acumen depends on the methodology adopted. However, companies should focus on the following aspects to improve business knowledge;

1. Recruit candidates possessing professional qualifications in finance background
2. Facilitate and encourage employees who seek to learn and grow business competencies. Examples include; sponsoring professional programs, MBAs, etc.
3. Set annual goals to individuals to improve business acumen and review and reward those who achieve the goal.
4. Involve the team as much as possible in client communication to allow members to learn from customer stories.

Documents are important in any project to serve as validation proof. The scrum teams are concerned with developing comprehensive documents as the importance and usage of the documents are subjected to deteriorate over the time period of a project. Thus prototyping is an alternate solution for the scrum teams with minimal documentation. The prototype has to be validated with the customer at the early stage of requirement elicitation. The requirement or the product backlog item should not be considered as 'development ready' until the prototype is approved by the customer.

The thorough understanding of the overall requirement helps a business analyst to connect requirements together. Missing requirements and requirement incompatibility arise due to the less knowledge in the overall picture. Therefore, a continuous approach should be developed to enhance the team's knowledge of the overall requirement. The knowledge gap level is a changing attribute of any team. Therefore, the knowledge gap should be analyzed in proportionate to the expected level. The following guidelines are proposed to improve the vision of the overall picture.

1. Plan a series of workshops with the product owner to share the knowledge.
2. Involve members with a poor overall view in the customer meetings.
3. Develop a traceability matrix, for long-lasting projects. A traceability matrix can be used in requirement elicitation to ensure important features are not forgotten.
4. Allocate a scheduled time for research and development in the subject area. New findings are to be shared with others to improve the organizational wide knowledge.

5.5 Research Limitations

The present study encountered few limitations in conducting the research. Requirement engineering is a widespread function across any software organization. It is difficult to draw a line separating the other roles and business analysis as requirements are used and managed by every tier in a team. Therefore, perceptions and expectations on requirement management are not similar among all job categories. Teams use a wide variety of tools, techniques, and processes that create wide-ranging challenges in own requirement management processes. The strategies proposed in the present study is therefore not fitting to every micro process.

A strategy is a plan to achieve a long term goal. The measures of requirement engineering are evolving with time along with the technological expansions and process optimizations. A vision towards the future needs and changes that require to the future is hard to capture. Thus changes to current strategic plans should be expected to occur during the long run. Therefore, the strategies to overcome the challenges in RE should not be a barrier to adopt new changes in the industry. Time and scope utilized in the research were not enough to conduct a validation of the planned strategies with experienced professionals in the software industry.

The prevalent limitation in the present study is that accurate information is not available about companies or teams that use Scrum as their development methodology. The perceptions and opinions build in this survey may be influenced by the other methodologies as well, if individuals are working in different methodologies. The survey can be extended to avoid the limitations and the future research directions are discussed in Recommendations for future research studies.

5.6 Recommendations for future research studies

Further research can be carried out on requirement management in product based offshoring companies. The present study was generic about the product and project-based companies. However, specific complications on RE exist in product based companies. They include; continuous need in industry research, developing features that are commonly used, and upfront knowledge in the market movements etc. These limitations should be eliminated to ascertain better results from the requirements engineering. Future studies should focus on the complications of business requirements in product environments and adaptability of requirement management to yield effectiveness and productivity.

Complex software projects have circumstances that are different in nature. These projects have versatile needs of requirement management. Complex projects managed in scrum environments have not been frequently researched. Therefore, complex requirement analysis and management in complex projects should be focused on a separate research study. Furthermore, the study can be extended to find out a model to address the documentation aspects discussed in the present study.

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APPENDIX A - Pre-Survey

Pre-survey has consisted of open-ended questions. 23 professionals participated in the pre-survey and they emphasized the factors identified in the LR. Some additional concerns were also highlighted during conversations.

1. Pre-Survey Result Evaluation

Interviewers had varied ideas on handling requirement management process effectively. However, their concerns related to requirement engineering challenges were in line with the literature review.

2. Interview questions & answers

Question with summarized responses
1. What are the key challenges you have seen in requirement engineering with scrum teams?
• Requirement confirmation delays leading to *Developers reluctant to start working as the requirement is incomplete *QAs cannot start their work with insufficient requirements • Lack of business-minded personnel in scrum teams • Lack of communication skills in the development teams, who gather requirement • No proper document to refer • Time-boxed - and RE produce a poor output • Requirement changes are not documented • The big picture is missing • Cannot find a single document for the entire requirement • The team doesn’t go through the requirement in detail before implementation • Starting development with half incomplete requirements • Requirement versioning • Prioritization • Lack of adherence to the sprint backlog • Knowledge is undocumented • Fewer details make difficulties in QA teams to write test scripts • Starting development with incomplete requirements • Requirement traceability • Requirement changes during the sprint • Sometimes we carry forward incomplete requirements from the last sprint

2. What are the key challenges in the requirement management process in offshore development?
• Problems/delays in requirement completion • Tools like JIRA are not commonly used by clients • Client expectation for a broader scope- making the RE process longer • Lack of customer support to understand the requirement • Time differences make communication delays • hidden requirements • The full business context is not revealed • Miscommunication due to language
3. What should be improved in terms of requirement management for offshore development?
• Communication • Documentation • Interfacing with the customer • Eliminate ambiguity • Improve on visuals (prototyping and wireframes)
4. What tools are used in the requirement management process? (JIRA, Slack etc)
• JIRA • Slack • Asana • Open Project
5. Does Your customer respond to your queries frequently? Do you have to wait long for clarifications?
• Avg: 1 day • Max: 4 days

Pre-survey summary

Summary of the results obtained in the pre-survey is depicted in Table C 1- Pre Survey Summary. The summary indicates the mostly stated concern by the interviewers. As illustrated in Table C 1, communication is the key concern in offshoring teams. Lean document concept is the second key concern, which is widely accepted and practised in scrum teams. The popularity of tools and their usage have created limitations to requirement elicitation. Tools like JIRA have been increasingly popular among offshoring teams as they provide greater visibility and tracing to all the teams involved.

