



Customer communication challenges in Agile Requirements Engineering

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This thesis is submitted to the Faculty of Computing at Blekinge Institute of Technology in partial fulfilment of the requirements for the degree of Master of Science in Software Engineering. The thesis is equivalent to 20 weeks of full time studies.

The authors declare that they are the sole authors of this thesis and that they have not used any sources other than those listed in the bibliography and identified as references. They further declare that they have not submitted this thesis at any other institution to obtain a degree.

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Abstract

Context and background: Requirements engineering(RE) is a first and a very important phase in any software development which helps in building a suitable and customer satisfactory product. In the past few years, the use of Agile software development has become popular in the industry. Customer communication plays an important role in any software development life cycle. Customers state the requirements needed to develop a product in the Requirements Engineering phase. A project is likely to fail due to problems in customer communication during the RE phase.

Objective: This thesis aims to study the Customer communication challenges in Agile requirements engineering, prioritize these challenges, and also find out the mitigation strategies to overcome these challenges.

Research Method: A systematic mapping study is conducted to find out the customer communication challenges. Based on the data collected from the systematic mapping study, a survey is conducted to find out the mitigation strategies to overcome the customer communication challenges faced in the RE phase and also prioritize these challenges.

Results: Based on the data collected from the systematic mapping study, a total of 18 customer communication challenges are identified. In the second step, a survey is conducted based on the identified challenges. The prioritization of these challenges is done by calculating the risk analysis of the challenges from the survey data. And finally, mitigation strategies are mentioned to overcome all the identified 18 challenges.

Keywords

Requirements engineering, Agile, customer collaboration, Agile requirement engineering, customer communication, systematic mapping study, Survey.

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Requirements engineering(RE) is the important phase in any software development life cycle. The software development life cycle starts with requirements gathering. Requirements engineering is used for identifying stakeholders, their needs and documenting requirements that help in delivering a satisfactory final product[31].

Day by day Agile software development is gaining popularity in the world. The evolution from the traditional methods to Agile methods have changed the requirements engineering extremely. In traditional requirement engineering approach, the RE phase occurs only once at the beginning of development process and any changes in requirements in later stages can be very expensive to implement. But in Agile software development the requirements engineering phase occurs at all stages of the development. Changes in the requirements can be made at any stage of the Agile software development. For this reason Agile software development became very popular in RE field[13].

Agile manifesto states "Customer collaboration over contract negotiation" and "Individuals and interactions over processes and tools" [15], which means customer collaboration and individual interactions are given priority than contract negotiation and processes.

In Agile software development customer plays an important role in every stage of development process which leads to the delivery of a customer satisfactory product. In Agile, customer communication occurs multiple times rather than a single meeting to provide and update requirements at any stage of development cycle. Customer communication plays a key role in Agile software development but it has its own challenges[17].

Customer communication is the key in requirements gathering. Many risks arise in a project due to problems in customer communication during requirements engineering phase. Problems in Requirements engineering leads to failure of many software projects[23]. Although there are researches on challenges in RE[14][20][7][18], but there are not many researches focusing specially on customer communication and possible mitigation strategies to overcome customer communication challenges which is the aim of this thesis.

1.1 Aims and Objectives

1.1.1 Aim:

The aim of this thesis is to investigate, prioritize and mitigate the challenges that arise during customer communication in an Agile Requirements engineering process.

1.1.2 Objectives:

The objectives of this thesis are:

1. To understand the challenges faced during Agile Requirements engineering phase and study the challenges related to customer communication.
2. To identify the factors and prioritize these challenges to identify the most important challenges.
3. To identify solutions to overcome these challenges that are faced to reduce the risks in the project.

To do this, two research methods are considered, which are systematic mapping study and survey. From the systematic mapping study, a list of customer communication challenges faced in Agile requirements engineering are identified. Based on the data collected from systematic mapping study a survey will be conducted to find out the mitigation strategies to the identified customer communication challenges faced in Agile RE and also prioritization of these challenges is done.

1.2 Research Questions

Research questions are formulated based on the aims and objectives mentioned in section 1.1.

RQ1: What are the customer communication challenges faced in Requirement engineering process in Agile software development?

***Motivation:** Customer communication plays an important role in Requirements phase of any software development life cycle. Problems in customer communication in RE phase can lead to many risks in the software project. So, it is important to identify the challenges related to customer communication in Agile RE.*

RQ2: How are the customer communication challenge prioritized?

***Motivation:** Based on the challenges gathered from RQ1, the prioritization of the challenges is done based on the frequency of occurrence of these challenges in a project and impact of these challenges on the project. This prioritization helps identify the important challenges that needs more effort and attention that helps reduce risks in the project.*

RQ3: What are the mitigation strategies that can be proposed for these challenges?

***Motivation:** From RQ1, the customer communication challenges in Agile RE phase are collected. To overcome these challenges proper mitigation strategies are found that reduces the risks in the project.*

1.3 Thesis Outline

This thesis report is structured into six sections. In Section 1, introduction is described that gives a description about the research topic, aims & objectives, the research questions and the research gap of the thesis. In Section 2, background and related work is described. Section 3 mentions the research methodologies used in the study. Section 4 discusses the results and analysis of the thesis. Section 5 discusses the information collected from the Section 4. Section 6 mentions the conclusion of the thesis and also addresses the future work that can be done as an extension to this research. The thesis outline is mentioned in the figure 1.1.

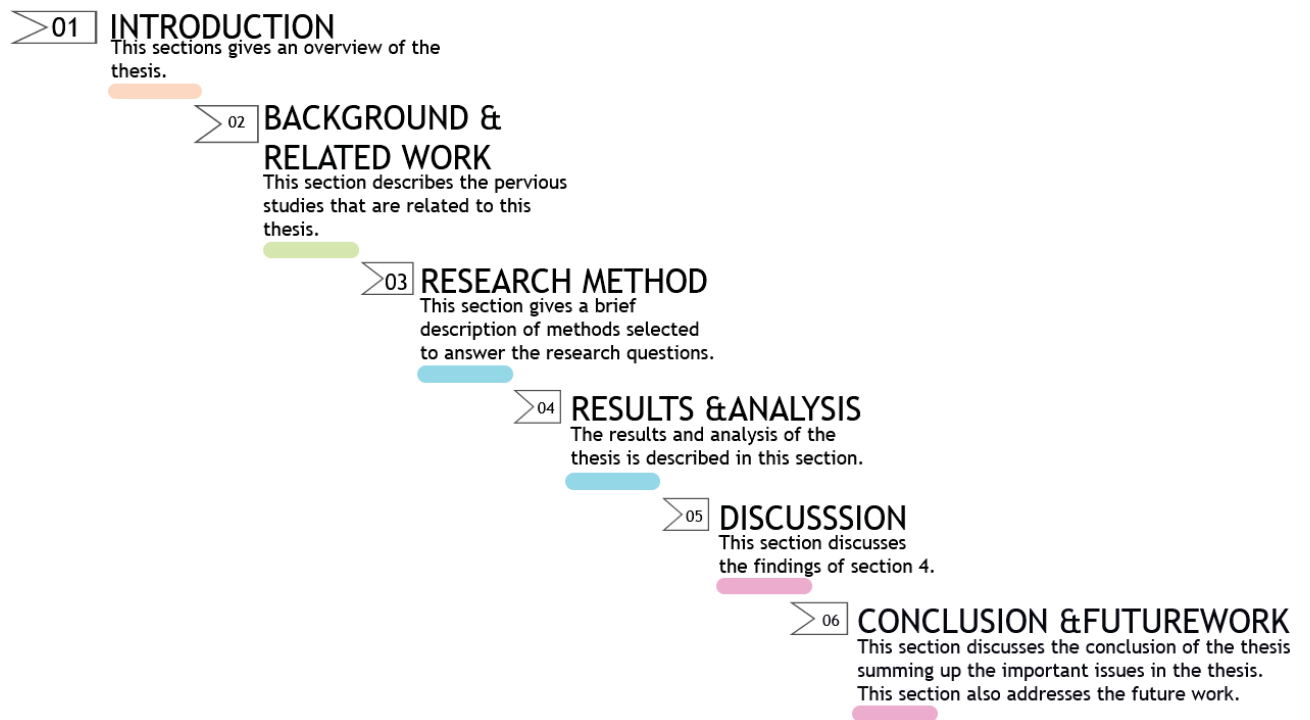


Figure 1.1: Thesis roadmap

2.1 Background

This section gives an insight of terminologies and the concepts that are related to this thesis. The first step is to know what is Agile and why Agile is used. Next step is to know how requirements engineering takes place in Agile software development.

2.1.1 Agile

Agile software development has become extensively increasing in software systems for the past decade leaving the traditional life cycle models behind[2]. Agile methodology strives in delivering the product faster by giving a high priority to customer satisfaction. Agile is a continuously iterative process where there is a continuous communication between the customers and the developers in each step of the software development life cycle. Agile is open to changes in requirements at any phase of life cycle. This led to the increase in use of Agile in software systems. Agile software development consists of a set of practises and frameworks that are based on 4 values and 12 principles[15]. Agile manifesto and principles are implemented with the purpose of continuous delivery of a better software that provides priority to customer satisfaction.

Agile Manifesto

"We are uncovering better ways of developing software by doing it and helping others do it"[15]. The Agile manifesto consists of four values to which are:

Agile Manifesto [15]

1. *Individuals and interactions over processes and tools.*
2. *Working software over comprehensive documentation.*
3. *Customer collaboration over contract negotiation.*
4. *Responding to change over following a plan.*

Figure 2.1: Agile manifesto

- **Communication:** The first item mentioned in the manifesto states that individuals and interactions are given importance than the process and tools. The customers need to explain the product that is needed by them clearly to the team that delivers the product. The priority is given to people and communication between them.
- **Customer collaboration:** The third item mentioned in the manifesto states customer collaboration is given more importance to contract negotiation. Agile is an iterative process that provides continuous delivery to the customer. Unlike traditional methods of signing the contract at early stages which is difficult to change, the Agile allows opportunities for changes that the customer requests. Customer is involved and given control at every stage of the life cycle.
- **Change in Plan :** From the fourth item mentioned in the manifesto, responding to change is given more importance to following a fixed plan. Agile methodology accommodates changes in plans and changes in requirements at any stage of life cycle. Unlike traditional methods the requirements are not gathered only at the start of life cycle but also at every stage of development life cycle. There is no fixed plan and changes can be made at any point as per customers choice.

From the figure 2.1, the listed three red colour items are considered and described as these three items are related to this thesis.

Agile principles

The 4 Agile manifestos and 12 Agile principles are the foundation of Agile software development process. These help in developing and delivering a desirable software that the customer is satisfied with. This happens when the product delivered is valuable to the customer. Based on the Agile manifesto the 12 Agile principles are declared. These are:

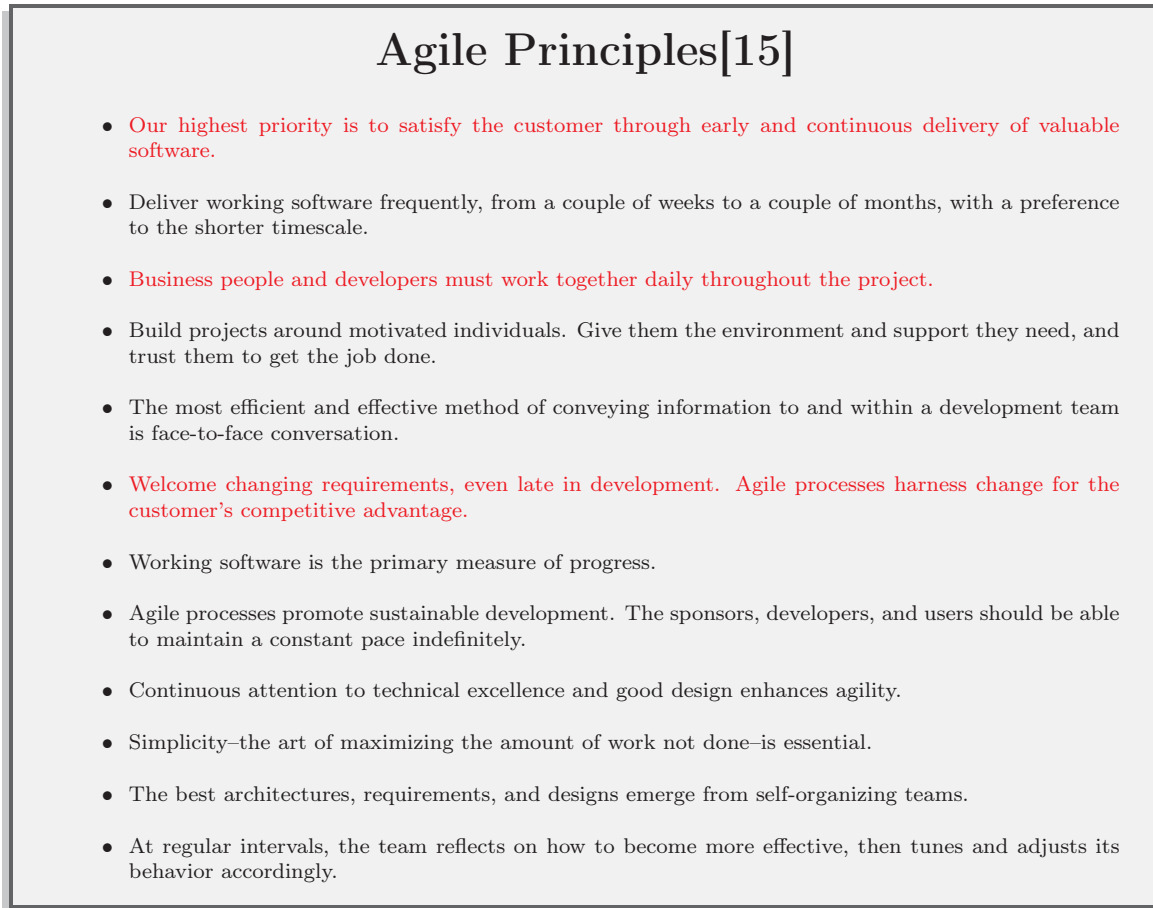


Figure 2.2: Agile principles

2.1.2 Requirements engineering

Requirements engineering is the process of defining , collecting and maintenance of the requirements. Bashar et al[31] defines requirements engineering as "*Requirements engineering (RE) is the process of discovering the purpose, by identifying stakeholders and their needs, and documenting these in a form that is amenable to analysis, communication, and subsequent implementation*".

2.1.3 Requirements engineering process in Agile

The requirements engineering process in Agile software development is very dynamic and flexible in way of work[9]. The requirements engineering occurs differently in traditional and Agile software development. The main difference is that the requirement engineering processes is focused on gathering all the requirements and documenting them before the design phase in the traditional model, while in Agile requirements engineering encourages change in requirements at any stage even at late stage in the software development life-cycle[12]. Customer collaboration has changed a lot in Agile requirements engineering. Customer was only involved in the early stage of traditional software development to gather requirements and was not involved in

the later phases. In Agile, the requirements engineering process is an iterative process and not a sequential process where the development occurs in a short cycles[9]. Requirements engineering process in Agile occurs at all stages so the customer is involved at all the phases of the development life cycle and performed multiple tasks to make changes and update the requirements[17]. Initially, the requirements are gathered from the customer and are prioritized based on the needs and wish of the customers. These gathered requirements are discussed in couple of weeks or every sprint based on agile frameworks used. Later the changes in requirements , re- prioritization of these requirements and also the scope of the next iteration is defined.

Chapter 3

Related Work

An empirical research conducted by Gizzatullina et al.[17] discusses the challenges in Agile requirements engineering. This study is one of the reason that led to the motivation in conducting this thesis. Gizzatullina et al.[17] conducted semi structured interviews to find out few challenges in Agile Requirements Engineering. The future work mentions to find out mitigation strategies for these challenges.

Naming the Pain in Requirements Engineering (NaPiRE) initiative which consists of globally curated family of surveys conducted on the status and problems faced in practical RE which was proposed by Daniel Mendez and Stefan Wagner. A global family of survey was conducted by Mendez et al.[14] with the help of researchers from different geographic locations. This research was conducted to find out the causes and problems faced by practitioners in Requirements Engineering phase and also the factors in RE phase that lead to failure of the project. This research identifies few of the challenges in RE phase which led to the motivation to conduct this research to find out the possible mitigation strategies to overcome the challenges related to customer communication in RE phase.

Inayat et al.[20] conducted a systematic literature review to analyze the impact of Agile on Requirements Engineering. This review reveals the practises of Agile RE and also the challenges phased in Agile Requirements Engineering. The findings of this review helps this research in identifying the challenges in Agile RE. This research intends to find out the mitigation strategies for these challenges.

Cao et al.[7] conducted an empirical study to find out the Agile practices, its benefits and their challenges. The findings of this research helps this research to find out the mitigation strategies for these challenges.

Heikki et al.[18] has conducted a mapping study to get a better understanding of Requirements engineering and problems in RE of Agile software development. This paper gives an insight in conducting this thesis. The future work states that the methods provided to solve the challenges are weak and needs further research which this thesis is going to provide. This study was conducted 6 years ago, as Requirements engineering in ASD is a constantly improving and changing field new research must be conducted in finding out more recent problems and solutions of these problems. Table 3.1 mentions few customer communication challenges found from the mentioned studies. In this thesis more customer communication challenges

Reference	Customer Communication challenges
Gizzatullina et al.[17]	Unwanted communication, Back to waterfall, New customer on role, Disagreement by customer.
Inayat et al.[20]	Rare customer involvement, Communication issues.
Heikki et al.[18]	Problems with client or customer representatives.
Mendez et al.[14]	Communication flaws between project team and customer, Under specified requirements by customer, Stakeholders with difficulties in separating requirements from known solution designs, insufficient support by customer, Weak access to customer needs and/or business information.

Table 3.1: Customer communication challenges found from previous studies

in Agile RE are mapped and mitigation strategies are provided to overcome these challenges and also these challenges are prioritized.

3.1 Research Gap

There are many research studies dedicated to challenges in Requirements Engineering, but there isn't much research that focuses only on customer communication in Agile RE. This thesis solely focuses on challenges related to customer communication in Agile RE phase.

