ANALYSIS OF SCRUM BASED SOFTWARE DEVELOPMENT TO IMPROVE RISK MANAGEMENT IN PAKISTANI SOFTWARE INDUSTRY

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Candidate of **Master of Science in Software Engineering (MSSE)** at the National University of Modern Languages do hereby declare that the thesis **Analysis of Scrum Based Software Development to Improve Risk Management in Pakistani Software Industry** submitted by me in partial fulfillment of MSSE degree, is my original work, and has not been submitted or published earlier. I also solemnly declare that it shall not, in the future, be submitted by me for obtaining any other degree from this or any other university or institution. I also understand that if evidence of plagiarism is found in my thesis/dissertation at any stage, even after the award of a degree, the work may be canceled and the degree revoked.

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ABSTRACT

Analysis of Scrum Based Software Development to Improve Risk Management in Pakistani Software Industry

Software evolves continuously to accommodate market volatility, posing danger to the project. Agile approaches have been suggested to handle these continuous changes in software requirements. Although, where there is a considerable amount of academic literature on the process of projects, a very negligible amount of research considered proper process for risk management in scrum projects in Pakistani Software Industry. The process of risk management involves seven processes such as planning, identification, qualitative analysis, quantitative analysis, risk response planning, risk response implementation, and monitoring. While adopting agile, many risks arise so proper mitigation strategies should be established by incorporating all risk management processes to overcome these risks. Existing literature lacks the implementation of proper processes for risk management that could lead the software toward failure. The major reason of failure of software projects is limited application of proper risk management. Agile methods like scrum do not propose particular activities for risk management. Due to this practitioner are not completely aware of these uncertain events. Keeping in mind this weakness, this study tried to provide mitigation strategies for a proper risk management process based on the scrum method. For that purpose, systematic literature review was conducted for identifying the challenges that can arise in agile software development. The practicality of these challenges was found by conducting survey in different software development companies. Based on these challenges mitigation strategies were proposed by conducting interviews from industry practitioners for mitigating these challenges. To validate these proposed mitigation strategies, a focus group methodology is applied. The mitigation strategies provide recommendations to mitigate the identified risk management challenges in scrum development. The proposed mitigation strategies will be helpful in reducing risks as well as in facilitating teams to handle them more easily in agile projects that use the scrum methodology and to enhance scrum project success rate.

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LIST OF ABBREVIATIONS

ASD	-	Agile Software Development
IEEE	-	Institute of Electrical and Electronics Engineers
IT	-	Information Technology
PMBOK	-	Project Management Body of Knowledge
RM	-	Risk Management
SLR	-	Systematic Literature Review
SEI	-	Software Engineering Institute

APPENDICES

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DEDICATION

This research is dedicated to my beloved parents and teachers throughout my career in education, whose good examples taught me to work hard for my goals, not only to love me unconditionally.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The complexities, serious rivalries, and instability of the software applications in the modern business environment, in which the software companies survive are the leading causes of new emerging risks as well as rapidly growing challenges. It is thought that a significant portion of software companies possess different opinions regarding software risks [1]. As a result, these companies are in need of well-established approach for managing risks that allows them to get rid of risks, address challenges before they occur and continue to maintain control of entire project's management [2].

In 1989, risk management in the development of software was recognized as an entirely distinct research area, and the spiral model was the first to include and implement the process of risk management [3]. Since the beginning of 21st century, software development companies have taken a shift from adopting traditional approaches towards adopting agile techniques[4]. In the risk management area switching from traditional methods such as cascading models towards innovative approaches like agile brings numerous challenges [5].

1.2 The Importance of Risk Management

In variety of other sectors such as security, finance and business, health and property, risk management has already been adopted. Boehm, in 1989 states that, "Risk management includes a collection of processes for addressing and dealing with risk items whose lack of fulfillment

introduces a serious threat towards effective execution and completion of software development project or demands a large number of modifications or rework". The process includes risk identification, assessment and prioritization of risk, as well as controlling and monitoring risk [6].

1.3 Agile Software Development Methodology

Agile is commonly implemented and is a highly effective substitute for classical software development techniques, in which considerable documentation must be needed for carrying out the whole process [7]. Traditionally used approaches are unable to cope up with quickly emerging requirement changes in industry and technology [8]. Clients can no longer expect their demands or requirements in advance and expect an additional return from software. Consequently, developed innovative strategies to handle these changes in requirements [9]. These agile techniques involve number of different processes that all observe the similar fundamental principles, values and principles.

The Agile Manifesto prioritizes the following principles: valuing people and their interactions over rigid processes and tools, emphasizing functional software over exhaustive documentation, fostering collaboration with customers instead of relying on contractual negotiations, and being adaptable and responsive to change rather than sticking to a fixed plan. [10].

Scrum is primarily an iterative as well as an incremental approach for managing or controlling software development projects and it is most frequently used in agile projects[11]. It offers a structured approach for development teams and organizations to methodically predict and prioritize the requirements of project and also to direct focus on high-priority risks or requirements that can be provided in each sprint. The scrum development process is illustrated in the figure 1.1 below [12].

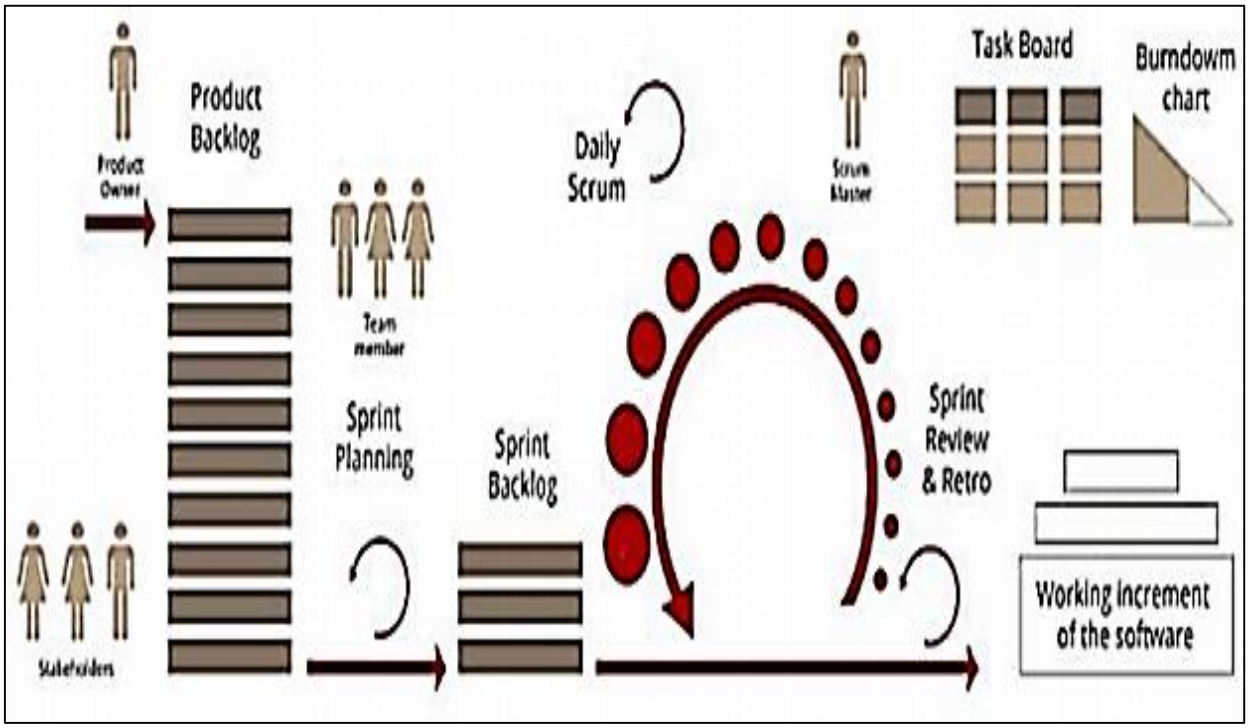

Figure 1.1: The Scrum Process [12]

It is a framework for agile project management that involves a series of iterations called sprints. Each sprint starts with a sprint planning meeting, where the product owner, the team members, and the stakeholders agree on the goals and tasks for the sprint, based on the product backlog. The product backlog is a list of features and requirements that the product owner prioritizes and maintains. The sprint planning meeting results in a sprint backlog, which is a subset of the product backlog that the team commits to deliver in the sprint. During the sprint, the team works on the tasks in the sprint backlog, and updates the task board, which shows the status of each task. The team also holds daily scrum meetings, where they report their progress, challenges, and plans to the scrum master, who is a facilitator and a coach for the team. The scrum master also monitors the burndown chart, which tracks the remaining work in the sprint. At the end of the sprint, the team delivers a working increment of software, which is a potentially shippable product that meets the sprint goals. The team also conducts a sprint review and retro, where they demonstrate the software to the product owner and the stakeholders, and reflect on the process and the outcomes, and identify areas for improvement for the next sprint [12].

1.4 Agile Software Development in Pakistan and in Other Countries

Agile software development is crucial in today's global landscape, offering adaptability and responsiveness to changing market needs [13]. It fosters innovation, collaboration, and efficient value delivery to customers. These approaches can have major quality and team efficiency benefits, but their use is neither easy nor pain-free [14].