The tools might not be familiar to business customers. Thus, customers are reluctant to use tools due to unawareness and security.

Customer responsiveness is also highlighted by the interviewers. Customer responsiveness depends on other factors – time and location, communication tool, clarity of questions made by the team etc. Lack of Overall view is a hindrance to the requirement management process, as the business analyst may overlook important linkages among functionalities and business rules that govern decisions.

Table C 1- Pre Survey Summary

Factor	**Number of responses**
Lean documents	18
Communication	21
Tools	12
Customer responsiveness	11
Big picture	13
Time-boxed	8

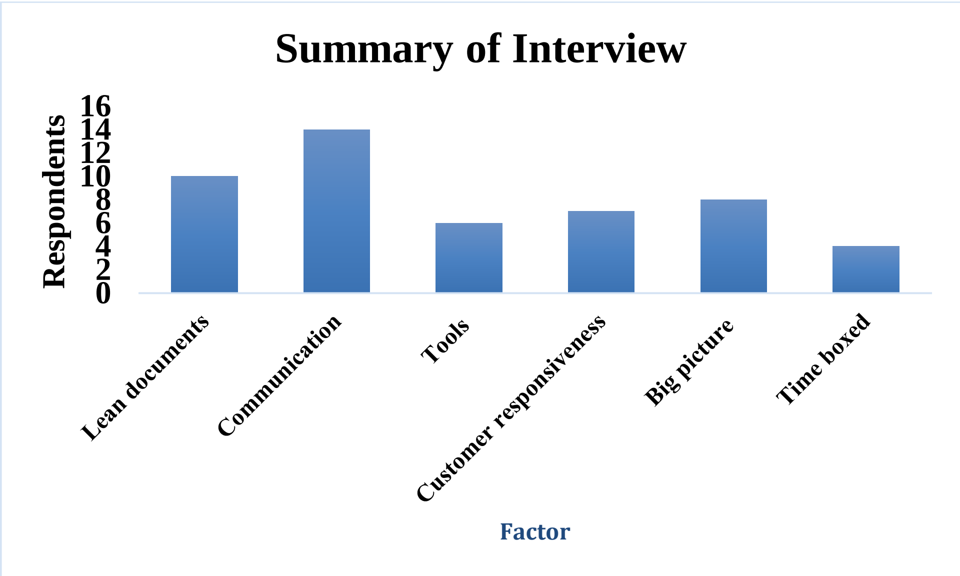

Figure C 1Graph of Pre Survey Summary

APPENDIX B – Final Survey

Address Note

Dear Sir/Madam,

Thanks in advance for filling this questionnaire which will approximately consume 5 - 10 minutes from your valuable time.

The survey has questions related to a few aspects of the requirement management process. IF you are a part of an offshoring Scrum team, and also participate in requirement process please spend a few minutes to fill the questionnaire.

This survey is conducted as the final project of an MBA in IT - University of Moratuwa. The main purpose of the survey is to identify key challenged in requirement engineering and to propose strategies to overcome challenges.

Thank you for your participation in the survey!!

Best regards
Sashika Hewawasam

General Questions

1. Age

	35 years and above
	31 - 35 years
	26 - 30 years
	24 - 25 years

2. Gender

	Male
	Female

3. What is your job role?

	Developer
	Architect
	Quality Assurance
	Business Analyst
	Project Manager
	Other

4. Have you ever engaged in requirement analysis at some point in your IT career?

	Yes, Frequently
	Occasionally
	No, never
	Yes, as required

5. How much of experience you do possess in the IT industry

	More than 10 years
	7-10 years
	5-7 years
	3-5 years
	Below 3 years

6. What is the development methodology followed in your company?

	Scrum
	Kanban
	Waterfall
	Devops
	Extreme Programming
	Other

Requirement management process

		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
7.	I feel comfortable with the requirement management process in my company					
8.	My team spends considerable time in reworking due to requirement errors					
9.	Initial time estimation, proven to be not sufficient at the end of a sprint, due to poor requirement management					
10	Final delivery gets delayed due to the frequent changes in the requirement when the sprint is started					

Scrum requirement process

		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
11	User stories are always written by the product owner or end users of the system					
12	Requirements can be gathered correctly when all the scrum members contact the customer					
13	Problem domain can be well-explained using scenario-based specification than user stories or use cases					
14	Our company facilitates additional conversations between the product owner/end users and the scrum team before accepting the user story into a sprint					
15	Requirement knowledge sharing among the scrum team can be done without a requirement document					
16	User stories focus only on the business & functional requirements. Technical aspects are ignored					
17	Offshoring teams should encourage wire-frames, prototyping and flow charts to ensure all stakeholders understand the requirement					
18	Business Analyst's knowledge gap in the entire scope of the project/product leads to, requirement overlaps with another sprint backlog item					
19	Requirements will not be compatible with existing business rules if the BA has a limited understanding of the entire scope of the project/product					
20	Important functionalities may not be covered in requirement analysis due to Business Analyst's poor understanding of the overall picture					
21	The time span of a sprint is not sufficient for a detailed requirement elicitation process					
22	What percentage of time do you recommend to allocate in the requirement management process in an offshoring scrum team?	○ <= 10% of the total time ○ 11 -30 % of total time ○ 30 -50 % of total time ○ >= 50 of the total time				
23	Requirement detailing should start at-least before two sprints					

Technology

		Strongl y agree	Agree	Neutral	Disagre	Strongl y
24	Client interaction with the team is affected due to the unfamiliarity of the communication tools used					
25	Scrum teams cannot find a single document describing the entire requirement as they are maintained in tools.					
26	Prototyping is the best technique that an offshore team can use to demonstrate the requirements captured.					
27	Joint application design is limited with offshore scrum teams due to the low support and fewer interactions from the customers.					