Research like [20][7] focus on problems in requirement engineering, this thesis focuses only on the challenges faced due to customer communication in Agile requirement engineering. NaPiRE initiative conducted by Mendez et al[14] also provides few problems in Requirements engineering but does not focus solely on customer communication and does not provide mitigation for these challenges. The problems mentioned in the researches are not similar, each research discusses different challenges in requirements engineering. According to recent study conducted by Gizzatullina [17] on challenges in Agile RE, the study mentions in future work to find the mitigation strategies to the challenges. The research gap that this thesis fills is to identify all the challenges focusing solely on customer communication in Agile Requirements engineering and provide mitigation strategies to overcome these challenges.

In this section the research method and research questions are defined to achieve the aims and objectives of the thesis. The research method selection and motivation for selecting the method is defined. The process involved to conduct each method is discussed in detail.

There are three most commonly used empirical research methods according to Wohlin [44]. These empirical methods are survey, case study and experiments. From these mentioned empirical research methods, surveys are considered for this thesis. The reason for not considering other two research methods are :

- An experiment is not selected because , according to Wohlin et al.[44], an experiment is conducted in a controlled environment. According to this research there is no need for a controlled environment to achieve the aims of this study.
- A case study is not selected because, according to Benbasat et al.[3] a case study is used to explore a phenomenon in a real time context by gathering information from a small sample of people or organization. This thesis aims to find out the mitigation strategies for the customer communication challenges faced by many organizations covering a huge sample and not limiting it to a particular organization. To achieve this survey methodology is chosen.

Secondary research is conducted for research synthesis that is done by collecting data from the previously published studies[39]. The secondary research method that is considered in this thesis is Systematic mapping study. The other popular secondary research is systematic literature review. The reasons for not considering systematic literature review is:

- Systematic literature review is not considered because it takes up more time and high effort to perform and analyze. Systematic mapping study covers more article and can structure larger field that systematic literature review.

4.1 Research Design

To understand, identify and solve the challenges faced in the Agile Requirements engineering, the following methods are proposed for the above research questions.

- Systematic mapping study (RQ1)
- Survey (RQ2 & RQ3)

To answer the RQ1 a systematic mapping study is chosen and to answer RQ2 and RQ3 a survey is chosen. This is a mixed method approach where both quantitative and qualitative data is obtained as results. The figure 4.1 gives the summary of the research methods.

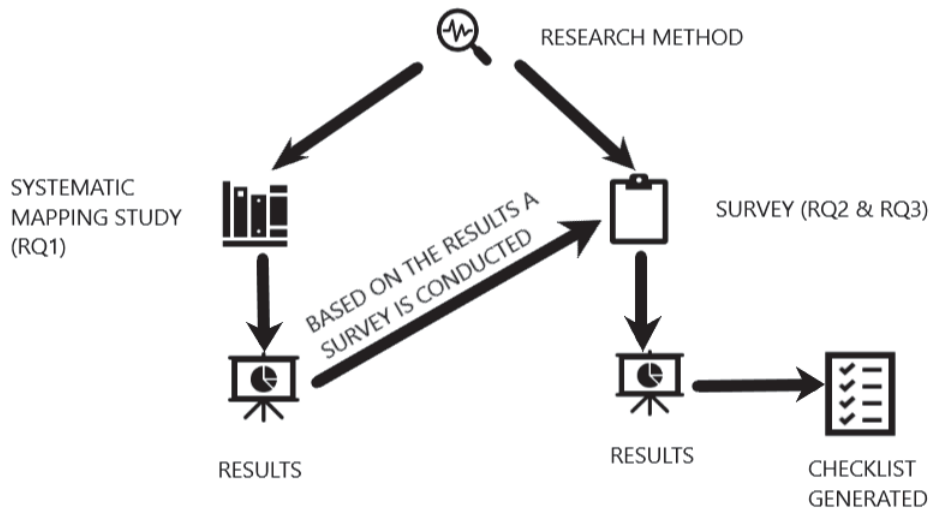


Figure 4.1: Research Design

From the systematic mapping study we list the customer communication challenges faced in Agile requirements engineering. Based on the results collected from systematic mapping study we conduct a survey to find out the mitigation strategies to overcome these challenges and also prioritize these challenges.

4.2 Systematic Mapping Study

In this thesis a Systematic mapping study is conducted to answer RQ1 to find out the possible challenges related to customer communication in Agile requirements engineering phase. A systematic mapping study is chosen to give an overview of the research, the type of research and the results focusing on a particular research topic. There are researches that mentions the challenges in Agile RE, in which different researches mentioned different challenges. This study identifies and maps all customer communication challenges in Agile RE from previous studies.

Systematic mapping study is conducted by the following steps[32]:

4.2.1 SMS design and planning

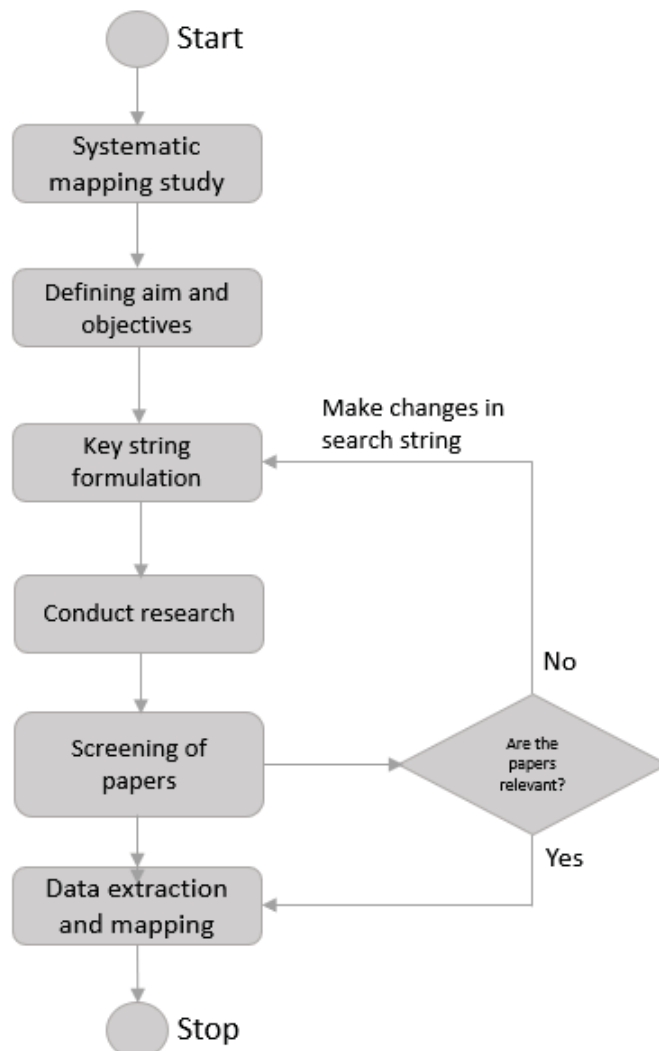


Figure 4.2: SMS design

4.2.2 Definition of research questions:

In this step it is decided to address which questions will be answered in Systematic mapping study. The goal of the research is defined in this step, which is to find out the customer communication challenges faced in RE phase (RQ1).

4.2.3 Conduct search:

In this step data collection takes place by collecting relevant articles using keywords on academic databases. For searching relevant articles keywords like "Requirements engineering", "communication challenges", "customer collaboration challenges" and "customer communication challenges in requirement engineering" are considered. The search strings are constructed using Boolean operators like OR & AND. A search strategy tool SPIDER is used to design a search string.

Motivation for SPIDER:

Building a search string is the key and important step in conducting any systematic mapping study. Building an initial key string is a difficult and crucial step and many risks can arise if the key string is not properly formulated. To formulate this search string SPIDER search strategy is used by following its guidelines. SPIDER stands for Sample, Phenomenon of interest, Design, Evaluation, Research gaps [8]. There are other search strategy tools like SPICE, ECLIPSE and PICO, but these tools have limitations like they cannot fully meet all the requirements of qualitative research for specific researcher group and these tools cannot be suitable for different qualitative research questions. To overcome these limitations SPIDER tool was developed which is a better strategy for qualitative research.

SPIDER	Search term
S	"Requirement* engineering" OR "Stakeholder* need*" OR "Requirement* elicitation" OR "Customer requirement*" OR "Customer need*" OR
P of I	"Agile software development" OR "Scrum"
D	"survey" OR "case study" OR "interviews" OR "focus groups" OR "observations"
E	"Customer communication challenge*" OR "Customer communication issue*" OR "Customer collaboration problem*" OR
R	"mixed method*" OR "Qualitative method*" OR "Quantitative method*" OR

Table 4.1: SPIDER search

The databases used to find the relevant articles are Scopus, ACM Digital library, ScienceDirect and Springer.

The table 4.2 describes the keywords and operators used in formulating the search string.

Search String formulation		
Keyword sets	Keywords	Operators used
Set 1	("Requirement* Engineering" OR "Stakeholder* need*" OR "Requirement* elicitation" OR "Customer requirement*" OR "Customer need*")	AND
Set 2	("communication challenge*" OR "communication issue*" OR "communication problem*")	AND
Set 3	("Agile software development")	AND

Table 4.2: Search string formulation

Final search string	
Search string	Description
Taking set 1, set 2 and Set 3 together (Set 1 AND Set 2 AND Set 3)	("Requirement* Engineering" OR "Stakeholder* need*" OR "Requirement* elicitation" OR "Customer requirement*" OR "Customer need*") AND ("communication challenge*" OR "communication issue*" OR "collaboration problem*") AND ("Agile software development")

Table 4.3: Final search string

The table 4.3 shows the search string that is used in the database to search for data required for this research.

4.2.4 Screening of papers:

In this step the inclusion and exclusion criteria is taken into consideration. After applying the search string in databases and gathering the articles, the next step is to apply the inclusion/exclusion criteria to filter the papers that are relevant to the aim and objectives of this thesis.

Inclusion Criteria:

- Books, and peer reviewed articles like journals, conference papers that are related to the aim and objectives of this thesis are taken into consideration. The papers that report this data are taken into consideration.
- Based on reading the title, keyword and abstract of the papers, the papers related to Agile requirements engineering are considered.
- Articles from years 2001-2020 are considered because agile came into existence from 2000.
- Articles which are accessible are considered.
- Papers that are written only in English are considered.

Exclusion Criteria:

- Research that do not report any results or findings which are present only in form of PowerPoint presentations or abstracts are excluded.
- Papers that are not related to Agile requirements engineering are excluded.
- Papers that are not related to software engineering domain are excluded.
- Studies that are not in English language are excluded.
- Papers which have no accessibility are excluded.
- Articles that are not peer reviewed like magazines, lecture notes, index pages are excluded.
- Duplicate papers found in different databases are excluded.

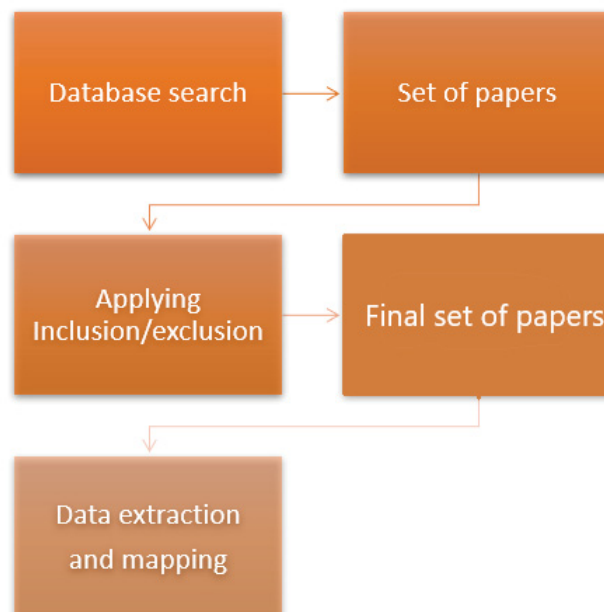


Figure 4.3: Flow of systematic mapping study

The figure 4.3 shows the flow of process that takes place in a systematic mapping study. First, a set of papers is found from apply search string in databases. Second, the initial collected set of papers in taken and inclusion/exclusion criteria is applied to filter the studies. This is done by excluding papers of other languages that English, filtering by time period of the studies, studies that are open source etc. After this the papers are filtered by reading the title, abstract and keywords of the papers and even reading the whole paper sometimes to collect the papers that are relevant

to answer RQ1.

After collecting the articles from the databases and applying Inclusion/ Exclusion criteria, the papers are separated into primary studies and secondary studies. Primary studies are the studies that are self conducted studies for gathering information. These primary studies include surveys, case studies, experiments etc. Secondary studies are conducted to gather information for the previous studies.

The other method of information gathering used in this thesis is by identifying the primary studies from the secondary studies that are found from the database search. The first step is by going through all the references in the selected papers to identify the primary studies. The next step is to read the title, abstract and keywords of the primary studies that are collected from the reference list. Next the papers that are not related to the customer communication challenges in Agile RE are excluded. The duplicate articles that are found are also excluded. The final set of papers are considered after reading the studies that shows the results related to customer communication challenges.

4.2.5 Data extraction and mapping process:

The data extraction is done to extract the required data from the papers to answer the research question . Based on the classifying scheme of papers into categories data is extracted and the results are mapped. The research articles collected are based on following the checklist mentioned below in table 4.4.

Property	Description
Title	Articles are selected with the title relevant to challenges in Agile requirements engineering.
Abstract	Articles are considered by reading the abstract and checking if it is relevant to this thesis.
Author	Name of the author.
Year of publication	Papers between the years 2000-2020 are considered.
Language	Articles only in the language English are considered.
Article Type	Books, Journals, Conference papers that are related to aim and objectives of this thesis are taken into consideration.
Research methodology	Articles with empirical research methods are considered.
Subject	Articles related to Agile requirements engineering are considered.
Focus	Customer communication challenges that occur during requirements engineering phase in Agile.
Target audience	Articles that are intended for researchers, practitioners, industries are considered.

Table 4.4: Data extraction

Above table 4.4 reports the data extraction which is collected in excel sheet. The citations of papers are collected in excel after applying the search string on databases. After the inclusion/exclusion the papers are marked green which are relevant to the thesis and the discarded papers are marked red as shown in the above table 4.4.

4.3 Survey

A survey is proposed for answering RQ2 and RQ3 to find out the mitigation strategies to overcome the customer communication challenges and to prioritize these challenges based on the impact and frequency of occurrence in the project . A survey is chosen because it has a wider reach to the population as a result of which it gathers large amounts of significant data. A survey is used for describing, comparing and explaining knowledge, behaviour and attributes by collecting useful information or data. To conduct this survey based research few steps are considered. These are[30]:

4.3.1 Survey design

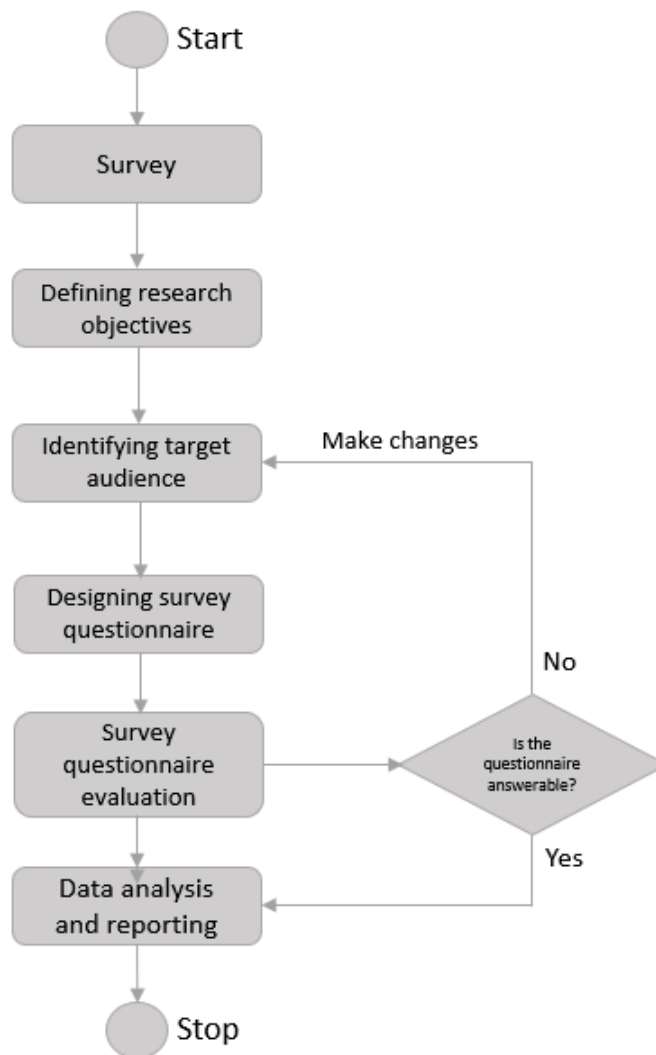


Figure 4.4: Survey Design

4.3.2 Defining research objectives

This is the first step for conducting a survey in which the goal and objectives of conducting this survey is defined. The questions in this online questionnaire would address the following:

- To prioritize the challenges found from RQ1.
- To find out mitigation strategies to the customer communication challenges.

4.3.3 Identifying target audience and sampling data

The target audience are the intended population of respondents that are expected the best to answer the survey. In this survey the target audience considered are the members of an Agile team. The team members include Developers, Scrum master, Product owner, tester, Architect owner, Technical & domain expert and integrator that have previously worked on projects using Agile principles and methodologies. These target audience are reached through LinkedIn, social media and through personal contacts working in companies.

4.3.4 Designing survey instrument

In this step the survey questionnaire is designed. The survey questions are designed based on the challenges collected from the systematic mapping study. For conducting this survey an online questionnaire is chosen that is created using Google Forms. This survey consists of close-ended questions where the respondents are asked to choose one of the options and open-ended questions where the answers may be a sentence, paragraph or even more.

The survey that is used in this thesis consists a total of 34 questions. The total time taken to answer this survey is approximately 15 minutes. These questions are used to collect the data that is categorized into three types as mentioned in the below tables.

Demographics:

The table 4.5 displays the questions related to the demographics. This data is collected to find out the experience of the respondent in Agile, the Agile methodology used, the type and size of the organization of the respondent, etc. The close ended questions are answered in the form of multiple choice questions(MCQs) and the open ended questions are answered in the form of short answer.

Challenges:

The table 4.6 mentions the questions that are used to collect the data related to the challenges, impact of the challenges on the project and the number of times of the occurrence of the challenges. The data collected from these questions is used to answer RQ2 which is prioritization of the challenges.