Many software companies in Pakistan are still using traditional methods for software development and software project management, and are therefore facing project failures. The use of inappropriate technology is one major reason for project failures [15]. IT projects are very complex, and therefore the software companies developing them need to manage these projects efficiently and effectively. The software industry in Pakistan has faced many problems due to lack of use of agile strategies by software development professionals [16].

In British countries, agile implementation often thrives due to several factors, including a robust technological infrastructure, ample resources, and a culture that values innovation and adaptability [17]. These countries typically have more mature software development ecosystems, with better access to resources, skilled professionals, and funding, which can facilitate the adoption of agile practices [16]. Software development businesses can sustain themselves only if their projects succeed. Information Technology and Software Development are one of Pakistan’s most rapidly growing industries [18].

In Pakistan, several hurdles make it hard for companies to use agile methods in software development. Firstly, there's a lack of skilled people who know about agile ways of working [19]. This is due to limited access to specialized training programs and a general lack of awareness within educational and professional settings [18]. Conversely, British countries like the UK benefit from better access to educational resources and a more mature software industry, leading to a larger pool of knowledgeable professionals experienced in agile practices [20].

In Pakistan, a cost-saving mindset prevails due to economic conditions and cultural inclinations towards seeking cheaper alternatives [21]. Conversely, British countries like the UK

prioritize value creation and quality solutions, influenced by a developed economy, higher standards of living, and regulatory frameworks promoting quality-centric practices [22].

Limited access to appropriate technology presents a significant challenge in Pakistan due to factors like limited research and development investment, infrastructure constraints, and economic limitations. This results in inadequate funding for technological advancements and restricted access to cutting-edge tools and resources for software development [23]. Conversely, British countries enjoy more developed technological infrastructures and higher investments in research and development, leading to better access to technology [24]. Regulatory frameworks in these countries further support technology adoption, making limited access to appropriate technology less prevalent than in Pakistan [25].

Additional factors include lack of resources, infrastructural limitations, cultural differences in work practices, hierarchical structures, deference to authorities, regulatory hurdles as well as funding constraints, can further complicate the implementation of agile methodologies in the country [112]. These challenges highlight the need for context-specific strategies and adaptations to ensure successful agile software development practices in Pakistan [15],[13].

1.5 Software Risk Management in Agile Software Development

According to PMBOK (Project Management Body of Knowledge), Risk is defined as “An event or unpredictable situation that, when it occurs, may result in either favorable or adverse effects on project goals, like scope, schedule, expense, and quality” [26].

Managing risks involve set of processes for managing and identifying events that are able of bringing about negative changes. According to Project Management Body of Knowledge risk management is a set of seven processes or activities that are Planning Risk Management, Identification of Risks, Qualitative Analysis of risks, Quantitative Analysis of risk, Planning Risk Responses, Implement Risk Responses, and Monitoring Risks [27].

McManus in his book “Managing Risk in the Development of Software Projects” states that, "Projects typically fail due to management errors instead of technological errors, and it might be claimed that managerial problems are more significant than technical problems in software development projects" [28]. Due to the responsiveness to changes in agile software project management many projects are uncertain and risky [29]. To make sure that software risks are appropriately identified and treated projects managed by employing adaptive techniques involves frequent evaluation of products as well as multi-functional teams to speed up the interaction, communication, and knowledge sharing [1]. Ultimately, many challenges remain unexplored due to the fact that they are overlooked during whole project life cycle. So, it is important to involve or integrate risk management processes in agile based software development [30].

Inability to implement risk management processes may lead to customer dissatisfaction, delay project schedule, the use of extra resources, and eventually project failure [31]. In project management, risk management knowledge area is considered as the most significant and properly managing risks is one of the most critical aspects for the project’s success [32].

In this research study, the scrum methodology is selected as it is the most applied and popular agile method [33]. The goal of this study is to find out risk management challenges and to develop mitigation strategies for managing risks in agile on the basis of principles of risk management to lower the risk impact. Results of the proposed mitigation strategies showed that these help in reducing project risk and increase reliability, usability, flexibility, and efficiency [34]

1.6 Risk Management in Pakistan and British countries

In the dynamic landscape of software development, effective risk management practices play a pivotal role in ensuring project success and mitigating potential challenges [35]. Effective risk management is indispensable for ensuring project success and minimizing potential setbacks. As organizations increasingly embrace agile methodologies to enhance productivity and adaptability, the variation of application of risk management practices become accentuated across different geographical contexts [34].

The software industry in Pakistan is still evolving, with fewer established standards and best practices due to the relatively growing nature of the sector [36]. In contrast India and British countries have more mature software industries with well-established standards and best practices, owing to their longer history of software development and larger market size [37].

In Pakistan the software industries may be fragmented, with smaller companies and less collaboration within the ecosystem, partly due to the smaller market size and fewer established players [38]. India and British countries typically have more consolidated and interconnected software industries with larger companies and better-established networks, facilitating greater collaboration and knowledge sharing [20].

The educational system in Pakistan may not prioritize agile methodologies and risk management in software engineering curricula, possibly due to limited resources and awareness [39]. Countries like India and British often have more comprehensive educational programs that cover agile methodologies and risk management, reflecting the higher priority given to technology education and industry relevance [22], [24].

Pakistan's geopolitical and economic factors, such as political instability or dependency on foreign aid, may introduce additional external dependencies and uncertainties, impacting risk management strategies [22], [40]. While India and British countries may also have external dependencies, they generally have more stable political and economic environments, reducing the extent of external uncertainties affecting risk management in software projects [22].

Other factors like lack of government support for software industry, Fewer policies and incentives for technology adoption and innovation, market immaturity with less established frameworks and tools for risk management, external dependencies hinder the production of more conducive environment for software development and risk management [22].

1.7 Problem Statement

Risk management processes play a crucial role in analyzing, assessing, and mitigating risks [41]. However, in agile methodologies, such as scrum, there is a notable absence of specific risk

management processes [33]. In Pakistan adopting agile practices and implementing risk management can be challenging because of lack of experienced professionals, lack of awareness about agile practices, cost of working, exclusive reliance of economic evaluation criteria, unavailability of appropriate technology, as well as lesser availability of resources [15]. This gap highlights the need to identify challenges related to risk management within scrum-based software development and guidelines to overcome these challenges. Existing studies have not adequately addressed this gap, leaving a research void in the domain of agile risk management, which calls for a comprehensive investigation to bridge this knowledge gap effectively. Furthermore, the guidelines for implementing risk management into scrum-based software development need to be explored to enhance the success of agile software development projects [11].

1.8 Research Questions

There are two research questions that explain this particular research which are following.

RQ1: What are the risk management challenges in scrum-based software development in Pakistani software development?
RQ2: What are the risk management mitigation strategies that can be helpful in mitigating risks in scrum-based software development in Pakistani software industry?

1.9 Research Objectives

The objectives of the study are:

Objective 01: The aim of RQ1 is to find out the risk management issues or challenges in scrum-based software development.

Objective 02: To determine what risk management strategies will be helpful in mitigating risks in software development in Pakistani software industry.

1.10 Goal of the Research Study

This research emphasizes the essential requirement for a seamless implementation of the risk management process. The main objective of this study is to identify the issues and challenges encountered due to lack of application of risk management processes in scrum software development methodology and to suggest validated mitigation strategies to resolve or mitigate these challenges. This research focus on generating list of identified issues or challenges through SLR. The results of the Systematic Literature Review (SLR) are examined. Then the list of identified challenges is validated through survey. After that interviews and focus group methodology are applied to gather and validate the mitigation strategies respectively.

1.11 Contribution and Significance

1. If this study is included in the body of literature, it may aid teams and project managers in overcoming scrum risk management challenge in the future.

2. The recommended mitigation strategies will assist teams in managing the risks that might arise in scrum projects and raise the likelihood that a project will succeed.

1.12 Research Scope

This research focuses exclusively on the following:

- This research study focuses exclusively on risk management within the context of software development using the scrum framework within the Pakistani software industry.
- The challenges encountered due to missing risk management processes are identified specifically for the scrum process.
- Conducted a survey within the industry, involving practitioners, to find the practicality of the identified challenges in Pakistani software industry.
- Suggested conceptual mitigation strategies for addressing the challenges identified through SLR.

- Performed focus group interviews to verify the proposed mitigation strategies.
- Conducted a systematic literature review (SLR) of papers published within the last ten years, spanning from 2011 to 2022.
- For interviews and focus groups, domain experts were selected based on their requirement of a minimum of 5 years of experience and specialization within their respective domains.

1.13 Thesis Organization

The study's scope was to figure out the risks due to missing risk management processes in scrum-based software development and propose mitigation strategies to mitigate these challenges.

This thesis consisted of five chapters. Chapter one includes the overview and introduction of the risk management process in scrum-based software development, its importance, and the problem statement is discussed in this chapter that is the core objective and focused area of this research. Moreover, this chapter outlines the research questions and their associated goals, defines the study's scope, and outlines its contributions. Its purpose is to lay the groundwork for the remainder of the thesis.