Soft skills

		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
28	Customers frequently interact with the development team to assist in a better understanding of the problem and domain.					
29	Requirement completion delays occur due to lack of swift feedback from the customer.					
30	Business analysts should have good presentational and communication skills to understand the requirement, negotiate with customers and to propose alternatives.					
31	Sound knowledge about business management, helps a Business Analyst to understand customer requirement.					
32	Lack of intensive background research of a project/product domain causes insufficient requirements.					
33	On-site teams of an offshoring scrum team can identify end-user expectations on User Experience better than off-site teams.					
34	Having domain expertise can capture the requirement easily within a short time frame.					
35	The time differences between the development team and the client's location have a severe impact on the requirement process.					

APPENDIX C – Final Survey Result Summary

1. Age

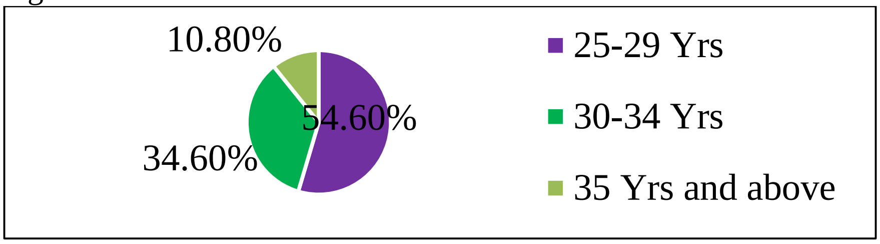

Figure D 1: Age

2. Gender

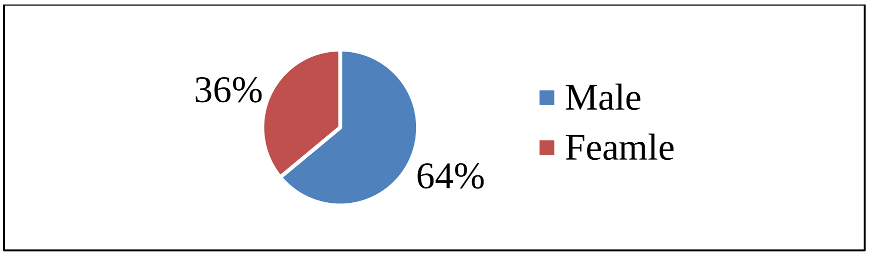

Figure D 2: Gender

3. What is your job role?

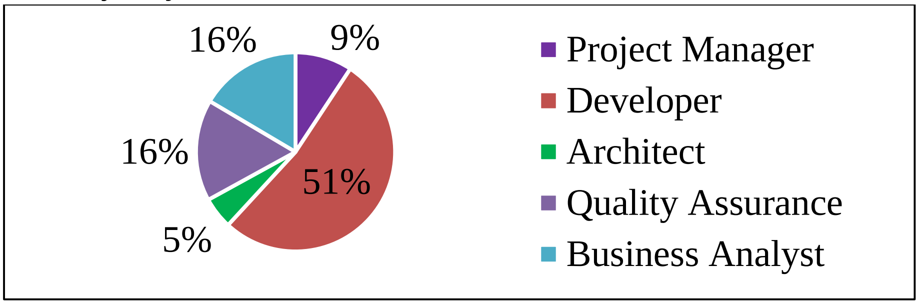

Figure D 2: Job role

4. Have you ever engaged in requirement analysis at some point in your IT career?