Q.no	Questions	Question Type
1.	What is the name of your organization?	Open-ended(Short ans)
2.	What is your current role in the organization?	Close-ended(MCQs)
3.	Please mention your working experience in an Agile environment?	Open-ended(Short ans)
4.	Mention the size of your organization?	Close-ended(MCQs)
5.	Specify the Agile method used in your project?	Close-ended(MCQs)
6.	Mention which type of domain you are working?	Open-ended(Short ans)

Table 4.5: Demographics

Q.no	Questions	Question Type
1.	What is the impact of the below-mentioned challenges on your projects?	Close-ended(MCQs)
2.	How many times have these selected challenges occurred in your project?	Close-ended(MCQs)

Table 4.6: Challenges

Mitigation strategies:

The table 4.7 mentions the questions that are related to mitigation strategies. These questions are used to gather the data that helps in finding the mitigation strategies to overcome the mentioned challenges. This set of questions help in answering the RQ3. Addition to the main aim of RQ3, these question are also used to collect information such as the affects that are caused by these challenges on the projects.

Q.no	Questions	Question Type
1.	How do these selected challenges affect your last completed project based on your experience?	Open-ended(Long answer)
2.	What are the measures that you have taken to overcome the above-selected challenges that you faced in the last completed project?	Open-ended(Long answer)
3.	What other possible mitigation strategies can you suggest for the above-selected challenges?	Open-ended(Long answer)
4.	What mitigation strategies can you suggest that can help overcome other non selected challenges?	Open-ended(Long answer)

Table 4.7: Mitigation strategies

4.3.5 Survey instrument evaluation

In this step the evaluation of the sample plan of the survey is done. The method selected for evaluation is pilot surveys where a mock survey is conducted to evaluate the questionnaire and make changes or additions if required. The mock survey was answered by my colleagues and peers who have previous knowledge about Agile

software development. Based on the survey answers and feedback, few changes were made in terms of elaborating the options and minor changes in the questions. The pilot implementation of this questionnaire is reported in the Appendix section of this thesis.

4.3.6 Analyzing survey data

In this step the data collected from the survey is analysed. To analyze this data both quantitative and qualitative analysis is done. Quantitative analysis is preformed on closed ended questions of the survey to answer RQ2 by performing descriptive statistics. Qualitative analysis is performed on open ended questions of the survey to answer RQ3 by performing thematic analysis. To perform this, Thematic coding is selected to analyze the data as it is flexible. To perform this analysis Nvivo tool is used to perform Qualitative data analysis(QDA).The data is then represented using graphical representations such as histograms or bar graphs.

Motivation for Thematic analysis:

Thematic analysis is selected in this thesis to analyse the responses that are gathered from the survey to answer RQ3. Thematic analysis is one of the most popular qualitative data analysis method[40][16]. Braun & clark[6] defined thematic analysis as “a method for identifying, analysing and reporting patterns or themes within data”. Thematic analysis is method that helps in making structures and meanings of the structures from the collected data from the respondent. Thematic analysis is not time consuming and is easily utilized by anyone with or without any basic knowledge about it. This method is used when there is a large amount of data, an option is provided to summarize the key points and features which is generally accepted by the practitioner’s and researchers.

Motivation for NVivo:

To perform the thematic analysis on the survey responses, Nvivo tool was used in this thesis. Nvivo is a widely used computer assisted qualitative data analysis software (CAQDAS) that is used to analyse qualitative and also mixed methods. This tool helps in analyzing an unstructured set of data that is collected from surveys, focus groups, interviews etc.

4.3.7 Documenting and reporting

The final step for conducting a survey research is documenting and reporting. Documenting is done from the start of the survey that helps researcher in keeping track of the process and make changes if any mistakes are done. Reporting is done at the end after collecting the analyzed results. In this it is decided what data can be included and what data can be left out.

Ethical Aspects: While conducting a survey based research, ethical aspects must be considered by following GDPR regulations. In this survey the personal information of the respondent is not mandatory and will not be presented.

Chapter 5

SMS Results and Analysis

5.1 Results of systematic mapping study

On applying the search string on four different databases, the total number of studies found are:

Database	Results
Scopus	84 papers
ScienceDirect	55 papers
ACM Digital Library	20 papers
SpringerLink	46 papers
Total	205

Table 5.1: SMS papers

From the papers collected on applying the search string on databases, inclusion and exclusion criteria is applied as mentioned in section 3.3.4 to filter the papers and get relevant studies. After applying the inclusion and exclusion on these papers the results are as follows:

Database	Results	Primary studies	Secondary studies
Scopus	9 papers	6 papers	3 papers
ScienceDirect	7 papers	4 papers	3 papers
ACM Digital Library	5 papers	4 papers	1 paper
SpringerLink	3 papers	2 papers	1 paper
Total	24	16	8

Table 5.2: Primary and secondary papers

A total of 24 papers are found on a total out of which 16 papers are primary studies and 8 papers are secondary studies. From the identified 8 secondary studies, a total of 6 primary studies were found that are related to the aim and objectives of this thesis. The total number of primary studies which are gathered from SMS to answer RQ1 are 22 papers which are shown in the table 5.3.

Database	Primary studies from database search	Primary studies collected from the secondary studies	Final set of primary studies
Scopus	6 papers	2 papers	8 papers
ScienceDirect	4 papers	2 papers	6 papers
ACM Digital Library	4 papers	1 papers	5 papers
SpringerLink	2 papers	1 paper	3 papers
Total	16	6	22

Table 5.3: Final set of papers

5.1.1 List of studies

The table 5.4 displays the articles collected from Scopus, ScienceDirect, Springer link and ACM digital library databases. These are the primary studies that are used to find out the customer communication challenges in Agile requirements engineering.

Ref no.	Name of the study	Author's name
S1.[1]	Quality requirements challenges in the context of large-scale distributed Agile: An empirical study.	Wasim Alsaqaf, Maya Daneva, and Roel Wieringa.
S2. [42]	An Empirical Study on Using Agile Methods in Global Software Development	VN Vithana, David Asirvatham, and MGM Johar.
S3.[36]	Prioritizing challenges of Agile process in distributed software development environment using analytic hierarchy process.	Mohammad Shameem, Rakesh Ranjan Kumar, Chiranjeev Kumar, BibhasChandra, and Arif Ali Khan.
S4.[43]	Requirements Engineering Practice and Problems in Agile Projects: Results from an International Survey.	Stefan Wagner, Daniel Méndez Fernández, Michael Felderer, and Marcos Kali-nowski.
S5.[37]	Taxonomical classification of barriers for scaling Agile methods in global software development environment using fuzzy analytic hierarchy process.	Mohammad Shameem, Rakesh Ranjan Kumar, Mohammad Nadeem, and Arif Ali Khan.
S6.[26]	Waste identification as the means for improving communication in globally distributed Agile software development	Mikko Korkala and Frank Maurer.

Ref no	Name of the study	Authors name
S7. [21]	A case study of Agile software development for safety-Critical systems projects.	Gibrail Islam and Tim Storer.
S8. [19]	Understanding information needs of Agile teams to improve requirements communication.	Anne Hess, Philipp Diebold, and Norbert Seyff.
S9. [5]	Are you biting off more than you can chew? A case study on causes and effects of over-scoping in large-scale software engineering.	Elizabeth Bjarnason , Krzysztof Wnuk, Björn Regnell.
S10. [11]	Software product line scoping and requirements engineering in a small and medium-sized enterprise: An industrial case study.	Ivonei Freitas da Silva, Paulo Anselmo da Mota Silveira Neto, Pádraig O’Leary, Eduardo Santana de Almeida, Silvio Romero de Lemos Meira.
S11. [41]	Best Managerial Practices in Agile Development.	Manasvi Talluri and Hisham M Haddad.
S12. [17]	Empirical Study of Customer Communication Problem in Agile Requirements Engineering.	Ilyuza Gizzatullina.
S13.[22]	Problems in Agile trenches	Mira Kajko-Mattsson.
S14. [27]	Evaluating eXtreme Scenario-based Design in a Distributed Agile Team.	Jason Chong Lee , Tejinder K. Judge , D. Scott McCrickard.
S15. [25]	Using Distributed Agile Patterns for Supporting the Requirements Engineering Process.	Maryam Kausar and Adil Al-Yasiri.
S16. [29]	Why the Development Outcome Does Not Meet the Product Owners’ Expectations?	Timo OA Lehtinen, Risto Virtanen, Ville T Heikkilä, and Juha Itkonen.

Table 5.4: List of studies

The table 5.5 mentions the studies that are obtained on gathering primary studies from the secondary studies gathered from the databases.

Ref no.	Name of the study	Authors name
S17[34]	'Desperately' Seeking Research on Agile Requirements in the Context of Large-Scale Agile Projects.	Knut H Rolland.
S18[4]	A Case Study on Benefits and Side-Effects of Agile Practices in Large-Scale Requirements Engineering.	Elizabeth Bjarnason, Krzysztof Wnuk, and Björn Regnell.
S19[33]	Agile requirements engineering practices and challenges: an empirical study.	Balasubramaniam Ramesh, Lan Cao, and Richard Baskerville.
S20[24]	Agile Requirements Engineering with Prototyping: A Case Study.	Marja Käpyaho and Marjo Kauppinen.
S21[28]	Distributed Agile: project management in a global environment.	Seiyoung Lee and Hwan-Seung Yong.
S22[38]	Categorization of risk factors for distributed Agile projects.	Supriya V Shrivastava and Urvashi Rathod.

Table 5.5: List of studies from secondary studies

5.1.2 Frequency of published articles:

The figure 3 displays the frequency of articles that are published over time. The articles that are published in year 2019 and 2014 are highest compared to others with 3 articles. Two articles were publishes in each year of 2020, 2018, 2017. In years 2015,2012,2011 and 2008 least articles were published compared to other years with 1 article in each.



Figure 5.1: Published articles

Figure 4 displays the frequency of primary articles that are extracted from the secondary studies like SLR and SMS obtained from the database search.

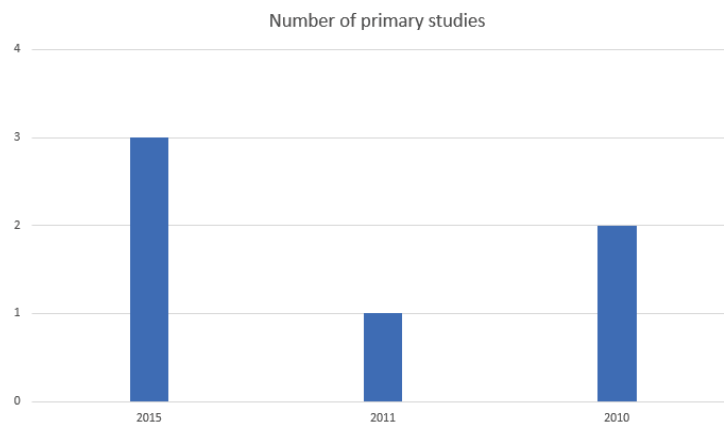


Figure 5.2: Primary studies

The below table 5.6 gives information about the primary studies found from the mapping study:

Ref no.	Article Type	Research Method	Year	Keywords
S1.	Journal	Case Study	2019	Agile large-scale distributed projects, Requirements engineering.
S2.	Conference paper	Survey	2018	Agile software development, global software development; challenges.
S3.	Journal	Case Study	2018	Agile development, challenges, distributed software development.
S4.	Journal	Survey	2017	Requirements Engineering, Agile Projects.
S5.	Journal	Survey	2020	Global software development, Agile development, Scaling barriers.
S6.	Journal	Case Study	2014	Distributed Agile software development, Lean software development, Communication.
S7.	Journal	Case Study	2020	Agile software development, Challenges.
S8.	Journal	Case Study	2019	Requirements specification, Requirements communication, Agile teams, Information needs.
S9.	Journal	Case Study	2012	Requirements scoping, Software release planning, Agile requirements engineering.
S10.	Journal	Case Study	2014	Requirements engineering, Agile methods, Software product line scoping.
S11.	Conference paper	Case Study	2014	Agile development, Agile methods, Best Agile practices, Agile challenges, Software development.
S12.	Conference paper	Case Study	2019	Agile software development, requirements engineering, customer collaboration.
S13.	Conference paper	Case Study	2008	Agile, Documentation, oral communication, product related problems, process related problems, communication owner, communication complexity.
S14.	Book	Case Study	2011	Usability, Agile, distributed development, extreme scenario-based design.
S15.	Book	Case Study	2017	Distributed Agile patterns, Global software engineering, Requirements engineering.
S16.	Conference paper	Case Study	2015	Scrum, Product owner, Root cause analysis, Requirements engineering, Global software development.

Ref no.	Article Type	Research Method	Year	Keywords
S17.	Conference paper	Case Study	2015	Requirements Engineering, Agile Requirements, Agile Software Development.
S18.	Conference paper	Case Study	2011	Requirements engineering, Agile.
S19.	Journal	Multi-Case Study	2010	Requirements engineering, Agile software development, requirements engineering risks, Agile practices.
S20.	Conference paper	Case Study	2015	agility, requirements engineering, prototyping, RE process.
S21.	Journal	Case Study	2010	Agile methods, Scrum, Distributed software development, Software globalization.
S22.	Journal	Case Study	2015	Distributed Agile Development (DAD), Agile software development (ASD), Distributed Software Development (DSD), Risk factor classification, Risk management in distributed Agile development.

Table 5.6: Final list of studies

RQ1: What are the customer communication challenges faced in Requirement engineering process in Agile software development?

The answer of this research question is the customer communication challenges that are faced in requirements engineering phase of Agile software development. The answer is obtained by the articles found from the systematic mapping study. The answer that is gained from this research question is used to formulate questions for the survey. A total of 18 customer communication challenges are identified from the systematic literature review. These challenges are group based on 10 factors from the previous literature as mentioned. The identified challenges found repeated in different studies is mentioned with the study number. The below table 5.7 displays the list of challenges found from the systematic mapping study.

FACTORS	CHALLENGES	STUDIES
Human Factors	CH1. The non-availability of customers for requirements negotiation, clarification and feedback.	S1
	CH2. Lack of customer involvement.	S3,S4,S5,S6,S8, S10,S11,S12,S18
	CH3. Too big number of customers that lead to too diverse and controversial requirements.	S12
	CH 4. Lack of trust between stakeholders.	S3, S19, S22
Distance	CH5. Communication challenge between teams and customers due to temporal distance.	S2, S7, S14
	CH6. Lack of communication infrastructure due to spacial distance.	S22,S7
Culture and language	CH7. Communication issues between stakeholders with different cultures and language.	S7, S22, S12

FACTORS	CHALLENGES	STUDIES
Knowledge	CH8. Misunderstanding of knowledge during customer communication.	S13
Overscoping	CH9. Communication challenges due to overscoping of requirements.	S9, S17, S18
Documentation	CH10. Insufficient communication with customers due to lack of documentation.	S8
Misunderstanding	CH11. Under specified requirements that are too abstract and allow various interpretations.	S4, S3, S11
	CH12. Misunderstanding of requirements communication due to difference in cultural values and languages.	S1, S13, S21, S15
Technology	CH13. Inappropriate selection of communication technologies.	S5
Others	CH14. Lack of communication training.	
	CH15. New person on role at customers side.	S3
	CH16. Increased communication costs.	S12
	CH17. Weak relationship between customer and project lead.	S21
	CH18. Communication lapse due to sudden change in requirements.	S4 S8

Table 5.7: Customer communication challenges

6.1 Survey results

This section discusses the results of the survey that is conducted to answer RQ2 and RQ3. An online questionnaire was designed for the survey by using google forms. Google forms is an open source survey administration application. This survey was answered by various practitioner's who are experienced in Agile methodologies and are working in an Agile environment. A total of 96 responses are gathered from the survey tool from which a total of 76 responses are considered by leaving out 20 incomplete responses. The survey responses data is read manually till the data is completely familiarised. These 20 incomplete responses are removed because the respondents only answered the close ended questions leaving out the open ended questions. The 76 responses are considered in this thesis because the respondents answered completely both the open ended and close ended questions that are asked in the survey questionnaire and the responses are relevant to achieve the aim of the survey.

6.1.1 Demographics

The question 1 focuses on the role of the respondent in an Agile team. This question is an close-ended question which can be answered by selecting an option in the drop down box. Out of the respondents a total of 15 are Developers, 12 are Testers, 11 are Technical and domain experts, 7 are Product owners, 5 are Integrators, 4 are scrum masters, 2 are Architect owners and the rest 20 others.

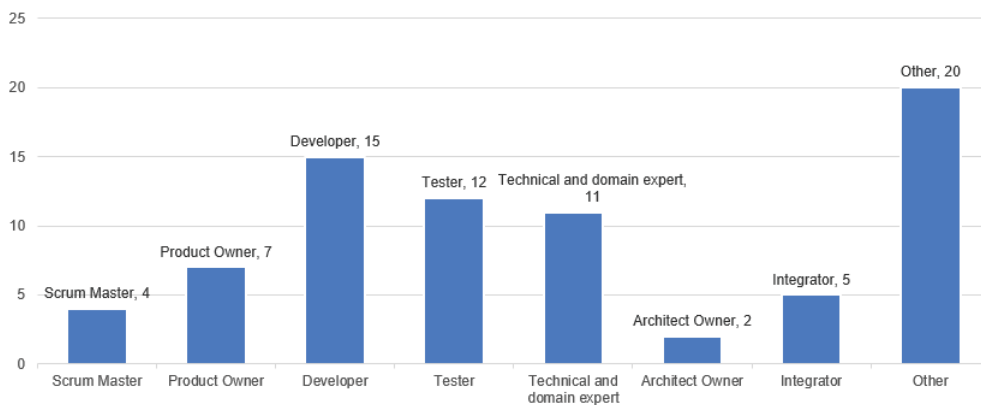


Figure 6.1: Q1. Role of the respondent

The question 2 mentions the working experience of the respondent in an Agile environment. Out of the respondents 53% have 0-1 years of experience, 24% have 2-5 years of experience and 18% have 6-10 years of experience and 5% of respondents have more than 10 years of experience. .