Following this, the second chapter of the thesis, titled "Research Methodology," explains the methodology employed to uncover the challenges arising from the absence of risk management processes in scrum-based software development. Essentially, this chapter serves as the guiding framework for the entire study, leading from its inception to its conclusion. Chapter three is all about the process of systematic literature review.

Moving forward, Chapter four, "Survey and focus groups findings and discussions" presents the outcomes derived from our survey and focus groups and conducts an in-depth analysis of these findings. Likewise, Chapter Five of this thesis delves into the "Conclusion and future work".

1.14 Summary

Throughout the software development process, risk management is the most critical activity that is usually neglected in agile software development[42]. There is a scarcity of knowledge in the literature on the degree of integration of agile methodologies and risk management procedures in Pakistani IT organizations [43]. A survey was conducted which shows, there are a number of possible challenges to agile software development. Risk management mitigation strategies are proposed that incorporate all risk management principles into agile development that apply scrum methods in order to help overcome these challenges. The suggested mitigation strategies help project managers handle projects that are developed using agile approaches more effectively

CHAPTER 2

RESEARCH METHODOLOGY

2.1 Introduction

The key objective of this chapter is to explain the techniques and research methods that are selected to carry out the research. The two main methodologies utilized for doing research are quantitative and qualitative. These two approaches are entirely different from one another but also closely related. Quantitative methods emphasized on statistical data that can be measured and applicable to a greater number of individuals, cases, or groups of individuals. Consequently, the quantitative approach typically converts data into figures or numbers and gives context to information [44]. While qualitative data is utilized for a limited number of individuals, cases, or groups of individuals and focuses on the accurate description of facts. This data involves words rather than numbers to convey the data. Combining quantitative and qualitative methods is also a good option, such as employing qualitative methods for gathering data and quantitative methods for analyzing data [45].

In this section of the thesis, methods used for identifying risks and challenges that could be faced in scrum-based software development due to lack of risk management processes are discussed. Once, the challenges are found, these are then validated through survey method. Based on these challenges risk management mitigation strategies has been proposed that are helpful in mitigating these risks. Then these strategies are validated through focus group.

2.2 Methods Used in Research Study

This chapter section delves into the structure of the conducted research study, presenting a

comprehensive procedure for its execution. The research study in question is centered around three key research inquiries: identifying challenges, validating the identified challenges, and outlining recommendations for overcoming these challenges. To visualize this, a flow diagram has been crafted, as depicted below in figure 2.1.

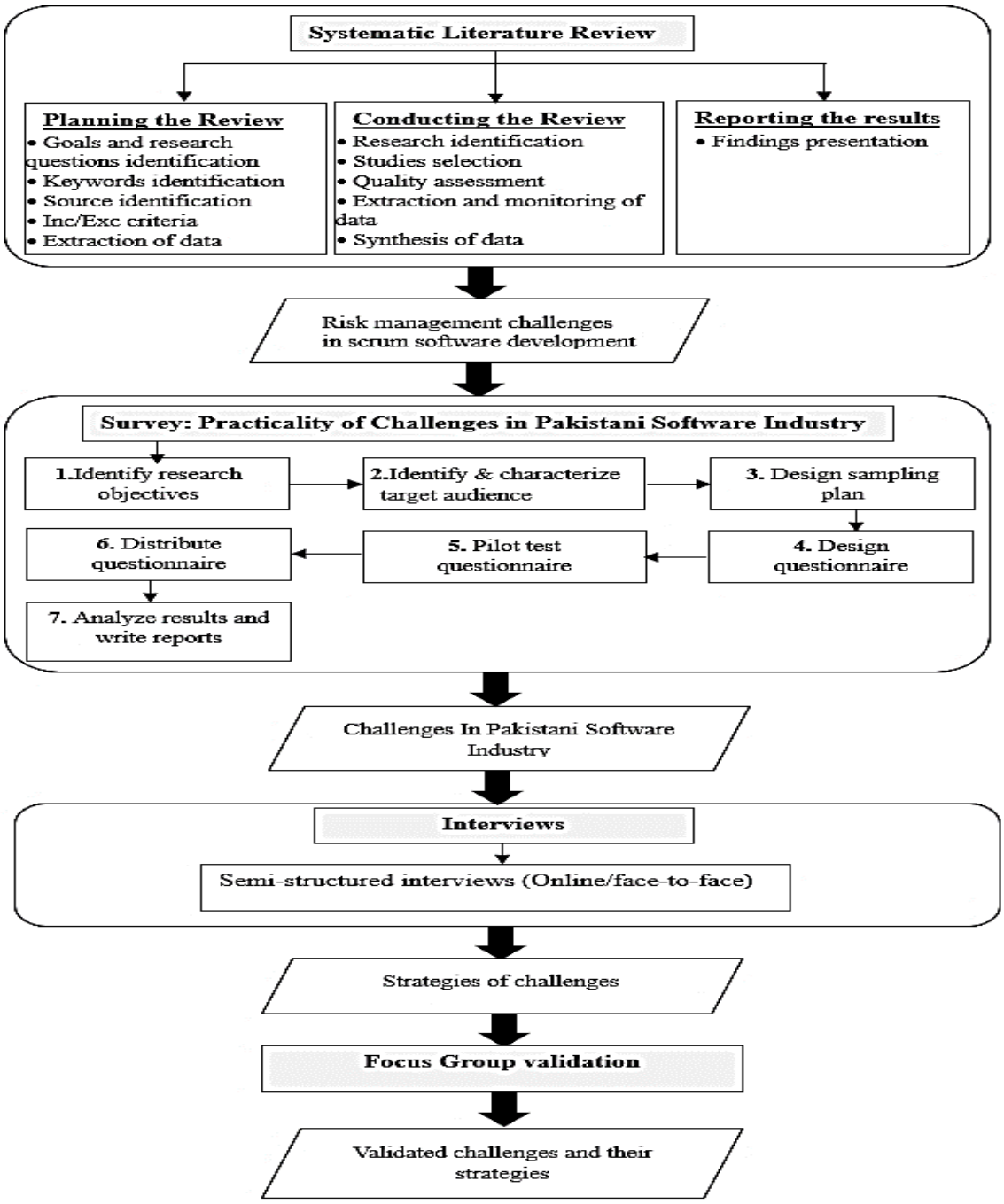

Figure 2.1: Research Methodology

2.3 Research Questions

Table 2.1 depicted each research question along with their methodology and outcome. These two research questions address some particular features of risk management in scrum-based software development. The methodology applied for data collection for all of these challenges and results obtained.

Table 2.1: Research Queries and their Corresponding Results

NO	Research Questions	Methodology	Outcome
RQ1	What are risk management challenges in scrum-based software development?	SLR and Survey Questionnaire	A list of identified risk management challenges in scrum-based software development.
RQ2	How Risk Management mitigation strategies will be helpful in mitigating risk in software development?	Interviews and Focus group	Mitigation strategies will be proposed through interviews and will be validated through a focus group.

2.4 Research Methodology

A methodology is defined as a procedure or structure of principles or guidelines[46]. It might offer guidelines from which precise methods or procedures could be easily understood and used to solve problems within the domain [47]. The main aim is to get appropriate results based on the final results or outcomes that will assist us to identify the problems faced by the software industry practitioners due to lack of implementation of risk management processes.

In this section, risks that could be experienced in scrum-based software development when risk management processes are not fully implemented are identified. Also, this research work will propose mitigation strategies for managing these risks. A qualitative technique has been applied to discover challenges from the existing literature available. To collect quantitative data on the challenges in managing risks in scrum-based software development, a research survey has been

conducted. Risk management mitigation strategies has been suggested on the basis of these challenges, that can be useful in reducing these risks. These mitigation strategies will then be validated using a focus group methodology.

2.4.1 Systematic Literature Review

The initial research method employed is Systematic Literature Review (SLR), which served the purpose of identifying the primary challenges that may arise when the risk management process is not systematically implemented into scrum-based development. For conducting SLR the best class guidelines proposed by Kitchenham [48]are adopted, as these are the most comprehensive and widely used guidelines for carrying out SLR in the discipline of software engineering. These standard guidelines consist of three parts: Review planning, Review conduction, and Results reporting [48]. Figure 2.2 represent the outline of the SLR stages.