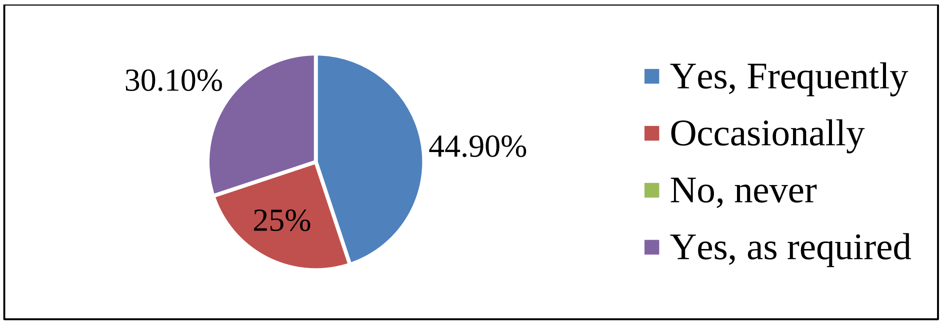

Figure D 3: Engagement in RE

5. How much of experience you do possess in the IT industry

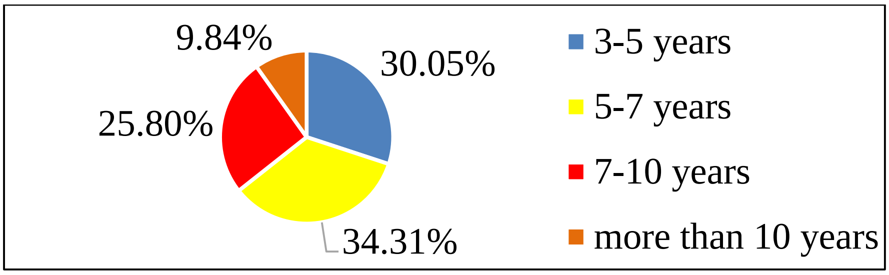

Figure D 4: Experience

6. What is the development methodology followed in your company?

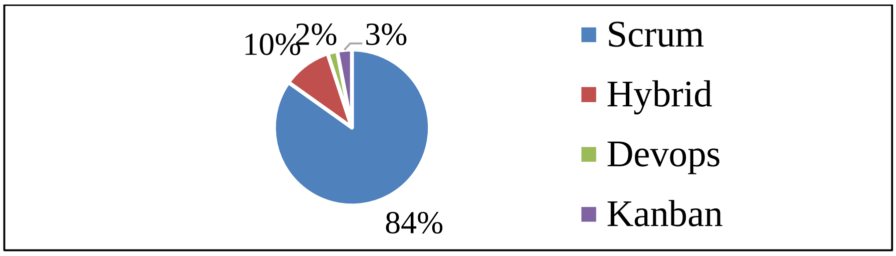

Figure D 5: Development Methodology

7. I feel comfortable with the requirement management process in my company

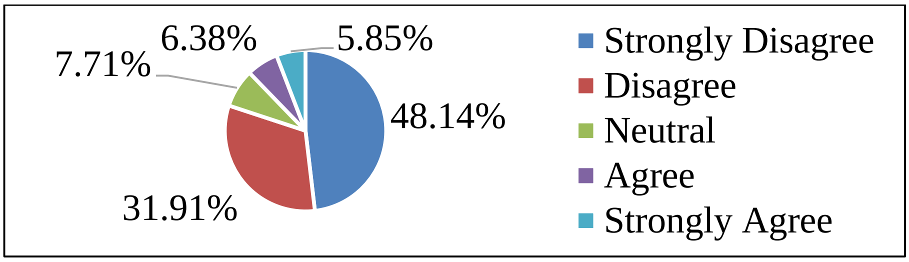

Figure D 6: Requirement Management Process

8. My team spends considerable time in reworking due to requirement errors

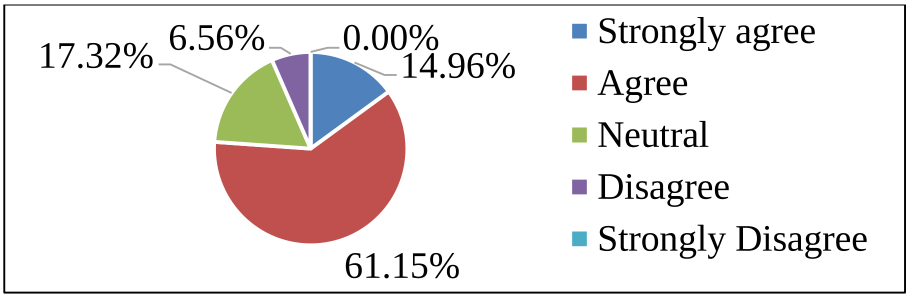

Figure D 7: Reworking

9. Initial time estimation, proven to be not sufficient at the end of a sprint, due to poor requirement management

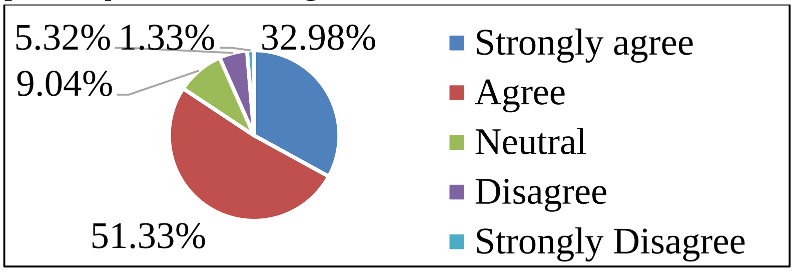

Figure D 8: Initial time estimation accuracy

10. Final delivery gets delayed due to the frequent changes in the requirement when the sprint is started

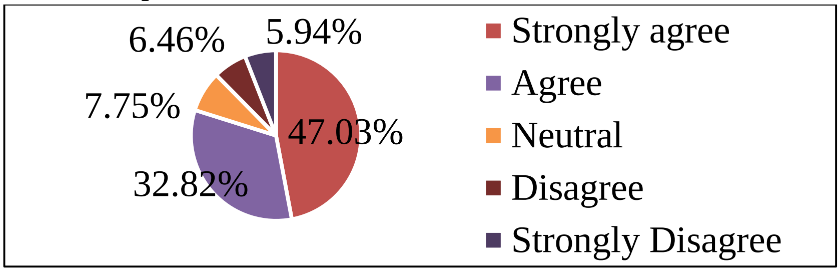

Figure D 9: Delivery delays

11. User stories are always written by the product owner or end users

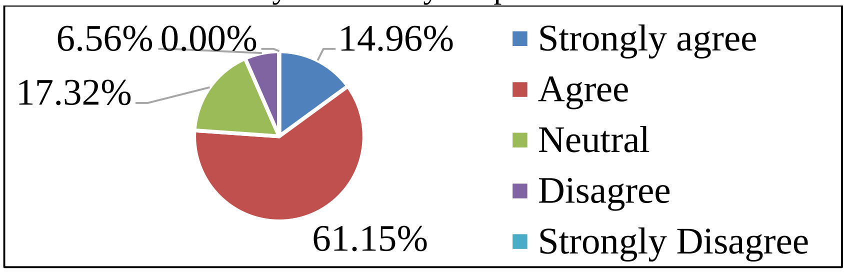

Figure D 10: User stories

12. Requirements can be gathered correctly when all the scrum members contact the customer

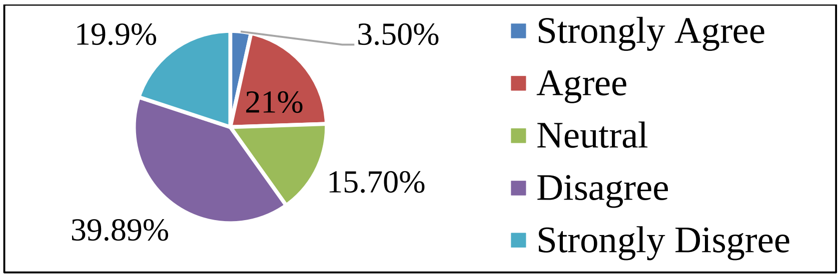

Figure D 11: Team participation