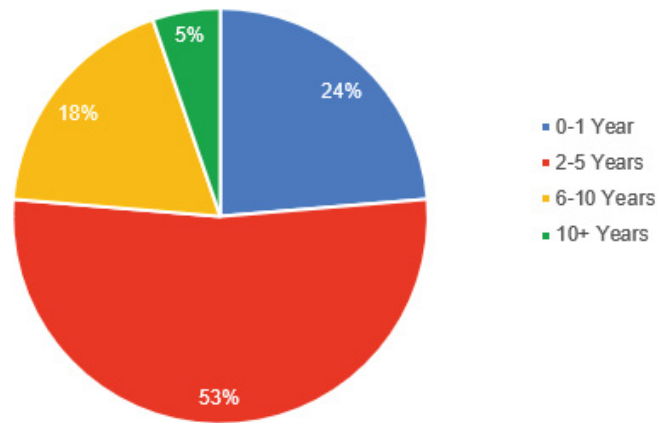


Figure 6.2: Q2. Experience of the respondent

The question 3 mentions the size of the organization where the respondents work. This question is a close-ended question that is answered by selecting option in MCQs. Out of the responses a total of 39% respondents work at large organization with number of employees more than 250, 29% work at small organization with number of employees between 10-49 and 21% of respondents work at a medium size organization with number of employees between 50-249 employees and 11% of respondents work in a micro organization with number of employees fewer than 9.

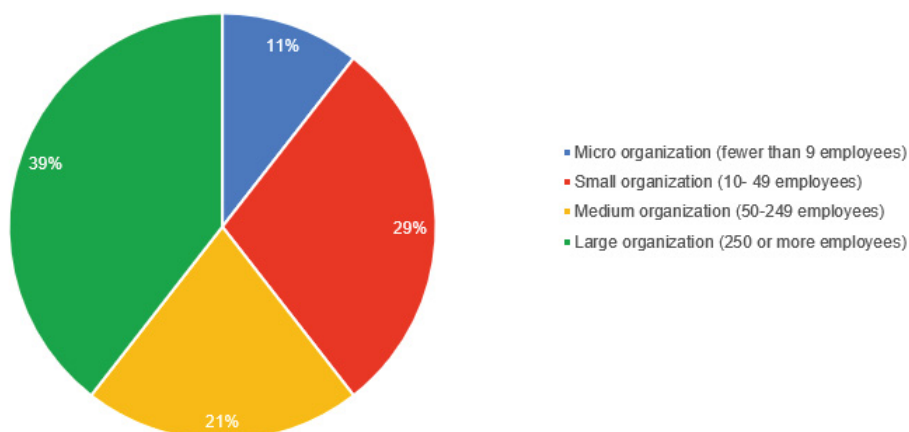


Figure 6.3: Q3. Size of organization

The question 4 mentions the sourcing strategy used by the organization of the respondent. This question is asked to know the location of work of the respondents so that we can know how the respondents managed the work based on different time zones and distance. This question is a close-ended question with a drop-down box. Out of the responses 51% respondents organization uses an Onshore in-sourcing strategy which is working in a same country and for same company, 24% respondents organization uses an Offshore in-sourcing strategy which is working in a different country and for same company, 13% respondents organization uses an Offshore out-sourcing strategy which is working in different country and for different company and 12% of respondents organization uses an Onshore outsourcing strategy which is working in a same country and for a different company .

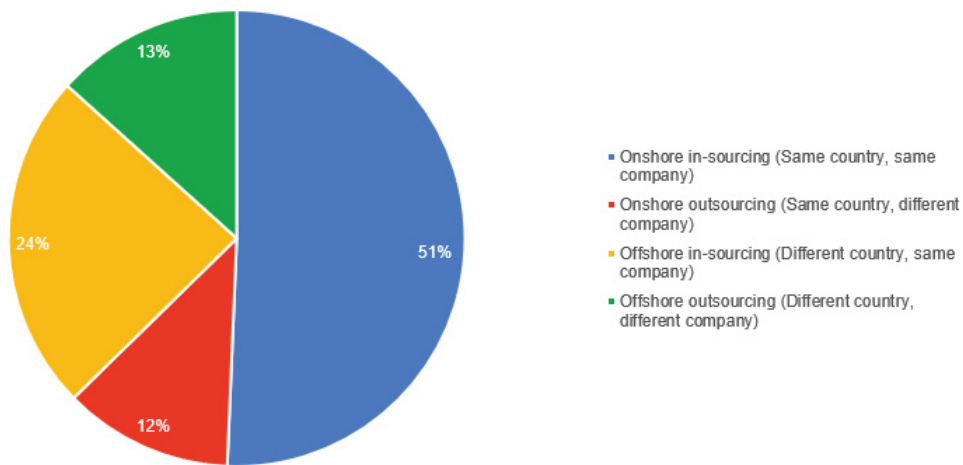


Figure 6.4: Q4. Sourcing strategy of organization

The question 5 focuses on the Agile methodology that is used by the respondents in their projects. The question is a close ended question which is answered by selecting the desired option from the checkboxes. Out of the responses 19 respondents are working using scrum methodology, 11 Feature driven development(FDD), 7 respondents are working using kanban methodology, 7 respondents are working using Dynamic Systems Development method (DSDSM), 6 respondents are working using Extreme programming (XP) and 4 of respondents are working using Crystal.

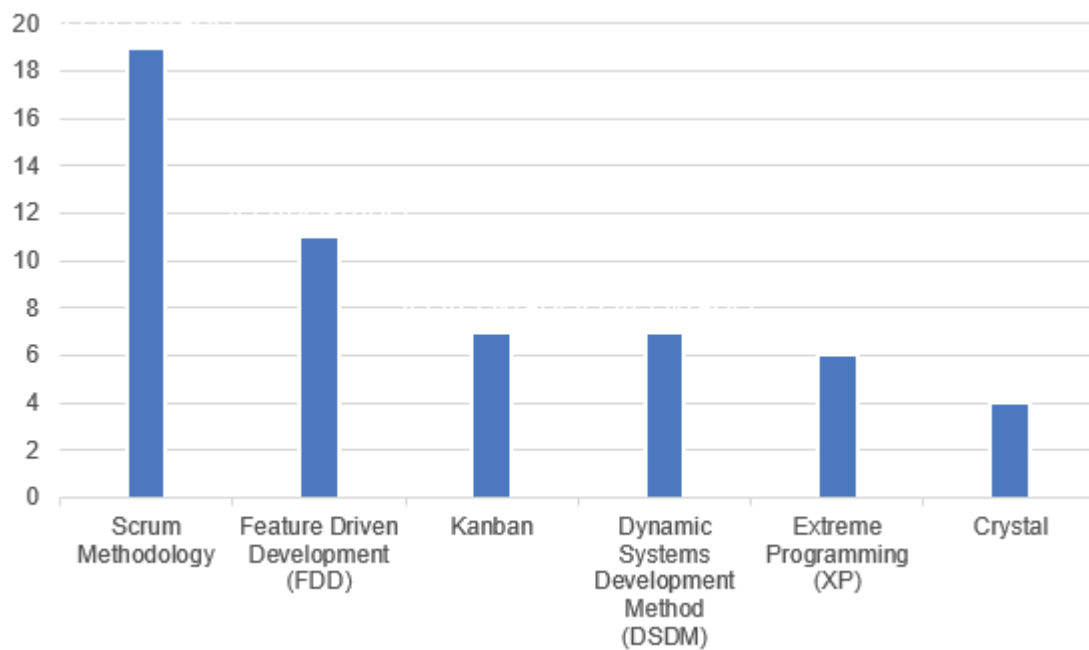


Figure 6.5: Q5. Agile method

6.1.2 Challenges:

The question 6 focuses on frequency of occurrence of challenges. This question is asked to gather data about the number of times the customer communication challenges occur in a project. This question is an close ended question which is to be answered by selecting option from the likert scale that ranges from low, medium and high. The table 6.1 and figure 6.6 mentions the results that are collected from the survey for this question.

The question 7 focus on the impact that these customer communication challenges cause in a project. This question is an close ended question which is to be answered by selecting option from the likert scale that ranges from very low, low, medium, high and very high. The table 6.3 and figure 6.7 mentions the results that are collected from the survey for this question.

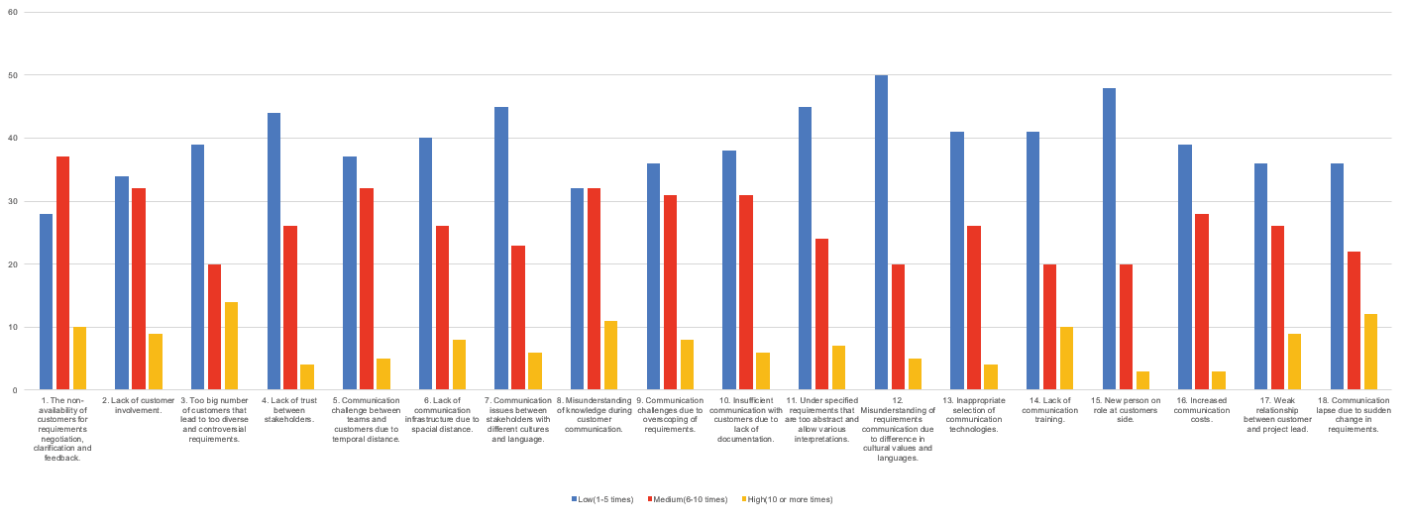


Figure 6.6: Q6. How many times have these selected challenges occurred in your project?

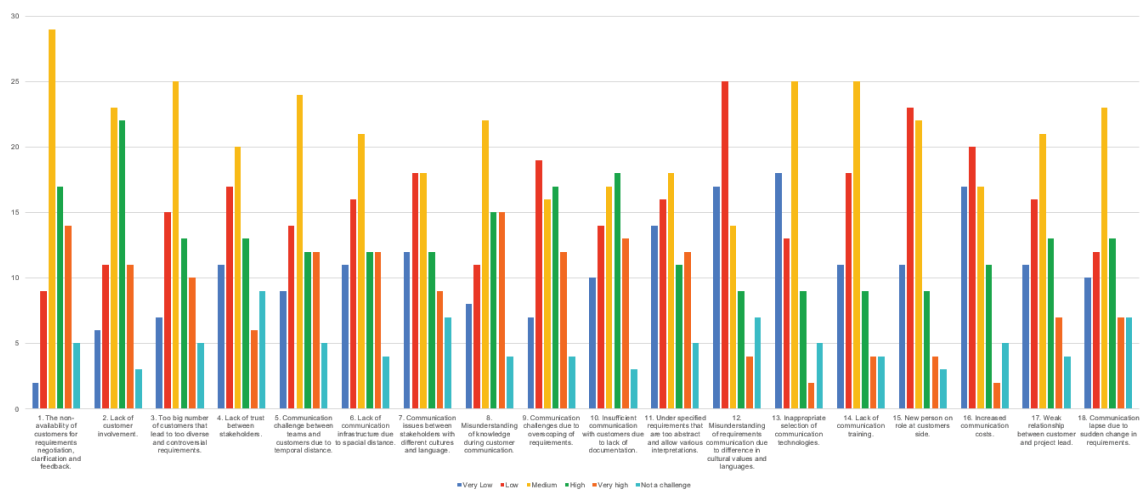


Figure 6.7: Q7.What is the impact of the below-mentioned challenges on your projects?

Analysis for RQ2

In this section the analysis of survey data is done for answering RQ2. The method used to analyze this data is descriptive statistics. First the analysis was performed on Question 6 of the survey which is the occurrence of the challenges in the project. The below table 6.1 mentions the data collected from the survey responses. The respondents were asked to answer the question by choosing between the three options for each of the challenge. The option scale has 3 options which are low, medium and high. The option scale can be in both in qualitative and quantitative form. To perform the risk analysis calculations the option scale which is in qualitative form in changed into quantitative form to perform risk analysis calculations[10]. The option scale has different levels with different value for each scale, like one scale has more value than other scale. To change this qualitative scale to a quantitative, the option scale is given a numerical values based on the values of the scale[10]. These options are given weights in an ascending order scale which ranges from 0.1 to 0.3 in which 0.1 is low, 0.2 is medium and 0.3 is high based on the values of the scale.

Challenge No.	Low	Medium	High
CH1	28	37	10
CH2	34	32	9
CH3	39	20	14
CH4	44	26	4
CH5	37	32	5
CH6	40	26	8
CH7	45	23	6
CH8	32	32	11
CH9	36	31	8
CH10	38	31	6
CH11	45	24	7
CH12	50	20	5
CH13	41	26	4
CH14	41	20	10
CH15	48	20	3
CH16	39	28	3
CH17	36	26	9
CH18	36	22	12

Table 6.1: Occurrence of challenges

The occurrence of challenges is calculated for each challenge. This is done by giving a total score to each of the challenge that is calculated by multiplying the number of responses to the given weights of scale. After finding the weights of each scale the median is calculated for each challenge which helps in ranking of these challenges which comes is done by considering the ordinal scale type. The median value of each challenge are mentioned in table 6.2.

Challenge	Low	Medium	High	Median
1. The non-availability of customers for requirements negotiation, clarification and feedback.	2.8	7.4	3	3
2. Lack of customer involvement.	3.4	6.4	2.7	3.4
3. Too big number of customers that lead to too diverse and controversial requirements.	3.9	4	4.2	4
4. Lack of trust between stakeholders.	4.4	5.2	1.2	4.4
5. Communication challenge between teams and customers due to temporal distance.	3.7	6.4	1.5	3.7
6. Lack of communication infrastructure due to spacial distance.	4	5.2	2.4	4
7. Communication issues between stakeholders with different cultures and language.	4.5	4.6	1.8	4.5
8. Misunderstanding of knowledge during customer communication.	3.2	6.4	3.3	3.3
9. Communication challenges due to overscoping of requirements.	3.6	6.2	2.4	3.6
10. Insufficient communication with customers due to lack of documentation.	3.8	6.2	1.8	3.8
11. Under specified requirements that are too abstract and allow various interpretations.	4.5	4.8	2.1	4.5
12. Misunderstanding of requirements communication due to difference in cultural values and languages.	5	4	1.5	4
13. Inappropriate selection of communication technologies.	4.1	5.2	1.2	4.1
14. Lack of communication training.	4.1	4	3	4
15. New person on role at customers side.	4.8	4	0.9	4
16. Increased communication costs.	3.9	5.6	0.9	3.9
17. Weak relationship between customer and project lead.	3.6	5.2	2.7	3.6
18. Communication lapse due to sudden change in requirements.	3.6	4.4	3.6	3.6

Table 6.2: Analysed occurrence of challenges

After finding the median values for each challenge, the challenges are sorted in descending order from highest value to lowest value. The below figure 6.8 displays the sorted occurrence calculated for each challenge that is represented in the form of a bar graph.

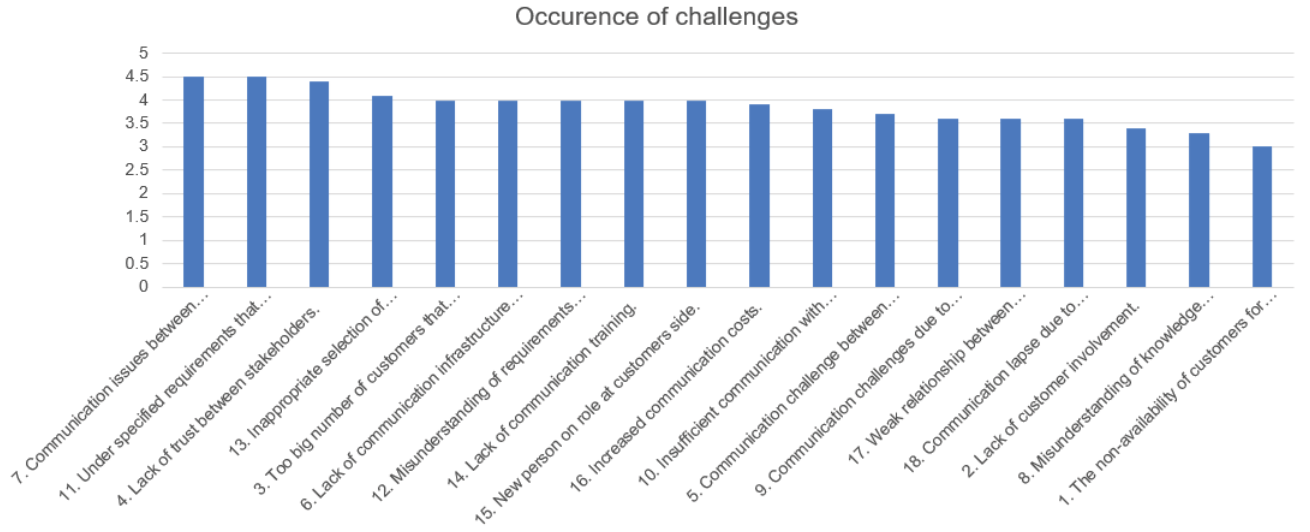


Figure 6.8: Bar graph of occurrence of challenges

Second the analysis was performed on Question 7 of the survey which is the impact of the challenges on the project. The below table 6.3 mentions the data collected from the survey responses. The option scale has 5 options which are very low, low, medium, high and very high. The weights are assigned a quantitative value same as the above occurrence of challenges. These options are given weights in an ascending order scale which ranges from 0.1 to 0.5 in which 0.1 is very low, 0.2 is low and 0.3 is medium, 0.4 is high and 0.5 is very high.