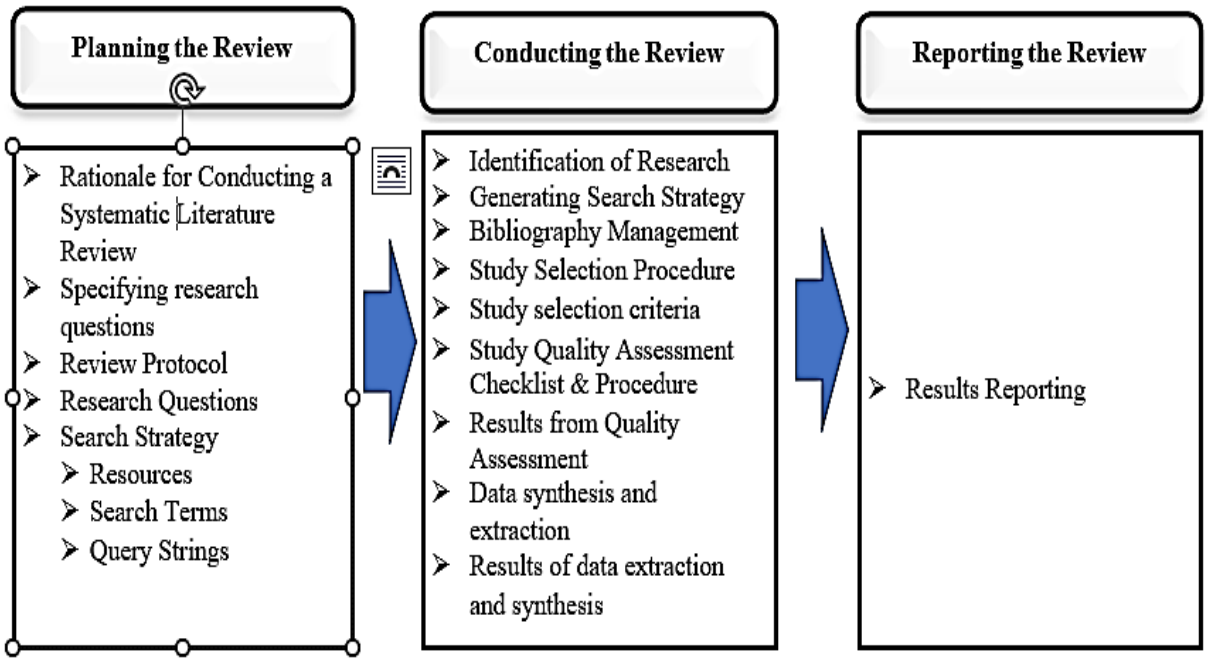

Figure 2.2: Kitchenham's SLR process

Following the definition of research objectives, the data collection phase of the systematic literature review (SLR) commenced. In the planning stage of SLR, the initial step was to clarify the

research goals and questions, as previously detailed in the first chapter. The subsequent objective involved establishing a review process.

This process encompassed defining the keywords used in the search, specifying the sources for obtaining relevant research papers, and establishing criteria for paper inclusion or exclusion. Finally, methods were devised for data extraction. In the second phase of a systematic literature review, a selected search strategy was used to find relevant research papers. These papers were then reviewed to determine if they met specific inclusion/exclusion criteria. The quality of these papers was also assessed. After obtaining a basic set of papers, a snowball sampling method was applied. This method involved looking at the references in the selected papers to identify additional relevant papers. This process continued until no new research papers were found. Once all relevant papers were collected, data from these papers was carefully read and organized. The objective of this systematic literature review was to identify challenges faced when implementing risk management procedures in scrum. All stages of the literature review process have been described in detail in the next chapter 3.

2.4.2 Snowball Sampling

Snowball sampling which is a non-probability sampling method proves to be a highly valuable technique for broadening the scope of the systematic literature review (SLR). It is often used to extend the search beyond the initial set of papers identified through traditional search methods. Snowballing refers to using the reference list of a paper or the citations to the paper to identify additional papers. However, it could benefit from not only looking at the reference lists and citations, but to complement it with a systematic way of looking at where papers are actually referenced and where papers are cited.

In a systematic literature review (SLR), researchers typically begin by searching for relevant papers using predefined search strategies and criteria. However, despite rigorous search efforts, some papers may still remain undiscovered due to various reasons like certain studies may not be captured by the initial search queries if they use unconventional terminology, specific acronyms, or domain specific jargon that are not included in the search strategy. Snowball sampling allows

for the inclusion of papers that may not be directly related to the initial search terms but provide valuable insights or perspectives. These papers may be referenced in the literature or cited by other studies, indicating their relevance. Some papers may not be indexed in major databases or may not be widely available online. Snowball sampling helps identify these less visible or harder-to-find papers. Snowball sampling can help capture a broader range of perspectives and insights by including studies from different contexts or populations. This can enhance the diversity and inclusivity of the SLR.

Following the inclusion/exclusion criteria, the initial step in implementing the snowball sampling method involves selecting the initial set of research articles for consideration. After retrieving the papers using the predetermined selection criteria, snowball sampling starts. Papers cited in the list of initially chosen papers were studied and on the basis of inclusion/exclusion criteria, these papers were selected. As soon as the detailed list of new research papers was found by applying snowball sampling, the quality of these papers was evaluated. Snowball sampling was carried out unless and until no new research papers were discovered. Figure 2.3 shows the process of snowball sampling method.

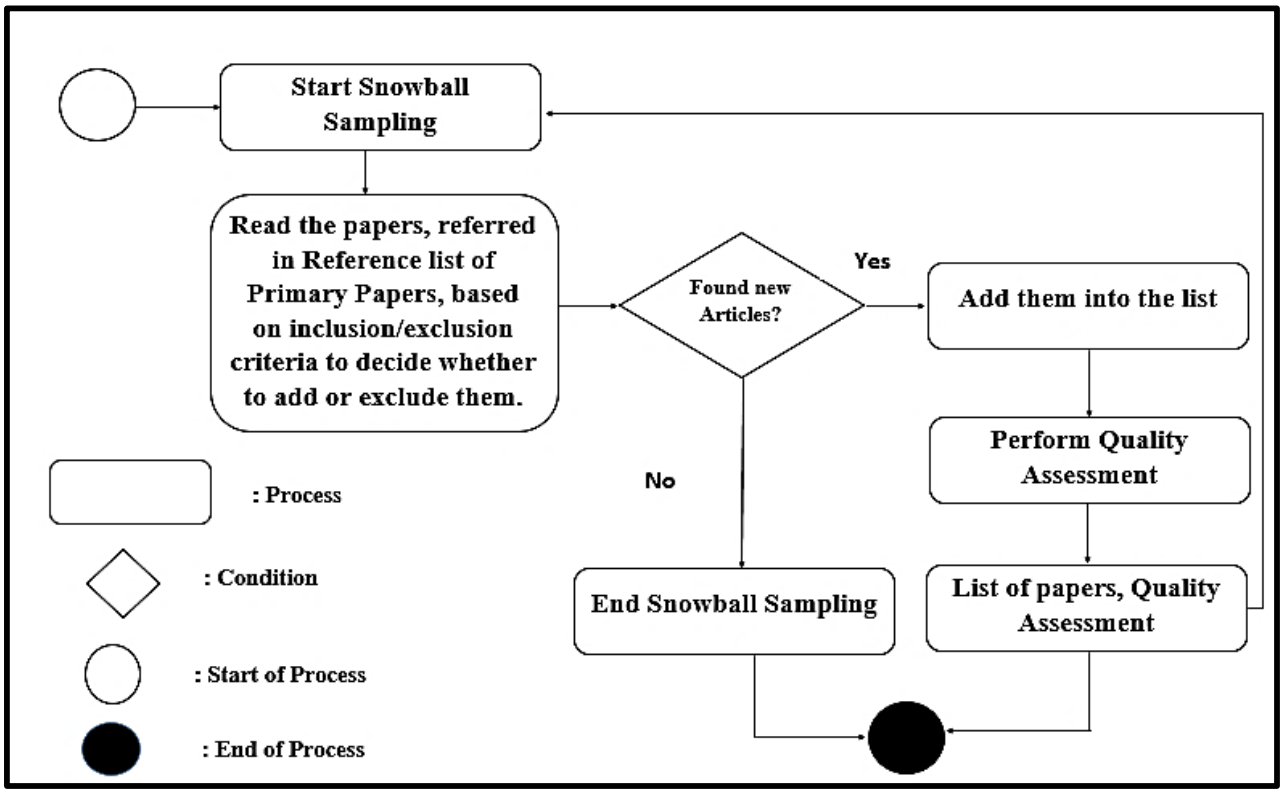

Figure 2.3: Snowball Sampling [49], [50]

2.5 Quantitative Method

The quantitative methodology is the statistical or numerical presentation and description of the discovered data. Usually, it includes collecting numerical data to explain a particular scenario or to provide a solution to a specific problem, like calculating the student's comprehension percentage for certain specific courses [51]. In general, quantitative approaches emphasized on quantifying social realities as well as defining the research through numbers. It is employed by researchers to calculate people's attitudes and actions toward specific circumstances [51]. In this study, quantitative data analysis was done using the survey approach.

2.6 Industrial Survey

The survey is a technique for gathering and analyzing data and is a widely used strategy in the field of software engineering as it is used to illustrate actions, attitudes, and gathering data from a substantial number of individuals by examining a subgroup of them. While using this technique, data is usually gathered by developing a standardized and predefined questionnaire. Interviews, which can be either structured, semi-structured, or unstructured, can also be used to perform survey research. Data is obtained by asking the respondents to respond to the predefined questions [52].

The questionnaire consists of a series of questions arranged in a specific sequence. It was distributed to the relevant individuals via email or postal mail, accompanied by a request to complete and return it. When conducting the survey via interviews, it can be done through either face-to-face meetings or telephone interviews. Conducting a survey technique necessitates having well-defined and comprehensive research questions, along with a clear understanding of the target population. This is crucial because obtaining the required information without focusing on a specific population would either be unnecessary or unfeasible to collect data from the entire population. The choice of sampling methods in research varies depending on the type of research being conducted.