13. Problem domain can be well-explained using scenario-based specification than user stories or use cases

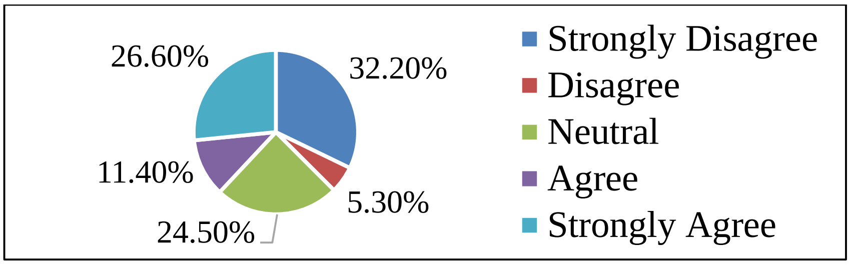

Figure D 12: Scenario-based specifications Vs User stories

14. Our company facilitates additional conversations between the product owner/end users and the scrum team before accepting the user story into a sprint

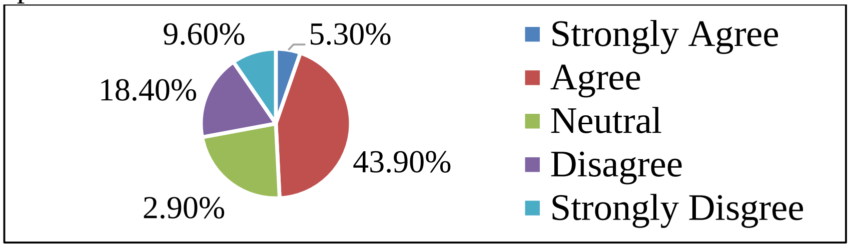

Figure D 13: Additional Conversations

15. Requirement knowledge sharing among the scrum team can be done without a requirement document

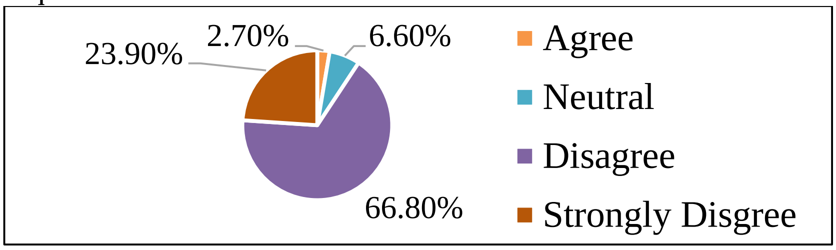

Figure D 14: Requirement documents

16. User stories focus on the business requirements. Technical aspects are ignored

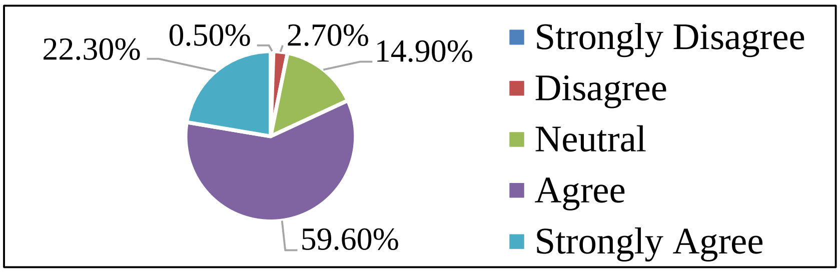

Figure D 15: Requirement documents

17. Offshoring teams should encourage wire-frames, prototyping and flow charts to ensure all stakeholders understand the requirement

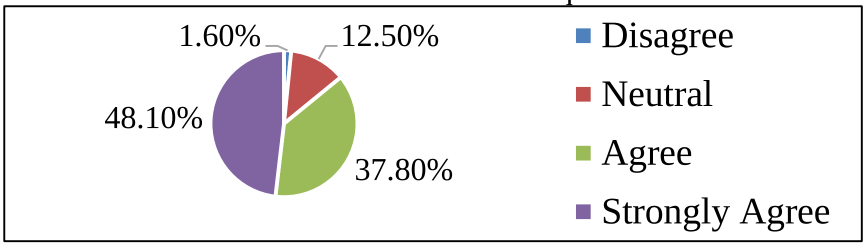

Figure D 16: Visual items in documentation

18. Business Analyst's knowledge gap in the entire scope of the project/product leads to, requirement overlaps with another sprint backlog item

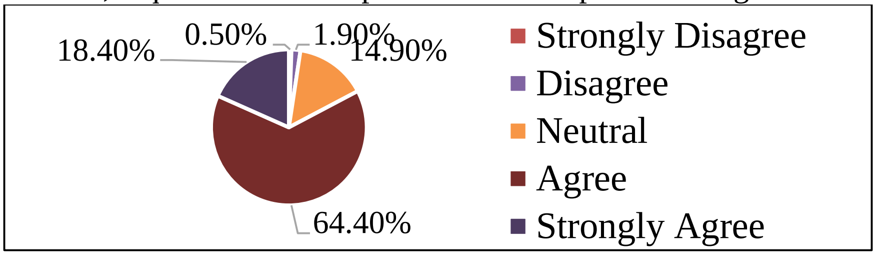

Figure D 17: Overall View and requirement overlaps

19. Requirements will not be compatible with existing business rules if the BA has a limited understanding of the entire scope of the project/product