Challenge No.	Very Low	Low	Medium	High	Very high
CH1	2	9	29	17	14
CH2	6	11	23	22	11
CH3	7	15	25	13	10
CH4	11	17	20	13	6
CH5	9	14	24	12	12
CH6	11	16	21	12	12
CH7	12	18	18	12	9
CH8	8	11	22	15	15
CH9	7	19	16	17	12
CH10	10	14	17	18	13
CH11	14	16	18	11	12
CH12	17	25	14	9	4
CH13	18	13	25	9	2
CH14	11	18	25	9	4
CH15	11	23	22	9	4
CH16	17	20	17	11	2
CH17	11	16	21	13	7
CH18	10	12	23	13	7

Table 6.3: Impact of challenges

Challenge	Very low	Low	Medium	High	Very high	Median
1. The non-availability of customers for requirements negotiation, clarification and feedback.	0.2	1.8	8.7	6.8	7	6.8
2. Lack of customer involvement.	0.6	2.2	6.9	8.8	5.5	5.5
3. Too big number of customers that lead to too diverse and controversial requirements.	0.7	3	7.5	5.2	5	5
4. Lack of trust between stakeholders.	1.1	3.4	6	5.2	3	3.4
5. Communication challenge between teams and customers due to temporal distance.	0.9	2.8	7.2	4.8	6	4.8
6. Lack of communication infrastructure due to spacial distance.	1.1	3.2	6.3	4.8	6	4.8
7. Communication issues between stakeholders with different cultures and language.	1.2	3.6	5.4	4.8	4.5	4.5
8. Misunderstanding of knowledge during customer communication.	0.8	2.2	6.6	6	7.5	6
9. Communication challenges due to overscoping of requirements.	0.7	3.8	4.8	6.8	6	4.8
10. Insufficient communication with customers due to lack of documentation.	1	2.8	5.1	7.2	6.5	5.1
11. Under specified requirements that are too abstract and allow various interpretations.	1.4	3.2	5.4	4.4	6	4.4
12. Misunderstanding of requirements communication due to difference in cultural values and languages.	1.7	5	4.2	3.6	2	3.6
13. Inappropriate selection of communication technologies.	1.8	2.6	7.5	3.6	1	2.6
14. Lack of communication training.	1.1	3.6	7.5	3.6	2	3.6
15. New person on role at customers side.	1.1	4.6	6.6	3.6	2	3.6
16. Increased communication costs.	1.7	4	5.1	4.4	1	4
17. Weak relationship between customer and project lead.	1.1	3.2	6.3	5.2	3.5	3.5
18. Communication lapse due to sudden change in requirements.	1	2.4	6.9	5.2	3.5	3.5

Table 6.4: Analysed impact of challenges

The impact of challenges is calculated for each challenge. This is done by giving a total score to each of the challenge that is calculated by multiplying the number of responses to the given weights of scale. After finding the weights of each scale the median is calculated for each challenge which helps in ranking of these challenges which comes is done by considering the ordinal scale type. The median value of each challenge are mentioned in table 6.4.

After finding the median values for each challenge, the challenges are sorted in descending order from highest value to lowest value. The below figure 6.9 displays the sorted impact calculated for each challenge that is represented in the form of a bar graph.

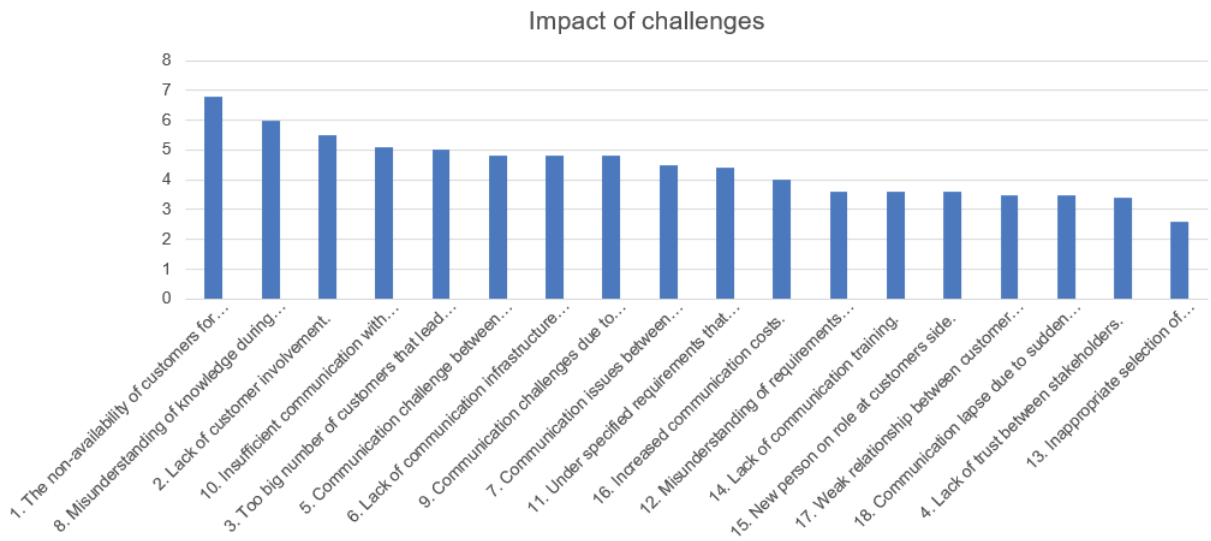


Figure 6.9: Bar graph of impact of challenges

RQ2: How are the customer communication challenge prioritized?

The answer of this research question is calculated from the data collected from the survey. Prioritizing the challenges helps to identify the challenges that causes more effect on the Agile project that needs more attention to avoid them. This prioritization of challenges is done by finding out the challenges that causes high amount of risk to the project. This is done by calculating the risk analysis.

The degree of risk is calculated by multiplying the probability of occurrence of the challenge and the impact caused by the challenge[35].

$$Risk = Impact * Probability$$

From table 6.2 and 6.4, the values of probability of occurrence and impact for each challenge is calculated. From using the above formula for risk analysis, the values of each challenge is calculated as shown in table 6.5. The challenges are sorted based on the total weight of each challenge. The higher the weight of a challenge the higher

the risk of the challenge on the project. By sorting the challenges on descending order the priority of the challenges is shown in table 6.6.

Challenge	Occurrence	Impact	Total
1. The non-availability of customers for requirements negotiation, clarification and feedback.	3	6.8	20.4
7. Communication issues between stakeholders with different cultures and language.	4.5	4.5	20.25
3. Too big number of customers that lead to too diverse and controversial requirements.	4	5	20
11. Under specified requirements that are too abstract and allow various interpretations.	4.5	4.4	19.8
8. Misunderstanding of knowledge during customer communication.	3.3	6	19.8
10. Insufficient communication with customers due to lack of documentation.	3.8	5.1	19.38
6. Lack of communication infrastructure due to spacial distance.	4	4.8	19.2
2. Lack of customer involvement.	3.4	5.5	18.7
5. Communication challenge between teams and customers due to temporal distance.	3.7	4.8	17.76
9. Communication challenges due to overscoping of requirements.	3.6	4.8	17.28
16. Increased communication costs.	3.9	4	15.6
4. Lack of trust between stakeholders.	4.4	3.4	14.96
12. Misunderstanding of requirements communication due to difference in cultural values and languages.	4	3.6	14.4
14. Lack of communication training.	4	3.6	14.4
15. New person on role at customers side.	4	3.6	14.4
17. Weak relationship between customer and project lead.	3.6	3.5	12.6
18. Communication lapse due to sudden change in requirements.	3.6	3.5	12.6
13. Inappropriate selection of communication technologies.	4.1	2.6	10.66

Table 6.5: Prioritized challenges

In the above table 6.5, the challenges are arranged in the order of highest risk to lowest risk by prioritizing them. The below figure 6.10 displays the bar graph with trend line of the challenges after prioritizing them.

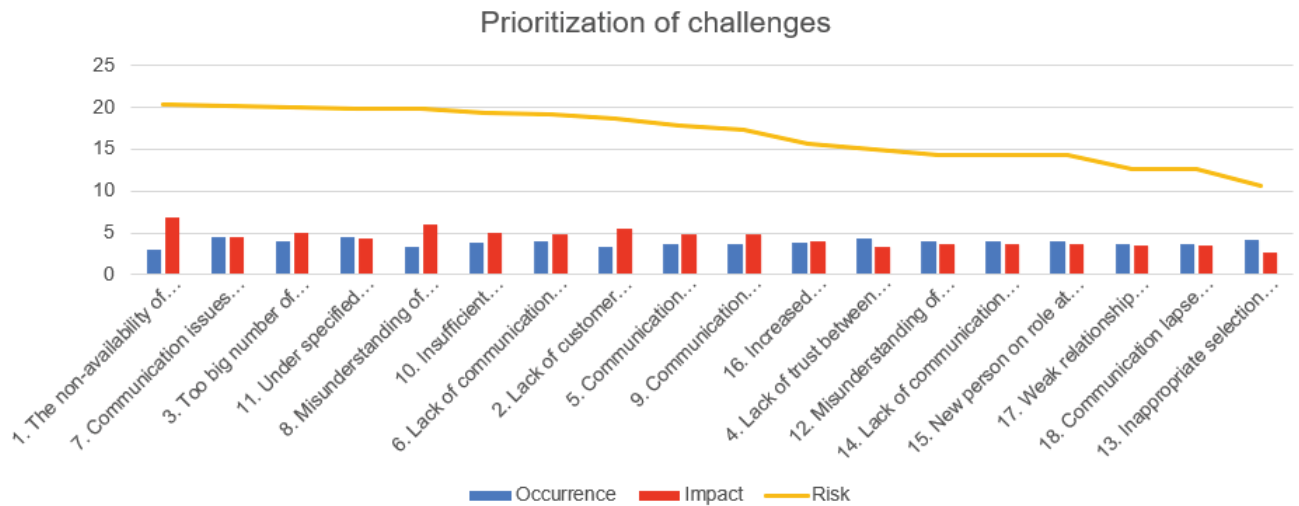


Figure 6.10: Barplot with trend line chart of prioritized challenges

CH no	Challenge	Priority
CH1	The non-availability of customers for requirements negotiation, clarification and feedback.	1
CH7	Communication issues between stakeholders with different cultures and language.	2
CH3	Too big number of customers that lead to too diverse and controversial requirements.	3
CH11	Under specified requirements that are too abstract and allow various interpretations.	4
CH8	Misunderstanding of knowledge during customer communication.	5
CH10	Insufficient communication with customers due to lack of documentation.	6
CH6	Lack of communication infrastructure due to spacial distance.	7
CH2	Lack of customer involvement.	8
CH5	Communication challenge between teams and customers due to temporal distance.	9
CH9	Communication challenges due to overscoping of requirements.	10
CH16	Increased communication costs.	11
CH4	Lack of trust between stakeholders.	12
CH12	Misunderstanding of requirements communication due to difference in cultural values and languages.	13
CH14	Lack of communication training.	14
CH15	New person on role at customers side.	15
CH17	Weak relationship between customer and project lead.	16
CH18	Communication lapse due to sudden change in requirements.	17
CH13	Inappropriate selection of communication technologies.	18

Table 6.6: Prioritized challenges

The above table 6.6 displays the challenges in the prioritized order, where challenge 1 is given highest priority and the least priority is given to challenge 13 based on the responses gathered from the survey.

6.1.3 Mitigation

The question 8 focuses on the mitigation strategies for the challenges that are selected by the respondents in the previous question 6. This question gathers data about the solutions to overcome the challenges. This question is an open ended question and is answered in the form of a short or long answer.

Analysis for RQ3: To analyse the open ended question, thematic analysis was performed. This is conducted by following steps:

- **Familiarizing with data:** The first step of thematic analysis is by getting familiar with the data collected from the survey. The survey data is read repeatedly until we get familiarized with the survey data. In this process the incomplete and irrelevant data is identified and removed.
- **Generating codes:** In this step the initial codes are generated after getting familiarized with the data. The codes are used to identify the interesting themes from the data. These themes are generated by using tool and manually. Some codes are auto-generated using the Nvivo tool and the rest are generated manually. A total of 176 categories of codes were identified that are relevant to the data.
- **Identifying themes:** The codes that are identified and grouped in the previous step are now put into the themes that are generated based on the respective challenges in the study. Initially few themes are auto generated from the tool and if there are any codes left they are listed, compared and manually assigned to the a theme. Repeated verification was done on the generated themes and their respective categories of codes in order to avoid redundancies making the data more reliable and understanding. The list themes are presented as in table 6.7.

Reference no.	Theme	Reference no.	Theme
1.	Communication	15.	Customer
2.	End user	16.	Training
3.	Flew teams	17.	Contract
4.	customer relationship	18.	Estimation
5.	Meetings	19.	Experienced person
6.	People	20.	Documentation
7.	Tools	21.	Feedback
8.	Communication skills	22.	Requirements
9.	Communication tools	23.	Review
10.	Translate	24.	Details
11.	Experienced person	25.	Details
12.	Language	26.	Learning
13.	Technology	27.	System
14.	Flexible	28.	Changes

Table 6.7: Themes

- **Constructing Thematic maps:** Construction of the thematic maps is done for each challenge individually and later based on the map we make deductive conclusions. All the generated maps can be found in the next section above the respective challenges from figure 6.11 to 6.17.
- **Results from the Survey:** The results from the survey are analysed and displayed below for answering the RQ3 to find out the mitigation strategies to overcome the challenges.

RQ3: What are the mitigation strategies that can be proposed for these challenges?

The answer of this question is gathered after analyzing the data that is collected from the survey. This answer provides solutions to overcome the challenges faced by customer communication during Agile requirements engineering. This study identified a total of 18 challenges from systematic mapping study and intends to propose mitigation strategies for these challenges from this answer.

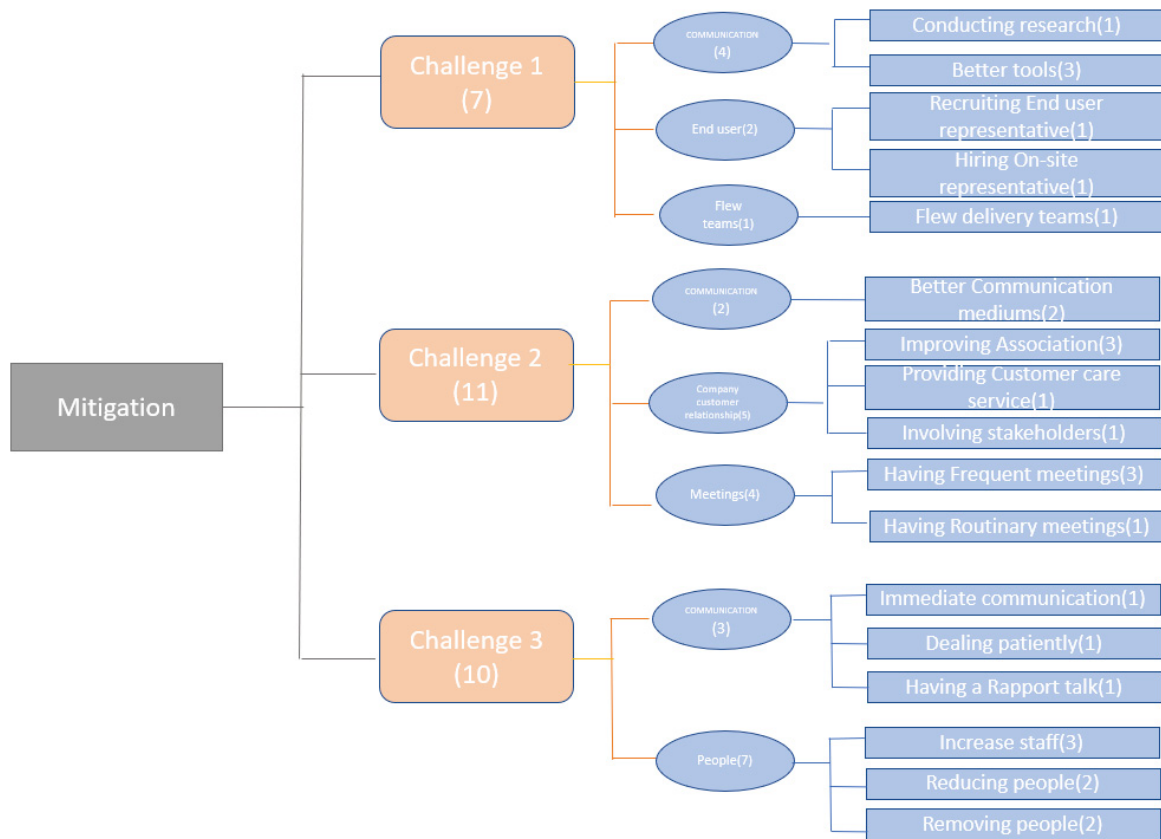


Figure 6.11: Thematic map for challenge 1,2 & 3

From the above figure 6.11 the mitigation for the challenges 1,2 and 3 are mentioned below.

- **Challenge 1: The non-availability of customers for requirements negotiation, clarification and feedback.**

According to the figure for challenge 1 there are seven mitigation strategies proposed. There are three categories of themes for challenge 1 which are communication, end user and Flew teams. From the communication code the mitigation strategies mentioned are *"Challenge 1 can be overcome by conducting more research on customer communication part "*, three respondents mentioned *"This challenge can be overcome by using appropriate technology and better communication tools"*. From the second code, End user the mitigation strategies mentioned are *" Federal product owners recruit end user representatives from multiple offices and roles. These end user representatives provide context, feedback and early testing directly to contracted delivery teams."* and *"Challenge no. 1 can also be solved by hiring an on-site customer representative"*. The third code, Flew delivery teams the mitigation strategies mentioned are *" on one of my projects the government flew in end user representatives to work daily with the delivery team for 30 days at a time. More recently the government did the reverse, and flew delivery teams out to observe end users using their software. The later model (flying the developers to the users) seemed to work best. Now major feature releases always include an site visit by the delivery team, usually in combination with a limited release with testing by end user representatives."*

- **Challenge 2 : Lack of customer involvement.**

According to the figure for challenge 2 there are eleven mitigation strategies proposed. There are three categories of themes for challenge 2 which are communication, company/customer relationship and Meetings. From the first code which is communication the mitigation strategies mentioned are *"This challenge can be overcome by using better communication mediums, communication tools and communication knowledge"*, other respondent mentioned *"I strongly recommend communication's workshops. They are really useful to overcome this challenge"*. From the second code which is company/customer relationship the mitigation strategies mentioned are *"Challenge no. 2 can also be resolved by improving the customer and company relationship"* other respondent mentioned *"According to me challenge no.2 can be solved by giving the customers the privilege to provide a representative among themselves who will be with the teams as the work progresses and give adequate feedback to others offsite."*. One respondent mentioned *"Challenge 2 is overcome by involving stakeholders from day 1"* and *"Challenge 2 can be resolved by having a customers care service"*. Finally for the third code which is meetings the mitigation strategies mentioned by respondents are *"Challenge 2 is overcome by routinary meetings and feedback with the customer"* and three respondents mentioned *"Challenge no. 2 is overcome by frequent "pinging" of the customer(s) to involve them more. This challenge is overcome by having more frequent meetings, direct and constant contact with customers"*.