In survey method, it is feasible to utilize large sample of population to gather data and information. They are very useful for collecting demographic information on the composition of sample. Comprehensive variable quantities and types of variables may be completely studied. The

survey is conducted following the guidelines presented by Kasunic in the publication from the "Software Engineering Institute (SEI)" [52]. His work was chosen for the survey because it is widely recognized and frequently applied in the field of software engineering.

A survey is conducted to find out the practicality of challenges that could be encountered during scrum software development when risk management is improperly implemented. This would additionally assist in establishing a foundation for proposing mitigation strategies as a resolution to the identified and analyzed problems.

There are many research surveys that address the issue of risk management and represent the survey results qualitatively. Survey was conducted in different countries like India, Netherland, Egypt and US [2]. In these studies, survey was conducted to integrate some risk management steps in scrum-based software development and the targeted respondents were scrum master, product owner and some undergraduate students [26]. Previous studies conduct survey to find out that which risk management step can be integrated in scrum [2]. Existing studies tried to validate proposed risk management framework through surveys [9]. This research study focuses on conducting survey to find out the practicality of challenges of risk management in scrum-based software development. Different software industries from Pakistan were targeted and the respondents were Testers, quality assurance engineers and risk managers working on scrum for many years.

2.7 Survey Steps

These are the steps for carrying out the survey. The figure 2.4 below represent the survey steps. The survey protocol consists of seven steps. All these are elaborated below.

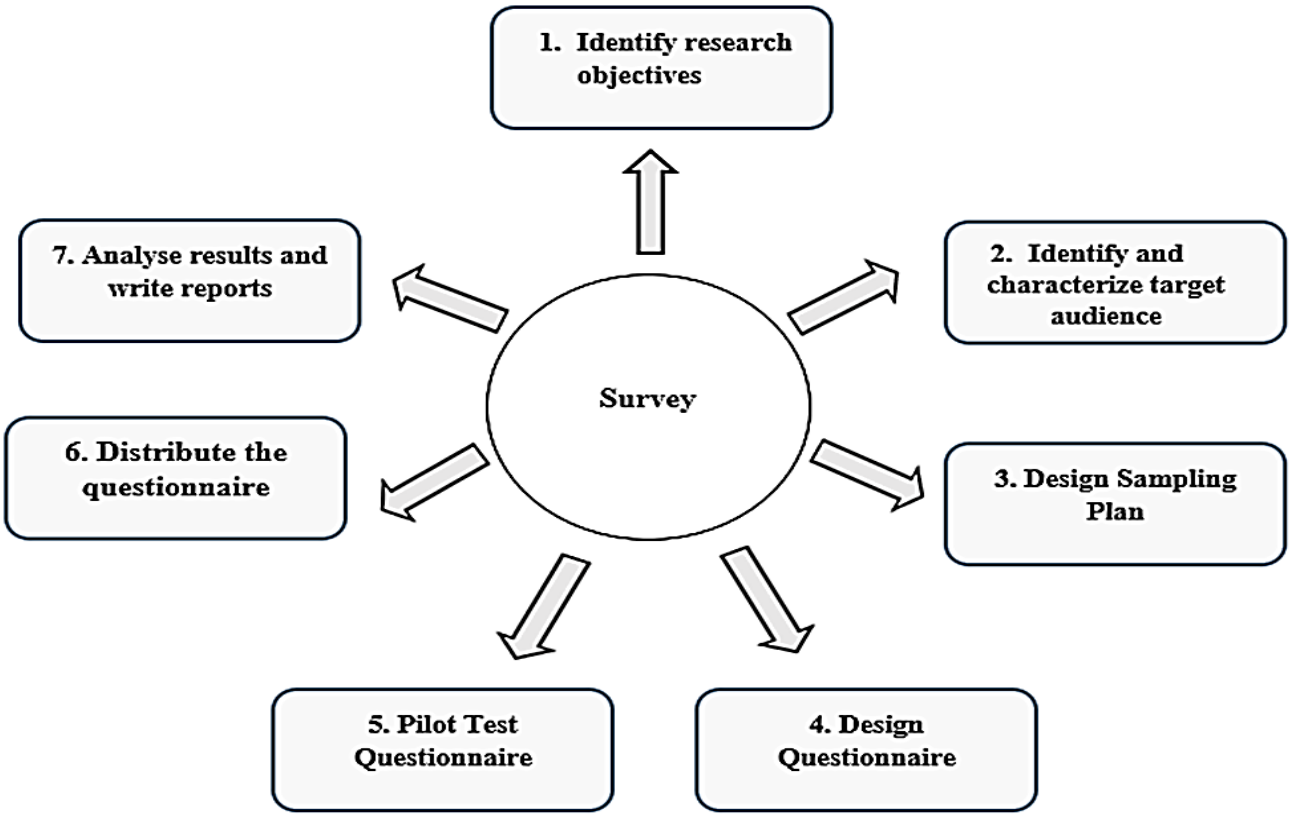

Figure 2.4: Survey steps [52]

Since our major focus is finding the practicality of challenges caused by the incomplete implementation of risk management practices in Pakistani software industry. So, the first step helped in identifying all the challenges that can be faced in risk management process in scrum-based development of software. In 2nd step of the survey, there is a need to figure out the target respondents that are indirectly or directly affected by the hit. It is done by visiting various software industries that are working on scrum. The 3rd step is all related to designing and formulating sampling plan. Fourth Step is important and is the foundation of survey. This is an important and challenging technique to design a questionnaire that is appropriate, effective, suitable and aligned with the specific subject matter is a crucial and demanding task. The 5th step is related to questionnaire testing with target audience. In sixth step, a properly structured questionnaire is shared between the target representative who will be presenting our research information. The last step, involve analyzing and gathering the data from questionnaires is necessary. The analysis will enable

us to compile a report that comprehensively outlines all potential factors and their underlying reasons [52].

2.7.1 Identification of Research Objectives

The major aim was to identify and report the challenges that can arise in scrum-based software development methodology due to incomplete application of the process of risk management. Improper implementation of risk management result in decreasing the reliability of scrum projects. In order to prevent future problems and gain a better understanding of them, it is crucial to first pinpoint and recognize these issues. Before conducting a survey, having a well-defined research objective is of utmost importance. It assists in defining the survey's scope by identifying the target respondents and the specific questions that need to be posed to them [52].

2.7.2 Identification and Characterization of the Targeted Respondents

During this stage, the specific population that serves as the foundation for the survey research has been selected. This population is integral for gaining a comprehensive understanding of the audience associated with the stated problem, whether it's through direct or indirect connections. Research is valuable only when it benefits the targeted audience, specifically those who can assist in identifying issues and can be aided by a solution. Recognizing and accurately analyzing the audience is a pivotal step in the survey process. Once the population is identified, it becomes the research's primary target audience. The audience is chosen according to the research perspective, aligning with the research objectives and identifying individuals who can offer the most relevant information pertaining to our research goals. After identifying the target audience, samples are selected for research. Samples represent a subset of the population and serve as a representation of the entire population. In surveys, the sample is studied, and the results are then generalized to the entire population [52].

In the industrial survey, the targeted audience consisted of agile and scrum practitioners. which include risk manager, project manager, quality assurance manager, and testing team who are

working in the software industries using agile methods. The total population size was chosen to be 1400 to make our results more significant. This population size is chosen because the scope of the research is broader and the researcher is collecting data from all over Pakistan. This also helped in fulfilling the research objectives.

2.7.3 Designing of Sampling Plan

In this stage, the methodology for selecting survey participants and determining the sample size was established. Different formulas such as Cochran's formula for the determination of sample size can be used to calculate the sample size. Determining the appropriate sample size depends on factors such as the desired level of precision, the chosen confidence level, and the size of the population [52].

I. Precision: Precision is like how accurate and close the information we gather is to the real facts about the whole group we're interested in. How precise we want to be depended on how much uncertainty we can handle when making decisions. If we want to be more certain, we need to study more people, which means a bigger sample size [52].

II. Confidence Interval: A confidence interval is like a range of values where we can be pretty confident that the real values, we're interested in are somewhere in that range. We use the standard deviation to figure out this range for either samples or entire populations [52].

III. Confidence level: Confidence level indicates how sure we are about our chosen sample. For example, if we pick 100 samples to represent our target group and we find that 95 out of those 100 samples are free of risks, it means we are 95% confident in our selection. To calculate the confidence level, we use a confidence interval and rely on z-values from a standard Normal distribution table [52].

IV. Population Size and Sample Size: The population size of 1400 was considered for the survey. The calculation of sample size is influenced by the population size, particularly when the population is small. Various formulas are employed to determine the sample size, depending on whether the

population is large or small. Cochran's formula is used to calculate the sample size for such calculations [52]. The sample size against the population size of 1400 was 302 according to Cochran's formula.

2.7.4 Design and Write the Survey Questionnaire

Developing a well-structured questionnaire is essential for collecting the most relevant information needed to answer the research questions. Questions are the sole credible means of interacting with respondents and serve as a window to the overall research. The quality of their responses depends on whether the questions were developed under proper peer supervision and guidance. In this step, the identification of the questions to be asked, their types and formats, and the sequence in which they will be presented were determined [52]. The Likert scale is a widely used tool in surveys to gauge respondent's attitudes towards specific topics. It involves single-choice, closed-ended questions designed for assessing the Likert scale. This approach allows for obtaining more detailed insights and perspectives from respondents regarding particular matters compared to a simple yes/no question. Typically, the Likert scale comprises five to seven items [52].