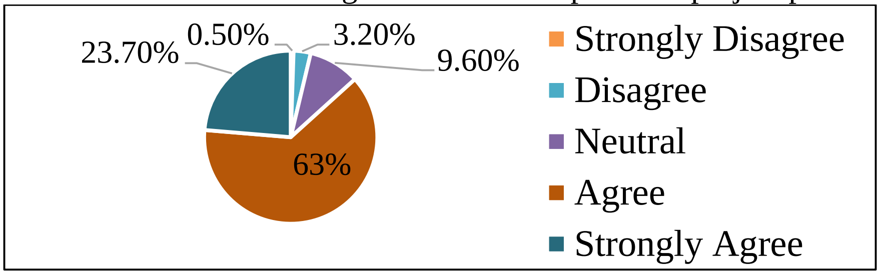

Figure D 18: Overall view and business rules

20. Important functionalities may not be covered in requirement analysis due to Business Analyst's poor understanding of the overall picture

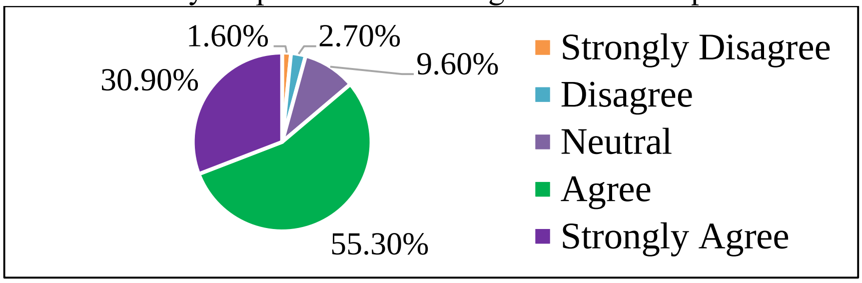

Figure D 19: Overall view and functionalities coverage

21. The time span of a sprint is not sufficient for a detailed requirement elicitation process

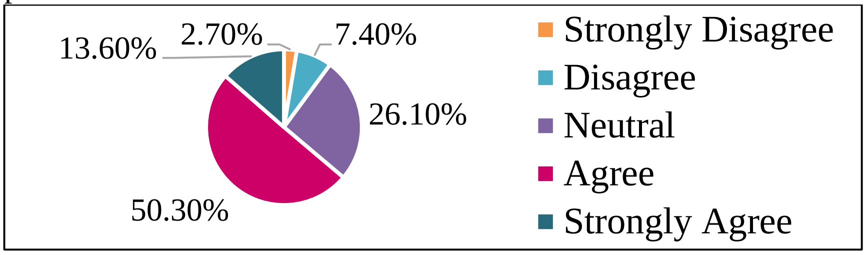

Figure D 20: Sprint time span

22. What percentage of time do you recommend to allocate in the requirement management process in an offshoring scrum team?