- **Challenge 3: Too big number of customers that lead to too diverse and controversial requirements.**

According to the figure for challenge 3 there are ten mitigation strategies proposed. There are two categories of themes for challenge 3 which are communication and people. From the first code which is communication the mitigation strategies proposed by the respondents are "Challenge no.3 is overcome by immediate communication with the customers for clarification", other respondent mentioned "Challenge number 3 is overcome by patiently dealing and considering the constructive ideas." Other respondent mentioned "This challenge can be overcome by having a rapport talk prior to development". From the second code which is people the mitigation strategies mentioned are : three respondents mentioned "This challenge is overcome by asking for more help and hiring more staff", two respondents mentioned "I overcame this challenge by adopting the use of division of labour. I assigned different levels of the project to as many subordinates to reduce the time constraint" and "having more meetings with less people" and two respondents mentioned "Rejection of clients with whom the attempts to establish a project were difficult to implement and by cutting down the middle people".

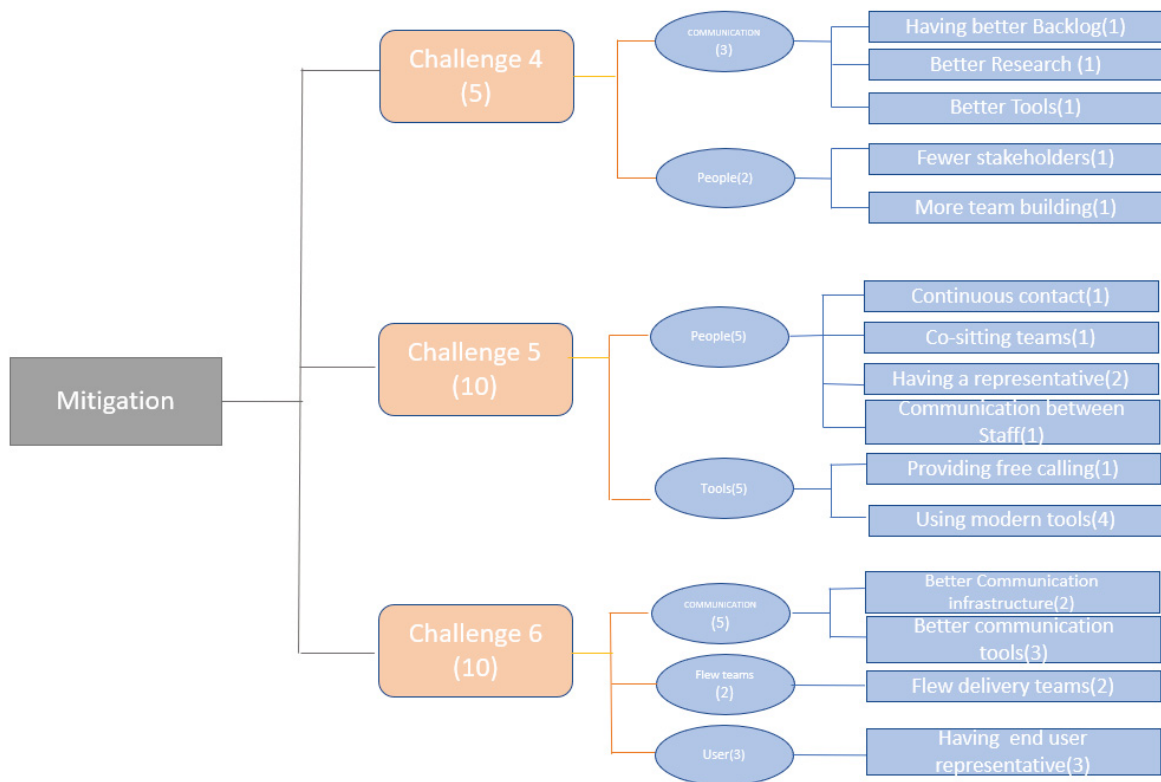


Figure 6.12: Thematic map for challenge 4, 5 & 6

From the above figure 6.12 the mitigation for the challenges 4,5 and 6 are mentioned below.

- **Challenge 4: Lack of trust between stakeholders.**

According to the figure for challenge 4 there are five mitigation strategies proposed. There are two categories of themes for challenge 4 which are communication and people. From the first code which is communication the mitigation strategies proposed by the respondents are *"Challenge 4 can be overcome by having better backlog and better communication with the client"*, one respondent mentioned *"This is solved by more research on our customer communication part"* and other respondent mentions *"This challenge is overcome by using better IT tools"*. For the second code which is people the mitigation strategies proposed by respondents are *"Challenge 4 can be mitigated by selecting a few stakeholders and not including a large number to avoid any mistrust"* and other respondent mentioned *"This challenge can be solved by having more team buildings and lunch"*.

- **Challenge 5: Communication challenge between teams and customers due to temporal distance.**

According to the figure for challenge 5 there are ten mitigation strategies proposed. There are two categories of themes for challenge 5 which are people and tools. From the first code which is people the mitigation strategies proposed by the respondents are *"Challenge 5 could be resolved with a continuous contact with the teams in order to reinforce the communication"*, one respondent mentioned *"Challenge 5 is overcome by co sitting the teams in a common place"*, two respondents mentioned *"Challenge no.5 can be resolved by having an on-site customer representative"* and other respondent mentioned *"This challenge is overcome by communication between in-house staff to onsite staff"*. From the second code which is tools the mitigation strategies proposed by respondents are *"Challenge no.5 was overcome by providing a free call mobile and texting to both team members and all the customers involved to effectively communicate and interact on the progress of the project"* and other respondents mentioned *"Challenge no. 5 It's best to use project schedule to have a better communication between teams. I used Gantt Project software. It's also good to have a coordinator from client side"* and *"Challenge no.5 can also be resolved by using modern communication tools"*.

- **Challenge 6: Lack of communication infrastructure due to spacial distance.**

According to the figure for challenge 6 there are ten mitigation strategies proposed. There are three categories of themes for challenge 6 which are communication, flew teams and user. From the first code which is communication the mitigation strategies proposed by the respondents are *"Challenge 6 is overcome by creating the communication infrastructure needed and by using online meetings"* and other three respondents mentioned *"This challenge can be overcome by using better communication tools on regular basis"*. The second code which is flew delivery teams the mitigation strategies proposed by respondents are *"Challenge no 6 is overcome by flying the delivery teams to the customers"*. The third code which is user the mitigation strategies proposed by the respondents are *"This challenge is overcome by having an end user representative"*

who provide context, feedback and early testing directly to contracted delivery teams".

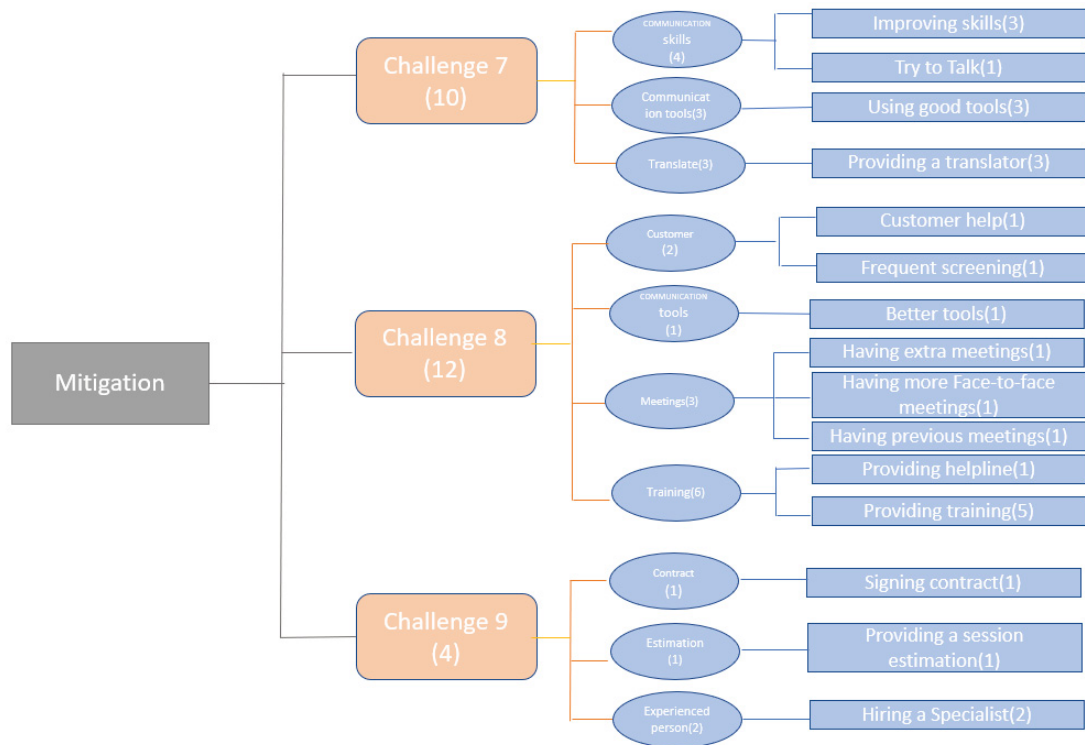


Figure 6.13: Thematic map for challenge 6, 7 & 8

From the above figure 6.13 the mitigation for the challenges 7,8 and 9 are mentioned below.

- **Challenge 7: Communication issues between stakeholders with different cultures and language.**

According to the figure for challenge 7 there are ten mitigation strategies proposed. There are three categories of themes for challenge 7 which are communication skills, communication tools and translate . From the first code which is communication skills the mitigation strategies proposed by the respondents are "7 we have improved our communication skills. ", one respondent mentioned "challenge no 7 is overcome by involving all the departments in the problems and by introducing new methods to communicate between different parts" and other respondent mentioned "To overcome this challenge is try to know, talk about it with them and respect it". The second code which is communication tools the mitigation strategies proposed by the respondents are "Challenge 7 is overcome by using better communication tools and different languages". The third code which is translate, the mitigation strategies proposed by respondents are "Challenge no.7 can be resolved by giving people good translators".

- **Challenge 8: Under specified requirements that are too abstract and allow various interpretations.**

According to the figure for challenge 8 there are twelve mitigation strategies proposed. There are four categories of themes for challenge 8 which are communication tools, customer, meetings and training. From the first code which is communication tools, the mitigation strategies proposed by the respondents are *"Challenge no. 8 is overcome by using better communication tools"*. The second code which is customer, the mitigation strategies proposed by respondents are *"To overcome challenge 8, I asked a old and trusted customer to become our training help"* and other respondent mentioned *"Challenge 8 can also be overcome by more frequent screening of the "product", involving the customers week to week"*. The third code which is meetings, the mitigation strategies proposed are *"challenge 8 is overcome by setting up extra meetings with customers"*, one respondent mentioned *"Challenge 8 is overcome by having more face-to-face meetings and a "no dumb questions" series"* and other respondent mentioned *"To avoid misunderstandings, we have a previous meeting with the client to clarify what our service will be based on"*. The fourth code which is training, the mitigation strategies proposed by the respondents are *"Challenge 8 can be overcome through proper instructions and better helpline"* and five respondents mentioned *"Challenge no. 8 is overcome by training the customers and the employees who talk to the customer"*.

- **Challenge 9: Misunderstanding of requirements communication due to difference in cultural values and languages.**

According to the figure for challenge 9 there are four mitigation strategies proposed. There are three categories of themes for challenge 9 which are contract, estimation and experienced partner. From the first code which is contract, the mitigation strategies proposed by the respondents are *"Challenge no. 9 is overcome by explaining client the range of work with a care to the details. It should be done before signing the contract with subcontractor"*. The second code which is estimation, the mitigation strategies proposed by the respondents are *"Challenge 9 is overcome by providing a second estimation session"*. The third code is experienced partner, the mitigation strategies proposed by the respondents are *"trying to get more experienced personnel in the team to make better estimations is key to resolve challenge 9"* and other respondent mentioned *"To overcome this challenge we should have better communication with out client and we should specify everything on the beginning. We should have a specialist who know how to speak with client"*.

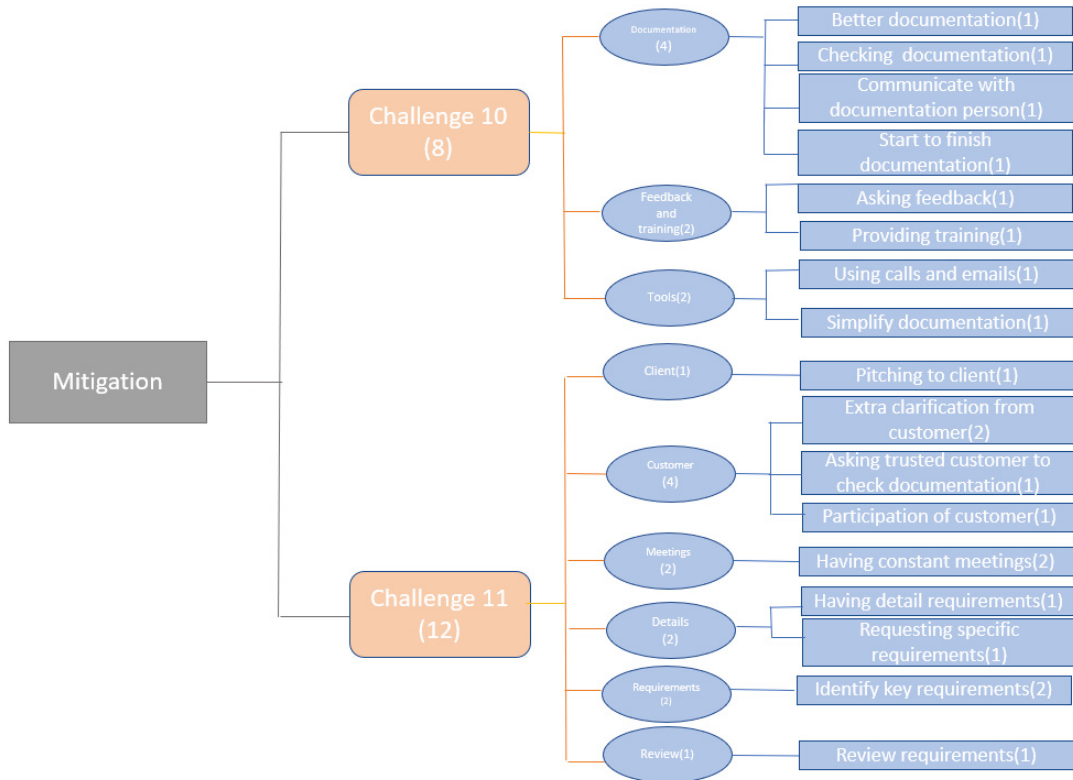


Figure 6.14: Thematic map for challenge 10 & 11

From the above figure 6.14 the mitigation for the challenges 10 and 11 are mentioned below.

- **Challenge 10: Misunderstanding of knowledge during customer communication.**

According to the figure for challenge 10 there are eight mitigation strategies proposed. There are three categories of themes for challenge 10 which are documentation, feedback training and tools. From the first code which is documentation the mitigation strategies proposed by the respondents are *"To overcome challenge 10, We could write much better documentation. Not necessarily more, but tighter, more concise and more useful documents"*, one respondent mentioned *"Challenge no.10 can also be resolved by checking the documentation periodically"*, one respondent mentioned *"Challenge 10 is solved by trying to communicate with the person responsible for providing the documents, as well as giving a warning that such situations should not occur in the future"* and other respondent mentioned *"Challenge. 10 - Everything should be documented from the start to finish"*. From the second code which is feedback training, the mitigation strategies proposed by the respondents are *"Challenge no 10 is solved by waiting to gather all of the problems before asking customers whether our method of resolving them"* and other respondent mentioned *"Challenge no.10 is overcome by providing training to the customers making them submit valid information about themselves"*.

The third code which is tools, the mitigation strategies proposed by the respondents are *"I was able to overcome this challenges by adopting the use of calls and emails for clarity purpose and sending of some necessary documents"* and other respondent mentioned *"Challenge no. 10 is solved if provided more tools to help simplify documentation"*.