In the research, closed ended questions are used to analyze the Likert scale. A five-item Likert scale was used to assess the opinions of respondents. The research employed close-ended questions of attribute, belief and attitude types, employing the Likert scale to pose these questions [52]. In attributes type of question, questions are typically asked about personal or demographic information such as occupation, experience, age etc. In attitude type of question, questions are asked about how people feel about some certain things to find out whether their feelings about some certain things are positive or negative. In belief type of questions, questions are asked about people belief of something. This type of question is more focused and can be referred as opinion question, in which question are asked to know about the belief of people about some certain thing and try to get their opinion on it [52].

In this study 5 attribute type questions were designed to know about the respondent demographic details. The other questions are belief type to know the belief of respondent about certain challenge. These question types were selected because they are best suited for achieving the research objectives. The survey a developed for industrial practitioners for getting mitigation strategies is shown in appendices section as depicted in Appendix C.

Based on the challenges in risk management in scrum questionnaire was developed. The purpose of the questionnaire was to check the practicality of the risk management challenges identified through SLR. The questions were designed to gather relevant and actionable insights from respondents that could contribute to a deeper understanding of the challenges and potential solutions related to risk management in Scrum-based software development in the Pakistani software industry. Total 30 Questions were designed in which 22 questions are designed against 15 identified challenges of risk management. The questionnaire was developed based on the challenges identified through SLR. Total 15 challenges were identified from SLR. Two questions were designed against the challenge that are considered to be more significant and one question for the less significant challenges. Like “resource estimation issue” is a challenge found from SLR. Two questions were designed to get the opinion of respondent about this challenge. The items of Likert scale are “Strongly Agreed”, “Agree”,” Neutral”,” Disagree”, Strongly Disagree. “Strongly Agree” means that the respondent is completely agreed with that statement of the question whereas “Strongly Disagree” means that respondent is not agreed. “Neutral” shows that respondent is neither agreed nor disagreed with the statement.

2.7.5 Pilot Test Questionnaire

A pilot test was conducted as part of questionnaire development to refine the questionnaire before the final version was prepared. This step aimed to enhance the questionnaire's wording and statements and validate its effectiveness [52]. The questionnaire was then distributed to 19 members of the target audience, all of whom responded. During the pilot test, most of the feedback received pertained to sentence structure and question phrasing. Some respondents found certain terms in the questionnaire difficult to understand, while a few expressed concerns about the questionnaire's descriptions. Based on their feedback and recommendations, the questionnaire underwent revisions

and adjustments. The questions were modified and refined to make them easier to understand and reduce survey ambiguity.

2.7.6 Distribute the Questionnaire

After finalizing the questionnaire through a pilot study, the questionnaires were distributed to the target audience. An online survey was conducted, and participants for this survey were selected by applying different filters while searching for suitable candidates on LinkedIn. Once appropriate participants were identified, the questionnaire was shared with them to gather their opinions on the identified challenges. In addition, visits were made to various software organizations that use the scrum methodology for software development, and the research questionnaire was distributed among the intended target audience. It was ensured that the questionnaire reached only the specific, desired audience [52].

2.7.7 Analyze Results

The concluding step involves receiving the questionnaire responses from the target audience. While collecting data is crucial, the subsequent step of analyzing and generating the desired results can be challenging. This analysis marks the final stage before proposing mitigation strategies based on the challenges that have been identified [52].

2.8 Sampling

In order to answer the research questions, it is doubtful that researcher should be able to collect data from all cases. Thus, there is a need to select a sample. The entire set of cases from which research sample is drawn in called the population. Since, researchers neither have time nor the resources to analyze the entire population so they apply sampling technique to reduce the number of cases [49]. Figure 2.5 illustrates the stages that are likely to go through when conducting sampling.

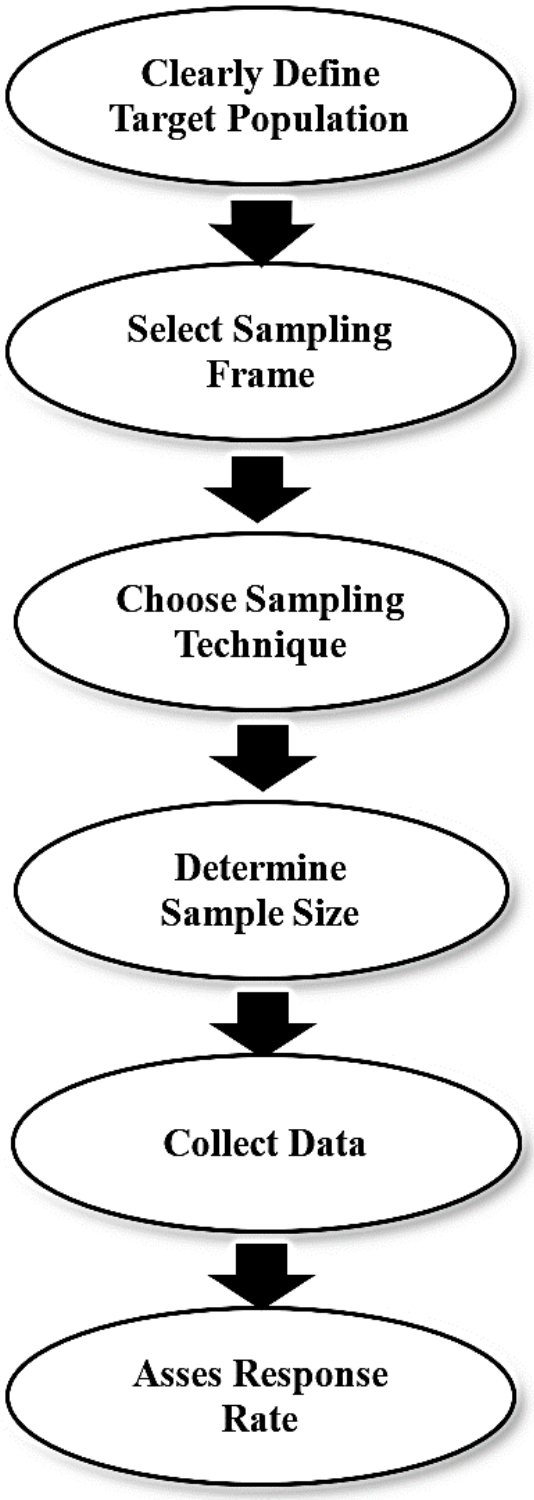

Figure 2.5: Steps of sampling process

2.8.1 Clearly Define Target Population

In this first stage, researchers clearly define the population they want to target. In general population is the total number of people related to specific area or field [49]. In this study, the target respondents were risk managers, testers, quality assurance engineers working in software industries of Pakistan utilizing scrum-based software development.

2.8.2 Select Sampling Frame

A sampling frame is a list of the actual cases from which sample will be drawn. The sampling frame must be representative of the population [49]. Sampling frame for this study was the risk managers, quality assurance engineers, testers working on risk management in scrum in Pakistani software industry.

2.8.3 Selection of Sampling Technique

Taking a subset from chosen sampling frame or entire population is called sampling. Sampling can be used to make inference about a population or to make generalization in relation to existing theory. In essence, this depends on choice of sampling technique [49]. In general, sampling techniques can be divided into two types:

i. Probability or random sampling
ii. Non- probability or non- random sampling

i. Probability or Random Sampling

Probability sampling means that every item in the population has an equal chance of being included in sample. It is almost free from biasness. Types of probability sampling include Simple

random sampling, Systematic sampling, Stratified random sampling, Cluster sampling, Multi-stage sampling [49].

ii. Non-Probability or Non-Random Sampling

Non-Probability sampling is usually associated with qualitative research and case study research design. Case studies are intended to study a real-life scenario by using small samples rather than making a statistical inference on the basis of large population. Types of non-probability sampling include Quota Sampling, Snowball Sampling, Judgmental Sampling, Convenience Sampling Figure below shows the type of probability and non-probability sampling [49]**.**

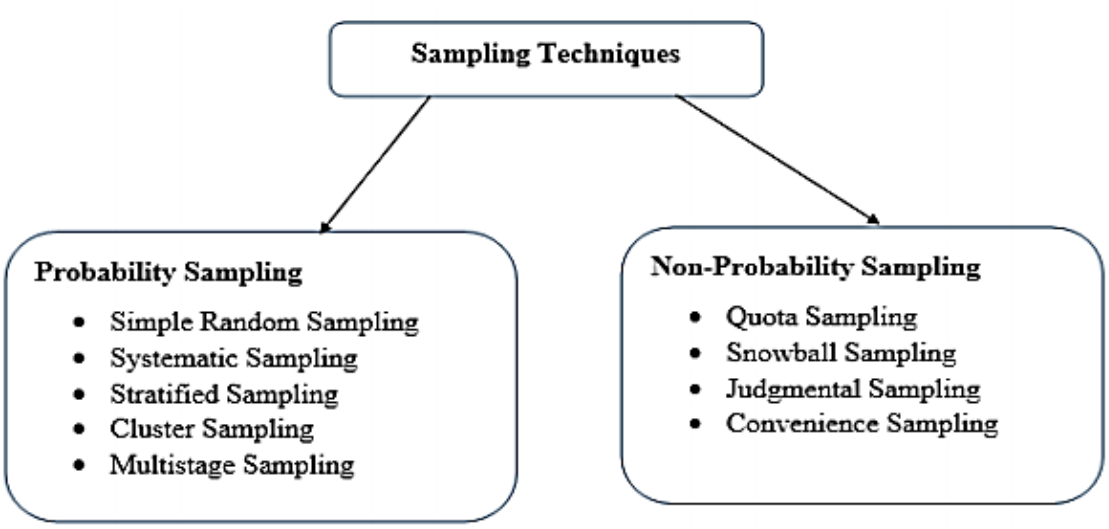

Figure 2.6: Types of sampling techniques

Type of probability sampling that is simple random sampling is used as it tends to be a popular sampling technique among students because it is an inexpensive and easy option compared to other sampling techniques [49]. It also allows us to avoid biasness, randomize the sample and make the results more credible. Therefore, in this study, random sampling technique is used that is often lightweight and readily available.