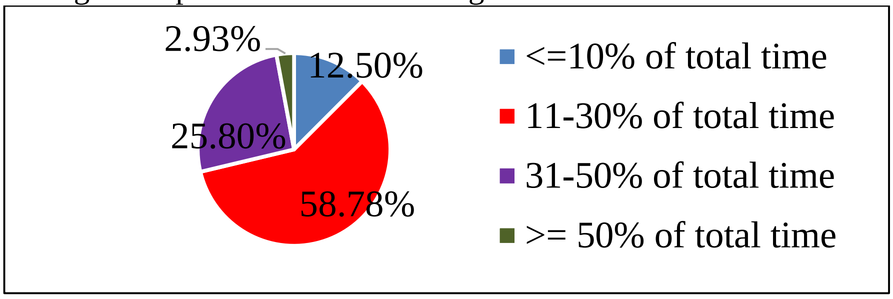

Figure D 21: Time allocation

23. Requirement detailing should start at-least before two sprints

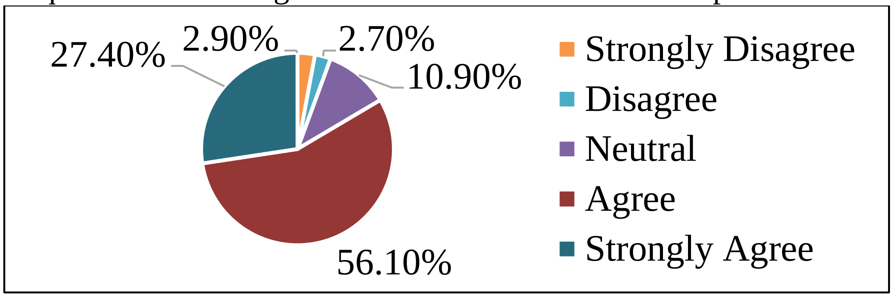

Figure D 22: Requirement detailing

24. Client interaction with the team is affected due to the unfamiliarity of the communication tools used

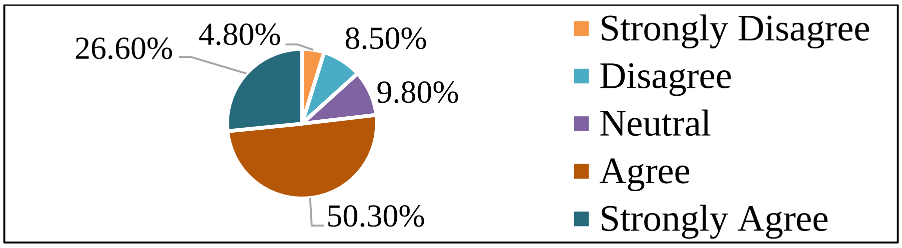

Figure D 23: Communication tools

25. Scrum teams cannot find a single document describing the entire requirement as they are maintained in tools.

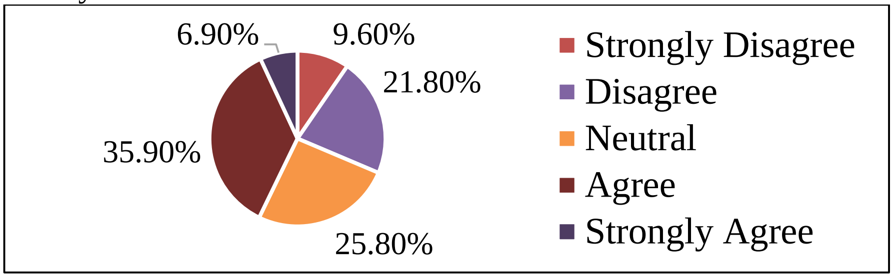

Figure D 24: Requirement documentation in tools

26. Prototyping is the best technique that an offshore team can use to demonstrate the requirements captured.

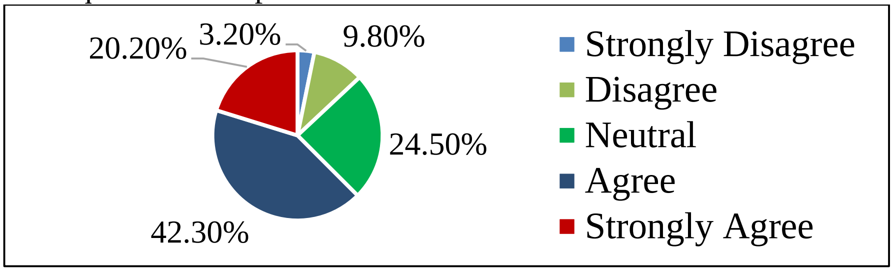

Figure D 25: Prototyping

27. Joint application design is limited with offshore scrum teams due to the low support and fewer interactions from the customers.

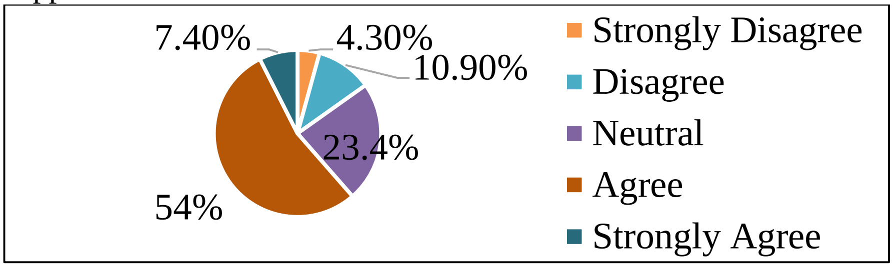

Figure D 26: Joint application design

28. Customers frequently interact with the development team to assist in a better understanding of the problem and domain.

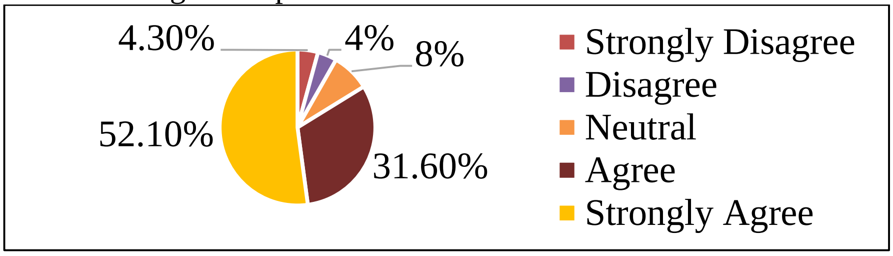

Figure D 27: Customer interaction

29. Requirement completion delays occur due to lack of swift feedback from the customer.

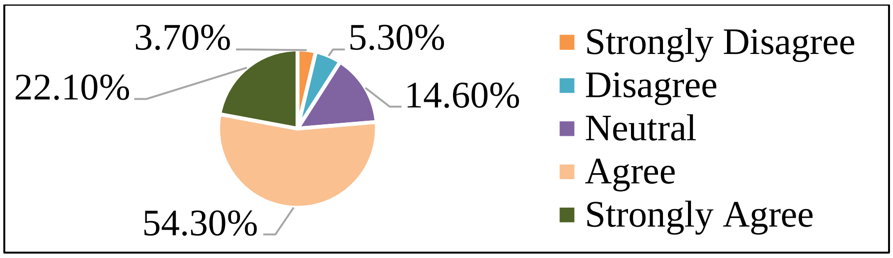

Figure D 28: Requirement delays

30. Business analysts should have good presentational and communication skills to understand the requirement, negotiate with customers and to propose alternatives.