- Challenge 11: Communication challenges due to overscoping of requirements.** According to the figure for challenge 11 there are twelve mitigation strategies proposed. There are six categories of themes for challenge 11 which are client, customer, details, meetings, requirements and review. From the first code which is client the mitigation strategy proposed by the respondent is *"Challenge no. 11 can be overcome by agreeing the details with the client"*. The second code which is customer, the mitigation strategies proposed by the respondents are *"challenge 11 is overcome by asking customers for extra explanation, clarification and by anticipating the needs of the customer"*, one respondent mentioned *"To overcome challenge 11: I asked a old and trusted customer to read all the documentations to avoid requirements that could allow various interpretation"*. The third code which is details, the mitigation strategies proposed by the respondents are *"For challenge 11 - Spend more time estimating and detail requirements in depth"* and one respondent mentioned *"Challenge 11 is overcome by requesting specific details to the customer"*. The fourth code which is meetings, the mitigation strategies proposed by the respondents are *"Challenge no. 11 is overcome by constant communication to meet the specifications. We had several meetings (both, internal and with customer) to clarify what customer wanted"*. The fifth code which is requirements, the mitigation strategies proposed by the respondents are *"Challenge no 11 is overcome by communicating with Engineering Manager and Documentation head on identifying the key requirements"* and other respondent mentioned *"Challenge no 11 can also be resolved by verifying the key requirements prior to documentation requirement"*. The sixth code which is review, the mitigation strategies proposed by the respondents are *"To overcome challenge 11- Try to review the questions with the company first and then with the participants that I want to involve with"*

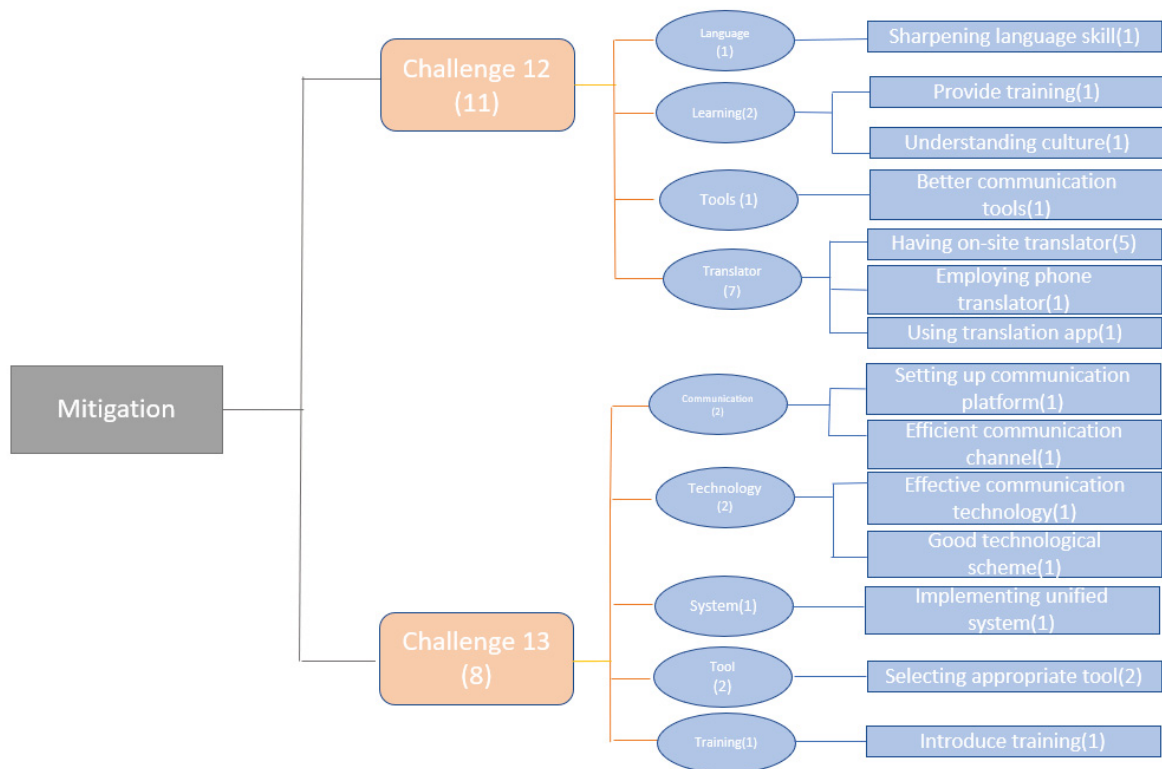


Figure 6.15: Thematic map for challenge 12 & 13

From the above figure 6.15 the mitigation for the challenges 12 and 13 are mentioned below.

- **Challenge 12: Insufficient communication with customers due to lack of documentation.**

According to the figure for challenge 12 there are eleven mitigation strategies proposed. There are four categories of themes for challenge 12 which are language, learning, tools and translator. From the first code which is language the mitigation strategies proposed by the respondents are "*Challenge 12 is overcome with sharpening the Language Skills*". The second code which is learning, the mitigation strategy proposed by the respondent is "*Challenge no. 12 can also be resolved if people get to learn and understand other people's culture. Thereby, leading to know each other better*". The third code which is tools, the mitigation strategy proposed by the respondent is "*Challenge 12 is solved by providing better information and use of tools that facilitate communication*". The fourth code which is translator, the mitigation strategies proposed by the respondents are "*The answer to solve challenge number 12 can be found by employing a certain translator who will be always available by phone*", five respondents mentioned "*Challenge no.12 can also be resolved by having a translator on-site for the customer*" and other respondent mentioned "*Challenge 12 was overcome by the introduction of a special apps that helps in language translation to different language*".

- **Challenge 13: Inappropriate selection of communication technologies.**

According to the figure for challenge 13 there are eight mitigation strategies proposed. There are five categories of themes for challenge 13 which are communication, technology, system, tools and training. From the first code which is communication, the mitigation strategies proposed by the respondents are *"To resolve challenge no13, communication platforms should be set in place before project starts"*, other respondent mentioned *"This challenge is overcome by using effective communication channels"*. The second code which is technology, the mitigation strategies proposed by respondents are *"Challenge 13 was overcome by going back to choose an effective communication technology which are very reliable and give us the best communication network which do not glitch at all"*, other respondent mentioned *"To resolve challenge no 13 - It's good to discuss technological scheme and equipment selection (before purchasing) with Project Designer"*. The third code which is system, the mitigation strategies proposed by respondents are *"Challenge 13 could be overcome by implementing one unified system for collecting data and messaging"*. The fourth code which is tool, the mitigation strategies proposed by the respondents are *"Challenge 13 can be resolved by referencing tools used in other successful projects, and agree with the customers on an appropriate tool"* and other respondent mentioned *"This challenge is overcome by more careful selection of the technologies"*. The fifth code which is training, the mitigation strategy proposed by respondent is *"To overcome the challenge 13 introduce training to customers and employees"*.

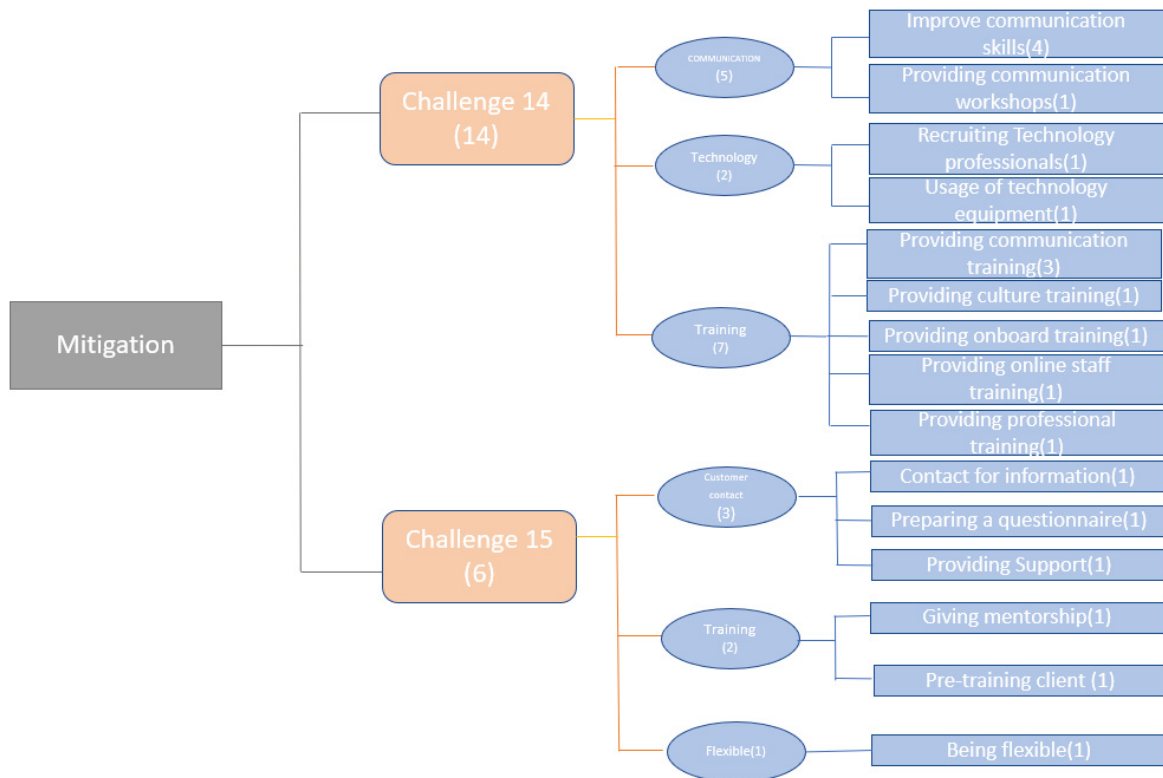


Figure 6.16: Thematic map for challenge 14 & 15

From the above figure 6.16 the mitigation for the challenges 14 and 15 are mentioned below.

- **Challenge 14: Lack of communication training.**

According to the figure for challenge 14 there are fourteen mitigation strategies proposed. There are three categories of themes for challenge 14 which are communication, technology and training. From the first code which is communication, the mitigation strategies proposed by the respondents are "Our organization trains each employee and develops their communication skills, in order to be able to create strong relationships with partners and customers and be able to adapt to every change that is presented", three respondents mentioned "Challenge no. 14 is overcome by Improving Communication skills", other respondent mentioned "Challenge 14 is overcome by providing serious communication workshops". The second code which is technology, the mitigation strategies proposed by the respondents are "Challenge 14 can be overcome by recruiting the communication technology professionals to always be around to guide the users on communication throughout the project and to also correct any glitch that might occur along the line during usage". The third code which is training, the mitigation strategies proposed by the respondents are "Challenge no. 14 is also resolved by choosing to learn and understand other's culture for faster communication", three respondents mentioned "Challenge 14 is overcome by giving communication training and tools that can be use while leading a meeting.", one respondent mentioned "challenge 14 can be solved providing on boarding training to every participant in the project about the methodolo-

gies an roles in the project" and other respondent mentioned "Challenge 14 is overcome by doing more online staff training".

- **Challenge 15: New person on role at customers side.**

According to the figure for challenge 15 there are six mitigation strategies proposed. There are three categories of themes for challenge 15 which are customer contact, flexible and training. From the first code which is customer contact, the mitigation strategies proposed by the respondents are "Challenge 15 is solved by contacting the person above to obtain the necessary information", other respondent mentioned "Challenge number 15 can be solved by preparing a list of questions and further tracing back to the customer in case of a confusion" and other respondent mentioned "Challenge 15 is overcome by providing support for the new person in the company by the customer". The second code which is flexible, the mitigation strategy proposed by the respondent is "Challenge no.15 can be resolved by being flexible". The third code which is training, the mitigation strategies proposed by the respondents are "Challenge 15 can overcome from mentorship with other clients" and other respondent mentioned "This challenge can be overcome by pre-training the client".

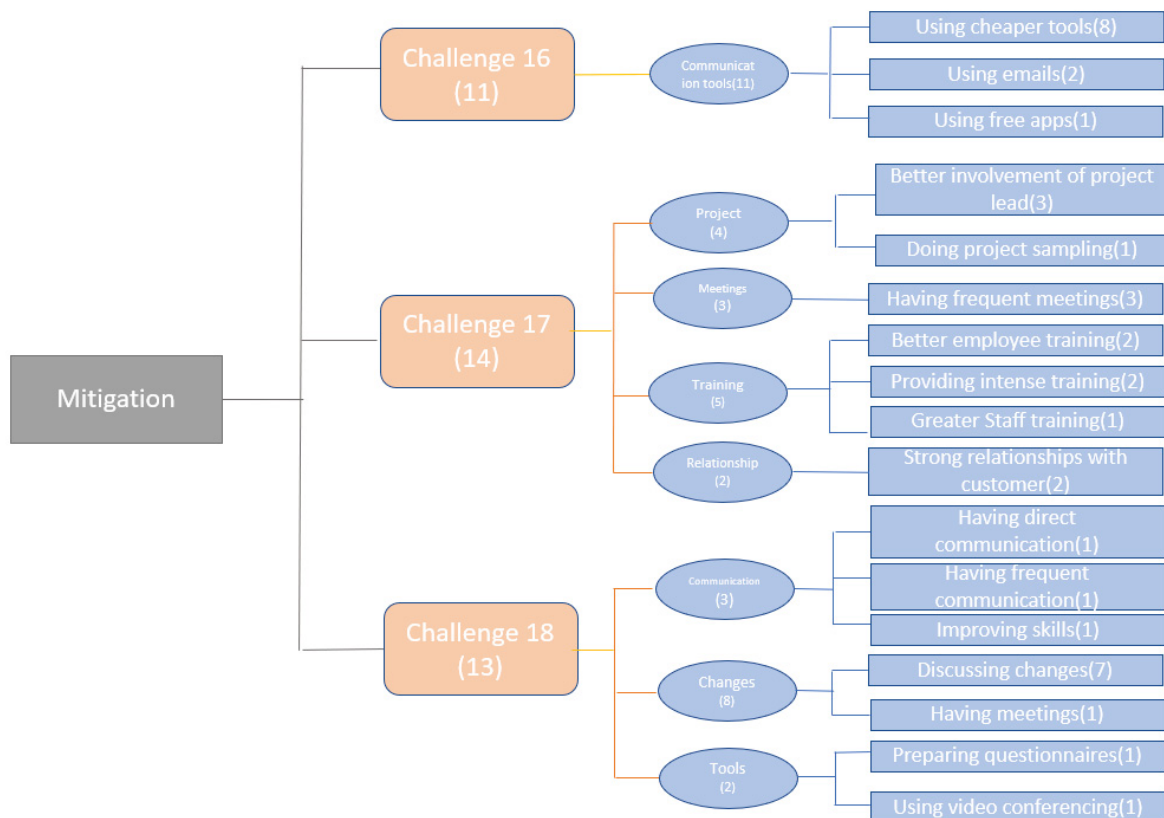


Figure 6.17: Thematic map for challenge 16, 17 & 18

From the above figure 6.17 the mitigation for the challenges 16, 17 and 18 are mentioned below.

- **Challenge 16: Lack of communication training.**

According to the figure for challenge 16 there are eleven mitigation strategies proposed. There is one category of theme for challenge 16 which is communication tools. From the code which is communication tools, the mitigation strategies proposed by the respondents are *"Challenge no. 16 - Tried to call or e-mail instead of going to the site. Tried to send the documentation by post office rather than personally and we resorted to the use of emails and social media channels to reduce cost"*, eight respondents mentioned *"Challenge no. 16 is overcome by using cheaper communication tools"* and *"It is a good example, we try to use communication tools close to and available from around the world, so that customers feel informed at all times"* and other respondent mentioned *"For overcoming challenge 16 use free apps like skype, slack or discord. There are many that are good and free"*.

- **Challenge 17: Weak relationship between customer and project lead.**

According to the figure for challenge 17 there are fourteen mitigation strategies proposed. There are four categories of themes for challenge 17 which are meetings, project, relationship and training. From the code which is meetings, the mitigation strategies proposed by the respondents are *"Challenge 17 can be solved with frequent meetings with the customer"*. The second code which is project, the mitigation strategies proposed by the respondents are *"Challenge 17 can be solved by doing project sampling by customers before projects completion"* and three respondents mentioned *"Challenge 17 is overcome by creating a good relationship between project lead and customer"*. The third code which is relationship, the mitigation strategies proposed by the respondents are *"According to me Challenge no.17 can be resolve by getting to know your customer"* and other respondent mentioned *"Our organization trains each employee and develops their communication skills, in order to be able to create strong relationships with partners and customers and be able to adapt to every change that is presented"*. The fourth code which is training, the mitigation strategies proposed by the respondents are *"Challenge 17 could have been averted with greater staff training"*, two respondents mentioned *"Challenge no. 17 is overcome by training all our team in building better relationships and problem solving"* and other two respondents mentioned *"Challenge 17 could be solved by workshops and intense training"*.

- **Challenge 18: Communication lapse due to sudden change in requirements.: Weak relationship between customer and project lead.**

According to the figure for challenge 18 there are thirteen mitigation strategies proposed. There are three categories of themes for challenge 18 which are changes, communication and tools. From the code which is changes, the mitigation strategies proposed by the respondents are *"Challenge number 18 can be bypassed with a meeting where you will say all you want to change and apply only those needed"*, seven respondents mentioned *"Challenge no.18 can also be resolved by properly discussing the changes in requirements without changing the entire scope of project"*. The second code which is communication, the mitigation strategies proposed by the respondents are *"Challenge no. 18 is*

overcome by direct communications", other respondent mentioned "Challenge 18 can also be resolved by more frequent communication (obviously) despite the change in requirements" and other respondent can be solved by "Challenge 18 can be solved by improving communication skills". The third code which is tools, the mitigation strategies proposed by the respondents are "Challenge no. 18 can be resolved by use of pictures and the use of questionnaires for clarity purpose" and other respondent mentioned "Challenge 18 can be resolved by the use of video conferencing".

This research aims to find out the customer communication challenges, prioritize these challenges and also mitigation strategies to the challenges that are faced during requirements engineering phase in Agile software development. The reason for selecting this research topic is that there are researches focusing on challenges in Agile and requirements engineering but a very few on challenges faced due to customer communication. Many researches mentioned that more research must be done in this area and also to find the solutions to overcome these challenges. Also there are no researches that prioritizes these customer communication challenges which this thesis intends to do.

Initially, to find out the customer communication challenges a systematic mapping study was conducted. From this mapping study a list of challenges were mapped. From this list of challenges a survey was conducted to prioritize and find out solutions to overcome these challenges. The discussion on research questions and explanation of results are mentioned below.

RQ.1: What are the customer communication challenges faced in Requirement engineering process in Agile software development?

The summary of results from the systematic mapping study is by identifying the challenges that are faced by customer communication in Agile requirements engineering. While the previous literature mostly focused on the challenges in Agile software development and Agile requirements engineering, this research focuses on challenges solely related to customer communication in Agile requirements engineering. From the collected papers(S1-S22), a total of 38 communication challenges are identified. Further, These challenges are reduced to 18 main challenges as few of the challenges are redundant that are related to the aim of this thesis.

The challenges identified from the systematic mapping study that are mapped in this study are found that they effect the project and causes risk in a real-time project. The verification of challenges is done from the real time data collected from the survey where the respondents mention the affects of these challenges. These are as follows:

- 1. The non-availability of customers for requirements negotiation, clarification and feedback :** The respondents mentioned that this challenge affects the usability, project life cycle and productivity of the project.

2. Lack of customer involvement: The respondents mentioned that this challenge affects the determination of what the customer really wants , productivity and the completion time of the project.

3. Too big number of customers that lead to too diverse and controversial requirements: The respondents mentioned that this challenge affected the cost and the completion time of project.