2.8.4 Determination of Sample Size

To avoid biasness and errors in sampling, and to generalize sample to population it is very important to have adequate size of samples. Here, adequate sample does not mean the ratio of sampled population, but the authentic size of the selected sample related to the complexity of population. Greater the sample size lowers the chances of errors and biasness in findings [49].

Numerous statistical formulas are available to determine the sample size. Cochran's formula was used to calculate the sample size. The sample size for the survey was 302. 302 responses are collected from different software industries of Pakistan. Sample size demonstrate the number of responses obtained rather than the number of distributed questionnaires as the number of distributed questionnaires is usually more than obtained responses, to compensate the unresponsive questionnaire.

2.8.5 Data Collection

Data is collected after deciding the targeted population, sampling frame, techniques to be used for sampling and the selected size of sample. Data is collected by distributing questionnaires in different software industries of Pakistan via LinkedIn, emails and by visiting these organizations.

2.8.6 Assess Response Rate

The number of cases who are agreed to be a part of study and to respond response rate. These cases are selected from real sample. It is very rare for the researchers to achieve 100% response rate due to many reasons, such as incapable to respond, unwillingness to respond, not eligible to respond or respondents might be available, but researchers are unable to reach or contact them. In addition, response rate is very important as every nonresponse is responsible for the biasness in concluding sample, so clearly defined sample, use of right sampling technique and using large samples might help to reduce the biasness in sample [49].

2.9 Respondent Profile for Survey

To confirm the practical existence of challenges identified through the systematic literature review (SLR), A survey was conducted among risk management practitioners and included demographic questions to gather background information. The target respondents of the survey were Testers, Quality assurance engineers, Risk managers working on scrum-based software development. The survey results indicated that every respondent possessed experience in risk management within the scrum methodology. Figure 2.7 illustrates the distribution of respondent's years of experience in scrum-based risk management, while the following figure depicts the percentage breakdown of respondent's experience levels.

Data was collected from different both male and female from different age groups. Generally, the selection of respondent on the basis of age, gender and experience do not affect the findings of the study but to avoid biasness respondents from diverse groups were considered that aligns with principles of equity and diversity, promoting a more balanced and representative approach to addressing challenges and formulating solutions in the Pakistani software industry.

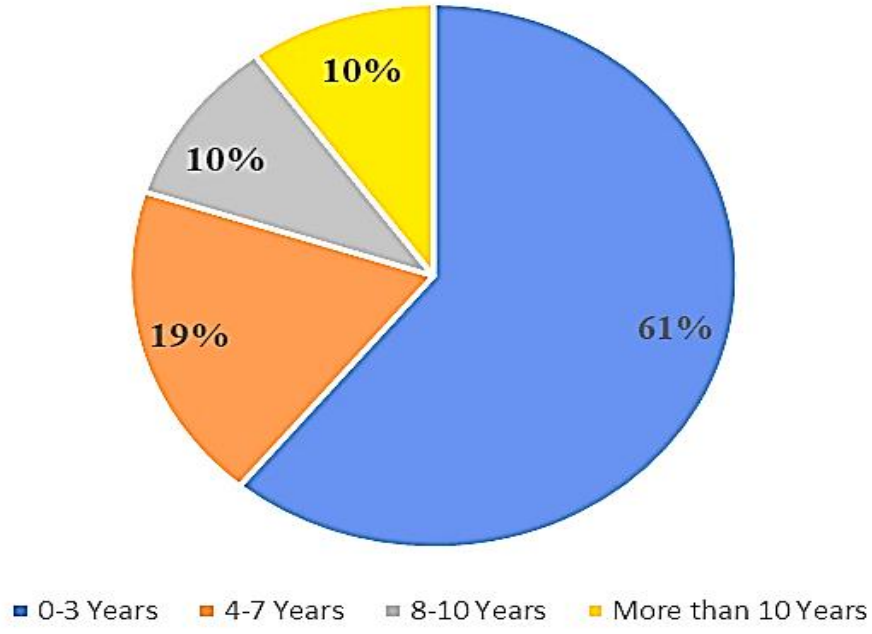

Figure 2.7: Respondent Experience Percentage

2.10 Qualitative Methodology

Qualitative research methodology proves effective in scenarios where a researcher explores a new area of study or seeks to unearth and articulate significant issues. Individual interviews and focus groups rank among the most frequently utilized methods in qualitative research [44].

2.11 Interviews

Individual Interviews

The individual interview stands out as one of the most widely employed tools in qualitative research methods. Depending on the researchers and the nature of the research, individual interviews can be crafted in three distinct ways. These interview formats include structured, semi-structured, and unstructured approaches. Moreover, interviews can be carried out either in-person or via telephone, making them highly adaptable. In summary, the three main types of individual interviews are structured, unstructured, and semi-structured [44].

Semi-Structured Interview: is utilized in this research. It features a limited structure, with a majority of questions being open-ended, allowing participants to provide detailed responses based on the research topic and the areas that require exploration. The questions posed in this type of interview are broad, encouraging participants to elaborate on their answers. This interview method facilitates in-depth discussions between the interviewer and interviewee while staying within the boundaries of the topic. In this format, the interviewer or researcher has the flexibility to steer the interview based on the quality of the interviewee's responses [44].

2.12 Focus Group

Ernest Dichter, a marketing and psychological expert, coined the term "Focus Group" in 1991. This term was used to describe gathering of a small number of individuals with the aim of

engaging in a discussion. Focus groups are a commonly employed method in action research. They essentially constitute a type of group interview involving 4 to 10 participants.

In certain situations, focus groups are favored over individual interviews because it is believed that the quality of information gathered through focus groups is superior and more effective when compared to individual interviews [64]. It is also preferable when resources are limited such as cost, which is measured per hour, so researcher can get 4 to 10 opinions at a time rather than single opinion unlike individual interview. Multiple focus groups can be conducted in order to gather more information or to get conformity of something. It limits in a way that only limited number of questions can be asked due to time constraints and it is very hard to fairly divide the time with each participant and participants have a very short time to share their opinions [62][72]. This is the last step of this research in which the proposed mitigation strategies are validated by focus group interviews with scrum practitioners.

2.13 Summary of The Chapter

In this chapter, available research methods have been discussed in terms of quantitative and qualitative methods. The research methods used in this research are then detailed in terms of research context and justification. The purpose of the survey was to validate the challenges by practitioners, identified through SLR. Employing a qualitative method, semi-structured interviews and focus groups help to acquire and validate the mitigation strategies in this research.

CHAPTER 3

SYSTEMATIC LITERATURE REVIEW

3.1 Introduction

In this chapter, the analysis was carried out on scrum-based software development and its potential to enhance risk management practices within the Pakistani software industry. Risk management is a critical aspect of project success, particularly in the dynamic and fast-paced realm of software development[4]. The integration of scrum, an agile framework known for its iterative and adaptive approach, with established risk management processes such as those outlined in the PMBOK Guide offers promising possibilities for mitigating uncertainties and maximizing project outcomes [26].

3.2 Background

Organizations accept the change to improve their overall efficiency and performance [53]. To compete and thrive in ever-growing and changing market requirements, organizations must be innovative and creative for which acceptance of change is required[54]. The software development systems in the organization may encounter unique risks as a result of the unique organizational change, and their responses have an impact on the process goals as the change is implemented[55]. For this reason, effective risk management process must be applied by adopting all processes for risk management. This paper looks at how Scrum software development teams deal with potential problems and uncertainties. It explores how they identify, evaluate, and manage risks to make sure the software development process goes well and achieves its goals.

3.3 Systematic Literature Review (SLR)

Systematic Literature Review (SLR) is the first adopted methodology, which is a well-known, formally approved, and extensively used protocol for conducting research. In addition to providing a detailed understanding of existing knowledge, it identifies the deficiencies and recent trends available for the research. The research study is conducted according to Kitchenham's Guidelines [43]. The need for accompanying the Systematic Literature Review is discovering the risk management challenges in scrum-based software development.