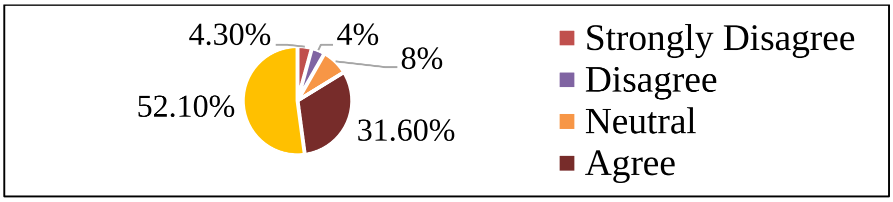

Figure D 29: Communication skills

31. Sound knowledge about business management, helps a Business Analyst to understand customer requirement.

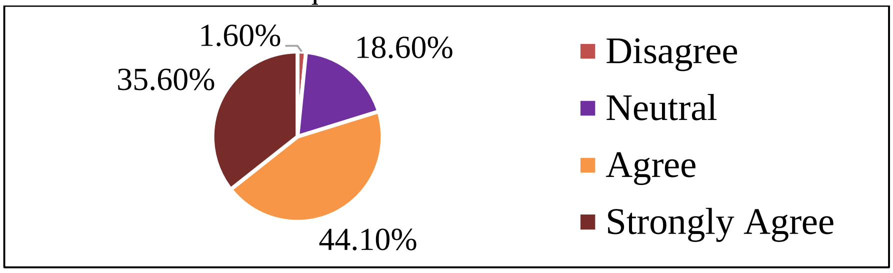

Figure D 30: Business analytic knowledge

32. Lack of intensive background research of a project/product domain causes insufficient requirements.

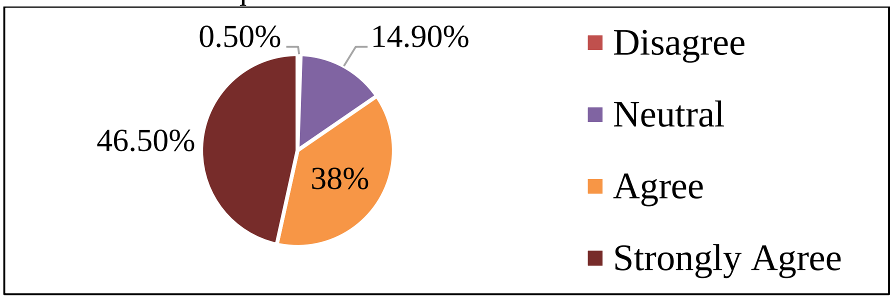

Figure D 31: Background researches

33. On-site teams of an offshoring scrum team can identify end-user expectations on User Experience better than off-site teams.

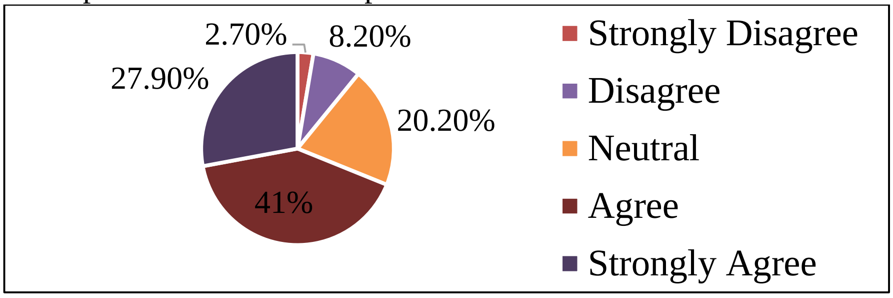

Figure D 32: Onsite teams

34. Having domain expertise can capture the requirement easily within a short time frame.

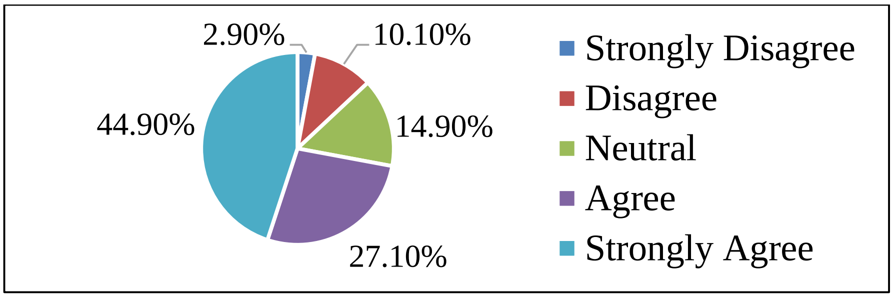

Figure D 33: Domain expertise

35. The time differences between the development team and the client's location have a severe impact on the requirement process.

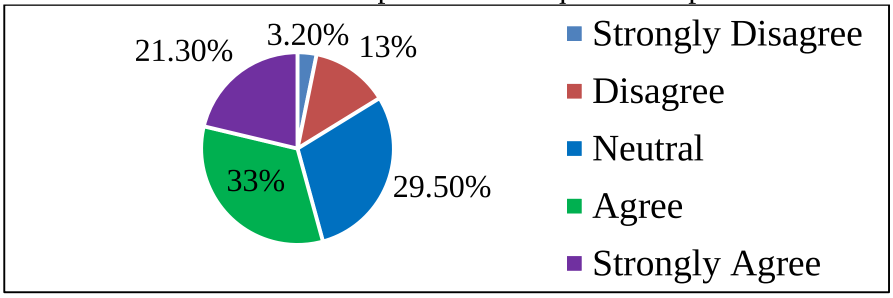

Figure D 34: Client location and time difference

APPENDIX D – Company List

Questionnaire distribution was made online and some companies have been contacted through their respective HR departments to fill the online survey. Other responses were collected through LinkedIn groups and other professional groups available in various social media networks. Therefore, the company of some respondents are not known. The company list includes the following.

1. Virtusa
2. SimCentric Technologies
3. Millennium IT
4. wso2
5. 99X Technologies
6. Creative Solutions
7. Gapstars
8. Unicorn Solutions
9. DMS technologies
10. QBuild Software
11. Omobio (Pvt) Ltd
12. Navantis IT (Pvt) Ltd
13. ZILLIONe
14. Cloud Solutions International
15. eBuilder
16. Direct FN
17. Attune Lanka
18. Intervest Software Technologies (Pvt) Ltd
19. Pearson Lanka
20. Tiqri Pvt Ltd
21. Calcey Technologies