4. Lack of trust between stakeholders: The respondents mentioned that this challenge affects the productivity and the funding of the project.

5. Communication challenge between teams and customers due to temporal distance: The respondents mentioned that this challenge had a negative impacts on the productivity of the project and also affects the completion time of projects.

6. Lack of communication infrastructure due to spacial distance: The respondents mentioned that this challenge affects the productivity, efficiency and completion time of the product.

7. Communication issues between stakeholders with different cultures and language: The respondent mentioned that this challenge no.7 affected the delivery time, execution time and the productivity of the project.

8. Under specified requirements that are too abstract and allow various interpretations: The respondents mentioned that this challenge 8 affects the effective design of implementation, the productivity and the lead time of the project.

9. Misunderstanding of requirements communication due to difference in cultural values and languages: The respondents mentioned that this challenge affects the productivity of the project.

10. Misunderstanding of knowledge during customer communication: The respondents mentioned that this challenge affected the completion time ,the productivity and delay in the implementation of the project which resulted in a lack of response from the client.

11. Communication challenges due to overscoping of requirements: The respondents mentioned that this challenge affected the release time , effectiveness, cost, time and the productivity of the project.

12. Insufficient communication with customers due to lack of documentation: The respondents mentioned that this challenge decrease the productivity rate, affects the communication skills, productivity and delays the product development.

13. Inappropriate selection of communication technologies: The respondents mentioned that this challenge affects the progress of the project, hinders team performance, the time and cost of the project.

14. Lack of communication training: The respondent mentioned that this challenge leads to slower negotiations with client, leads to imbalance in meeting customers need, leads to a low productivity rate and also impacts negatively on the productivity of the team member thereby affecting the product quality.

15. New person on role at customers side: The respondent mentioned that this challenge affects the delivery time and leads to diverse requirements in a project.

16. Increased communication costs: The respondents mentioned that this challenge affects the time and leads to diverse requirements.

17. Weak relationship between customer and project lead: The respondents mentioned that this challenge lead to delay in project.

18. Communication lapse due to sudden change in requirements: The respondent mentioned that this challenge directly impacts on the performance on the process requirements collection, leads to random dismissal of task and leads to increased lead time of the project.

These are the real time effects mentioned by the respondents which shows that the 18 identified challenges that are selected from the systematic mapping study are valid challenges that occur in real time agile environment. This mapping of the customer communication challenges helps the agile practitioners identify the challenges that are faced in their real time agile projects. There are not much previous researches that solely focuses on the customer communication challenges and it is hard to find out all the possible challenges from the researches. This thesis maps all the possible customer communication challenges which helps the practitioners and researchers by making it easy to find all of these challenges at one place and help them be aware of all these customer communication challenges that can be faced in their Agile projects.

RQ2: How are the customer communication challenge prioritized?

This research question is answered from conducting a survey. The challenges identified from the above research question is a base for preparing this survey. While previous studies like (S1-S22) mentioned in table 5.4 focuses on the challenges in Agile requirements engineering, there is no research that focuses on the prioritization of the customer communication challenges in Agile RE. The prioritization of challenges is to identify which challenge causes high risk in an Agile project. This is done by calculating the risk factor and arranging the challenges based on its risk from highest risk to lowest risk. Most of the researches focuses on identifying the challenges and solutions for the challenges but do not mention which challenge tends to causes more

amount of risk among them. Finding this out helps in giving more attention and effort in avoiding the challenges that causes high risk in the projects. The factors required to find the risk analysis are gathered from the survey. Table 6.5 mentions the prioritized challenges. The results obtained from this research questions helps the members of the agile team avoid these customer communication challenges that are faced in their real time agile projects based on the risks that these challenges cause. This prioritization of challenges helps the agile team members by preparing them the level of risk a challenge causes on a project that helps them give more attention during requirements engineering. Initially, by knowing which challenge is a high risk the members of agile team can avoid these challenges at early stages during requirements engineering phase based on the level of risk caused by these customer communication challenges. Secondly, if these challenges occurs in their projects then they can have a checklist that helps in prioritizing the challenges to which more and early attention must be given to remove the challenge. This prioritization of challenges helps the agile projects in terms of cost, effort, time and efficiency. The risks in a project leads to lot of extra costs in removing of these risks, so this prioritization of challenges helps in avoiding these risks and also this list helps in reducing the challenge that cause more risk and the low risk challenges can be avoided which helps in reducing the cost of the project. This prioritization list of customer communication challenges helps the agile team members give more effort in avoiding the challenges that cause more amount of risk to the project that leads to increasing efficiency due to low risk of the project. This prioritized challenges helps identify the challenges that cause low risks in the projects that helps the agile members to avoid giving more attention to these challenges that helps in reducing the effort and time of the agile project.

RQ3: What are the mitigation strategies that can be proposed for these challenges?

This research question is answered from the survey. This answer aims to find solutions to overcome the challenges that are identified from the systematic mapping study. This is answered in the form of open ended question. A total of 96 responses are gathered for this question and a total of 76 responses are taken into consideration after removing the empty and unrelated responses. The challenges proposed by the respondents help to overcome the customer communication challenges in real time Agile projects. The solutions mentioned are gathered from the respondents working in different type of organizations, experience and locations. The real time mitigation strategies proposed by this diverse set of respondents helps to overcome the challenges in different situations and cases. These mitigation strategies are mentioned in figures 6.11- 6.17.

It is observed from the responses that some of mitigation strategies proposed by the respondents for the challenges are similar to the solutions found from the literature and some are unique that help to overcome these customer communication challenges. For example, according to Inayat et al [20] the mitigation strategy mentioned to overcome challenge 1- "The non-availability of customers for requirements negotiation, clarification and feedback" is to have an on-site customer representa-

tive and by moving a developer to the customer. In this thesis for challenge 1, five mitigation strategies are proposed. Out of which the two mitigation strategies are similar to the above mitigation strategies proposed by Inayat et al [20].

The mitigation strategies proposed for the customer communication challenges helps the agile practitioners in overcoming these challenges that are faced in their real time agile projects. There are not much previous researches that have provided solutions in overcoming these challenges that are faced in real time. This thesis provided at least 5-10 mitigation strategies for each challenge. These unique mitigation strategies proposed in this thesis helps the agile practitioners and researchers in overcoming these challenges in different scenarios and cases. These mitigation strategies also act as checklist for future studies. The proposed strategies help in solving the challenges in real time agile projects by reducing the risk and improving the efficiency of the agile projects.

The responses from the survey help to answer the RQ2 and RQ3. The survey was open for around 40 days in which a total of 96 responses are collected. The first set of survey was sent out to collect feedback about the questionnaire and changes were made and the survey was resent after making the changes. Out of the 96 responses most of the responses are gathered from prolific.co which is an online platform where the paid respondents are found. Other sources of respondents are received from LinkedIn, facebook groups focusing on Agile environment.

7.0.1 Limitations of the study

The limitations in this study are mentioned below:

- **Survey time period :** The survey questionnaire was open for around 40 days according to the thesis timeline. A total of 96 responses are gathered from the survey which is a good amount of responses. If the survey was open for more time period then more amount of responses can be gathered that provides more amount of mitigation strategies for the challenges.
- **Database selection:** To conduct the systematic mapping study in this thesis a total of four widely used popular databases are selected which are Scopus, ACM Digital library, ScienceDirect and Springer. A total of 22 primary studies are selected from this SMS and a total of 18 challenges are identified to answer RQ1. The results gathered from these databases are promising and achieved the aim of RQ1, but there is a possibility of leaving few papers out that can be available from other databases.
- **Customer side survey:** Another survey can be conducted focusing from the perspective of the customers. This survey helps understand other problems that can be faced by the customer due to communication during requirements engineering.

This section discusses the threats to validity in this thesis. The research consisting of results have threats and proper measures are taken to get productive and efficient results. Research studies are often subjected to threats due to various factors and the nature of results. Wohlin et al.[44] in their paper proposed a set of guidelines which are implemented in this study to avoid unexpected outcomes and risks.

8.1 SMS validity threats

The validity threats for the systematic mapping study are mentioned by following the guidelines of Petersenn et al.[32] and Wohlin et al.[44].

8.1.1 Internal validity

Threats to internal validity are the properties that effects the results and the procedure of the research. For instance, consider a research with insufficient or irrelevant data which directly impact the results of the study. Hence a proper code of conduct is to be followed and precautions should be employed.

Initially, The major threat in any mapping study is the formulation of search string and the selection of papers. If the search string is not properly constructed then there may arise risks that effects the results of the systematic mapping study. To avoid this threat the search string is formulated by following the SPIDER search strategy [8]. Second, the issue arises in selecting the relevant articles. After formulating a proper search string, the papers from the database search are selected based on the inclusion/exclusion criteria by following the guidelines of Petersenn et al.[32] which is also verified by both thesis author and the supervisor.

8.2 Survey validity threats

In survey, four validity threats are mentioned as suggested by Linaker et al.[30] and Wohlin et al.[44] which are Internal, external, construct and conclusion validity.

8.2.1 Internal validity

The threats related to conducting a survey concern how well the survey questionnaires are formulated and how are the survey respondents selected. If the survey questionnaire is not answerable and the selection of target audience are not correct then it might lead to poor responses and poor results. To overcome these risk in the thesis,

- After a meticulous reading of all the literature results, relevant challenges were used as a reference to formulated the questions followed by a thorough revision of the generated questionnaire by the author and supervisor. This ensures that there are no unknown repercussions in the survey results which might lead to inappropriate results.
- The respondents selection for this study was supervised with the use of Prolific.co website, a paid survey tool which enables filtering the respondents based on their experience and background. Additionally, manual inspection was conducted for respondents from other sources like LinkedIn and facebook groups the focus on Agile to avoid respondents who are not working in Agile team.

8.2.2 External Validity

Threats to external validity involve the generalizability and relevance to other similar problems in this study. The results are utilized by the survey to provide mitigation strategies and prioritization of customer communication challenges in Agile requirements engineering. This is achieved by using open source tools and commonly used techniques to retrieve the data. Under the guidance of supervisor, Google forms was used to generate the desired questionnaire and was circulated in online platforms like Prolific.co and LinkedIn facebook groups that focus on Agile accessible upon request. Further, if there were any issues they were resolved by revisiting the respondent through emails.

8.2.3 Construct Validity

Threats to construct validity involve the ability to understand what is being examined and analyzed from the results. If the formulation of questionnaire is not correct then risks may arise when the the data collected from the survey is analysed. For this a robust questionnaire formulation should be made as an insight into checking and verifying the questionnaire before it is deployed to the respondents. This was tackled by sending out initial questionnaire formulations and collecting feedback from few respondents . Repeated revisions were made based on the feedback and verified by the supervisor as well.

8.2.4 Conclusion Validity

Threats to Conclusion validity involve various aspects but concern three important factors namely quality, correctness and Trust worthiness on the results. Risks may arise if there is not proper data analysis methods to analyse the survey data as the

survey gathers for open ended and close ended responses. A Risk impact approach was utilized to prioritize the challenges. Due to the presence of both open and close ended questions, Descriptive statistics was used for answering RQ2 followed by thematic analysis was implemented to rule out unique answers and list all the relevant results for RQ3.

9.1 Conclusion

Requirements gathering is the initial and crucial step of any software development lifecycle. The requirements are gathered from the customers. The process of gathering requirements occurs at every stage of Agile software development. Communication plays an important role in gathering the requirements that help build a customer satisfactory product. Problems in requirements engineering process leads to failure of any project. To avoid risks in the project it is important to identify the challenges that occur and to find the solutions to overcome these challenges. This thesis aims is to find out the customer communication challenges, prioritize these challenges and the mitigation strategies to overcome the challenges.

To achieve the aim of this thesis two research methods were considered. The data is collected through systematic mapping study and survey. First a systematic mapping study is conducted to answer RQ1 and the data collected from the sms is used to conduct the survey to answer the RQ2 and RQ3.

The systematic mapping study is conducted to find out the challenges that are faced due to customer communication in Agile requirements engineering. From the systematic mapping study a total of 22 papers were collected that are related to achieve the aim of the thesis. A total of 18 customer communication challenges are identified from the mapping study. From the identified challenges the survey questionnaire was prepared to answer RQ2 and RQ3.

The purpose of the survey is to understand the challenges in customer communication during requirements engineering in Agile software development companies and develop solutions to address the challenges. The survey is conducted to prioritize the challenges and also to find out the mitigation strategies to overcome these challenges. A total of 96 responses are collected from the survey. The prioritization of challenges to answer RQ2 was performed by calculating the risk that the challenges cause. This risk analysis is calculated from the occurrence of challenges and the impact of the challenges on the project. This data required to answer this was collected from he survey. This prioritization of challenges help to identify the challenges that cause more risk to the project so that they can be given more importance to reduce the impact of the risks in the project.

The responses from the survey also helps to answer the RQ3 which is to find out the mitigation strategies to the challenges. Thematic analysis is used to extract the data to find out the solutions to overcome all the identified 18 challenges.

9.2 Future work

In this thesis, a total of 18 customer communication challenges are identified, prioritised and mitigation strategies to overcome the challenges are also mentioned. Further research can be conducted to,

- Provide a checklist to understand how these challenges effect different companies. A checklist can be provided to find out the challenges and the effects that these challenges causes is different cases and scenarios of companies, i.e, companies with different domains, sizes, location, etc.
- Adapt the mitigation strategies for specific domain and company. As a future work, the mitigation strategies can be provided based on the different cases and scenarios of companies, i.e, companies with different domains, sizes, location, etc.
- A survey can be conducted from the customers perspective and find out the challenges they face and also solutions for those challenges.

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A.1 Survey Invitation

Hi, I am Abhinav Ram Kola, a Master's student in Software Engineering at Blekinge Institute of Technology, Sweden. With my supervisor Davide Fucci, I am researching "Customer communication challenges in Agile requirements engineering." The purpose is to understand the challenges in customer communication during requirements engineering in Agile software development companies and develop solutions to address them. As part of this research, we would kindly ask you to fill in the following survey.

<https://forms.gle/NLeJTM2tKiLsnPCR6>

The total time needed to complete this survey is approximately 15 minutes. The survey data is treated in compliance with the current GDPR regulations.

Thank you for your help!



The screenshot shows a Google Forms survey invitation. The title is "Customer communication challenges in Agile Requirement Engineering." The text explains that the survey is part of a Master's thesis to find mitigation strategies for customer communication challenges in Agile Requirements engineering. It provides contact details for Abhinav Ram Kola (Name: Abhinav ram kola, Email: abhinavram98@gmail.com, abko@student.bth.se). It also states that the survey data is treated in compliance with current GDPR regulations and will be kept anonymous. A "Thank you for your participation!" message is followed by a red asterisk and the word "Required". Below this, there is a question: "What is the name of your organization? *". The form is set against a light orange background. At the bottom, the URL "DOCS.GOOGLE.COM" is visible, followed by the title "Customer communication challenges in Agile Requirement Engineering." and a small information icon (i) in a circle.

Customer communication challenges in Agile Requirement Engineering.

This survey is conducted as a part of my Master thesis to find out the mitigation strategies to overcome the customer communication challenges faced during the Agile Requirements engineering phase, to find out the frequency of occurrence of these challenges, impact of these challenges on the project and also to find out additional challenges that may occur.

My contact details:
Name: Abhinav ram kola
Email: abhinavram98@gmail.com abko@student.bth.se

The survey data is treated in compliance with the current GDPR regulations. The data will be kept anonymous and processed for the sole purpose of this research.

Thank you for your participation!

* Required

What is the name of your organization? *

DOCS.GOOGLE.COM

Customer communication challenges in Agile Requirement Engineering.

i

A.2 Survey Questionnaire

A.2.1 Demographics

Customer communication challenges in Agile Requirement Engineering.

This survey is conducted as a part of my Master thesis to find out the mitigation strategies to overcome the customer communication challenges faced during the Agile Requirements engineering phase, to find out the frequency of occurrence of these challenges, impact of these challenges on the project and also to find out additional challenges that may occur.

My contact details:

Name: Abhinav ram kola

Email: abhinavram98@gmail.com, abko@student.bth.se

The survey data is treated in compliance with the current GDPR regulations. The data will be kept anonymous and processed for the sole purpose of this research.

Thank you for your participation!

* Required

What is the name of your organization? *

Your answer

What is your current role in the organization? *

Choose

Please mention your working experience in an Agile environment? (in years) *

Your answer

Mention the size of your organization? *

- ☐ Micro organization (fewer than 9 employees)
- ☐ Small organization (10- 49 employees)
- ☐ Medium organization (50-249 employees)
- ☐ Large organization (250 or more employees)

What is the most used sourcing strategy by your organization? *

Choose

Specify the Agile method used in your project? *

- ☐ Scrum Methodology
- ☐ Kanban
- ☐ Extreme Programming (XP)
- ☐ Crystal
- ☐ Dynamic Systems Development Method (DSDM)
- ☐ Feature Driven Development (FDD)
- ☐ Other: _____

Mention which type of domain you are working? (Example: Telecom, multimedia, embedded systems, etc) *

Your answer

How many times have these selected challenges occurred in your project?

	Low(1-5 times)	Medium(6-10 times)	High(10 or more times)
1. The non-availability of customers for requirements negotiation, clarification and feedback.	☐	☐	☐
2. Involving all stakeholders throughout the whole agile project.	☐	☐	☐
3. Lack of customer involvement.	☐	☐	☐
4. Too big number of customers that lead to too diverse and controversial requirements.	☐	☐	☐
5. Lack of trust between clients and vendors.	☐	☐	☐
6. Inadequate user-developer interaction due to lack of trust.	☐	☐	☐
7. Lack of trust between client and offshore team.	☐	☐	☐

A.2.3 Mitigation strategies

How do these selected challenges affect your last completed project based on your experience? (Please mention the challenge number. Example: 28. Your answer)

Your answer

What are the measures that you have taken to overcome the above-selected challenges that you faced in the last completed project? (Please mention the challenge number. Example: 28. Your answer)

Your answer

What other possible mitigation strategies can you suggest for the above-selected challenges? (Please mention the challenge number. Example: 28. Your answer)

Your answer

What mitigation strategies can you suggest that can help overcome other non selected challenges? (Please mention the challenge number. Example: 8. Your answer)

Your answer

Mention any other customer communication challenges faced in Agile RE that are not listed above. (Optional)

Your answer

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