The first phase of SLR process start by defining the keywords used in the search, specifying the sources for obtaining relevant research papers, and establishing criteria for paper inclusion or exclusion. Finally, methods were devised for data extraction. In the second phase of a systematic literature review, a selected search strategy was used to find relevant research papers. These papers were then reviewed to determine if they met specific inclusion/exclusion criteria. The quality of these papers was also assessed.

After obtaining a basic set of papers, a snowball sampling method was applied. This method involved looking at the references in the selected papers to identify additional relevant papers. This process continued until no new research papers were found. Once all relevant papers were collected, data from these papers was carefully read and organized. The objective of this systematic literature review was to identify challenges faced when implementing risk management procedures in scrum. All stages of the literature review process have been described in detail.

3.4 Planning Review

3.4.1 Rationale for Conducting a Systematic Literature Review

This approach is chosen to systematically investigate the existing body of literature pertaining to risk management challenges and strategies within Scrum-based software development, particularly in the unique context of the Pakistani software industry. The multifaceted

nature of the research question necessitates a comprehensive exploration of scholarly work, enabling us to identify, synthesize, and critically evaluate relevant studies. Through this SLR, it was intended to uncover insights that will not only inform our understanding of the current challenges but will also contribute valuable strategies for mitigating risks in Scrum-based software development within the specific socio-economic and cultural landscape of Pakistan.

3.4.2 Specifying Research Questions

Petticrew and Robert's PICOC (Population, Intervention, Comparison, Outcome, Context) criteria was used to frame research questions.

Table 3.1: Specifying research questions

Population (P)	Professionals involved in risk management in scrum-based software development
Intervention (I)	Risk management in scrum-based software development in Pakistani software industry
Comparison (C)	Comparison between Pakistan and other countries
Outcome (O)	Identification of risk management challenges and development of mitigation strategies in scrum-based software development
Context (C)	Pakistani software industry

3.4.3 Review Protocol

A review protocol specifies the methods that will be used to undertake a specific systematic review. A pre-defined protocol is necessary to reduce the possibility of researcher bias. For example, without a protocol, it is possible that the selection of individual studies or the analysis may be driven by researcher expectations. It includes the keywords used in search string to extract the related papers, sources from where the related papers got selected, criteria to include or exclude the papers and lastly strategies used to extract data.

3.4.4 Search Strategy

To initiate the plan, firstly the resources are identified from where the primary studies along with the search terms are selected. After that keywords were identified and query strings were generated.

Resources

Finding a research study involves using search terms and resources. Electronic medium data sources are used to retrieve the majority of journal articles, accepted manuscripts, and conference proceedings. Books or printed sources were not chosen to gather information. A list of electronic databases from which SLR reviews publications can be found in table 3.2 below. The majority of peer-reviewed literature on software engineering and computer science should be covered by these four electronic resources, according to our research. The selected resources focus on computer science and software engineering research papers and gather peer-reviewed papers or articles. Information related to database sources and query strings is shown in the below table:

Table 3.2: Sources of digital databases

Sources of digital databases
i. IEEE Xplore (https://ieeexplore.ieee.org/Xplore/home.jsp)
ii. Springer (https://www.springer.com/in)
iii. ACM Digital Library (https://dl.acm.org/)
iv. Wiley Online Library(https://onlinelibrary.wiley.com/)
v. Elsevier (https://www.elsevier.com/)

Search Terms

This was done by using search queries composed of keywords selected based on a set of strategies Keywords were identified, which assisted in finding and obtaining the relevant papers as needed. Words related to the topic are challenges, risk management, and scrum. Then by using

these keywords query strings were generated to find as many research papers as possible relevant to the research topic. The principle or idea is that the chosen keywords involve all their respective synonyms so, problems, issues, and risks are used as similar words for the keyword “challenges” and so on. The selection of keywords was guided by three core concepts: "Scrum software development," "challenges," and "utilization of agile methods," as indicated in the table 3.3 below.

Table 3.3: Major Search Terms Along with Their Alternatives

Search Terms	**Related Synonyms**
Challenges	Problems, Issues, Risks, Challenges
Mitigation	Solution, Reduction, Resolution, Removal
Scrum software development	Scrum software development, Agile Software development, Risk planning, and monitoring challenges in the Scrum
Risk Management Principles	Risk response planning and risk identification in the scrum, Risk Analysis issues in scrum software development

Query Strings

The query string was created by combining keywords and using Boolean operators such as OR and AND. OR operator is used when dealing with similar words or groups of words that have equivalent meanings, while the AND operator is employed when working with different words.

Table 3.4: Search Strings

Search strings
(“Problems”,” Challenges”, Risks”, “Issues”) AND (“Reduction” OR “Solutions” OR “Resolution” OR “Mitigation”) AND (“Scrum Software Development” OR “Agile Software Development”) AND (“Risk Management in Agile Software Development”) AND (“Risk Management Planning and Analysis Issues in scrum engineering”) AND (“Risk Identification and monitoring problems in Software Engineering”) AND (“Agile” OR “Agile Methods” OR “Scrum” OR “Scrum Methods”)

3.5 Conducting Review

The second phase of SLR in which the plan is being executed with the following steps shown below:

3.5.1 Identification of Research

Main goal is to discover a wide range of primary studies using an unbiased search method. We carefully and fairly approach this by using specific keywords and filters in databases to thoroughly explore literature related to Scrum-based software development and risk management challenges in the Pakistani software industry.

3.5.2 Generating Search Strategy

It involves 4 basic steps including identification of keywords, selection of sources, generating query strings and conducting research.

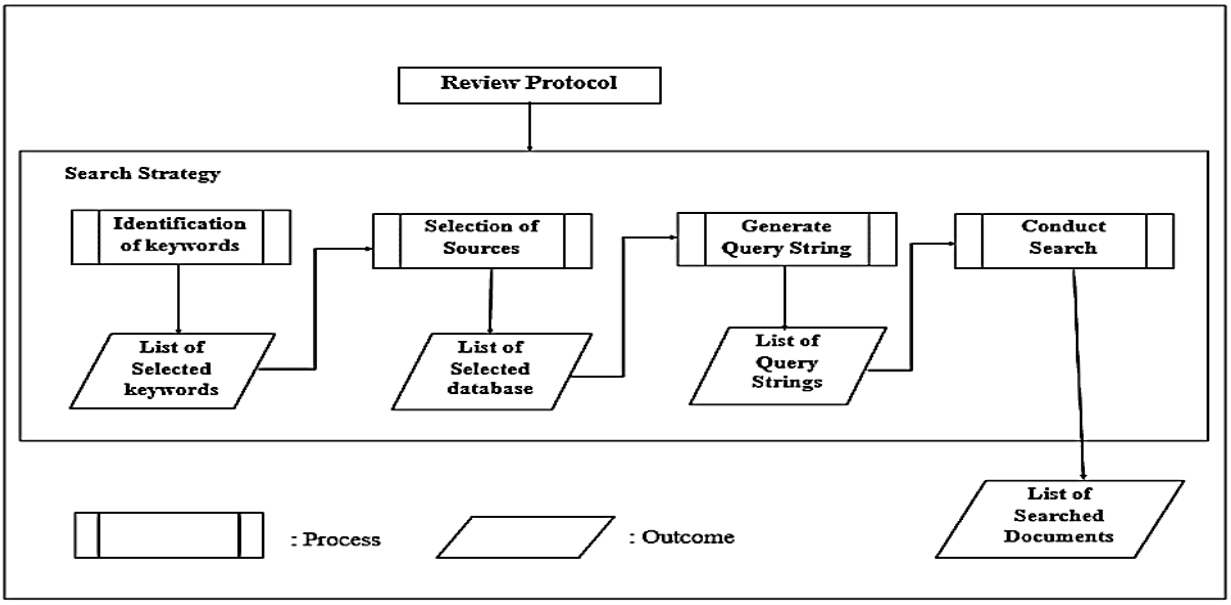

Figure 3.1: Generating search strategy

Bibliography Management

Mendeley Reference manager was used to manage the large number of references that were obtained from a thorough literature search.

3.5.3 Study Selection Procedure

It can take a long time to conduct a systematic literature review (SLR). After a series of steps, the SLR was completed. The search is started based on the title and time frame, which was 2011-2022. When it comes to selecting the most relevant documents, a filter is used. This is followed by the categorization of selected content using keywords and inclusion criteria. The final studies after applying all filters are shown in the coming sections.

3.5.4 Study Selection Criteria

A significant number of research papers were discovered using predefined search strings, aimed at locating all related papers useful for the research. To screen the collected papers and determine which articles are more pertinent to the topic for inclusion and which are less relevant for exclusion, A set of inclusion/exclusion criteria was applied, as illustrated in the table below.

Table 3.5: Inclusion and Exclusion Criteria

Parameters	Include	Exclude
Publication Date	Papers were collected from 2011 to 2022.	Papers dated prior to 2011 were omitted.
Research Topic	All the papers explaining different risk management challenges in Scrum software development were included. Papers explaining how the process of risk management is performed in scrum development were included.	Papers irrelevant to the research topic and questions were excluded.

Study Type	Only papers written in English were included. Only papers that were correctly published were included.	Papers that do not cover the required information on the topic. Papers not written in English language are excluded.
Peer Reviewed	Papers that were peer-reviewed were included.	Papers that are not peer-reviewed were excluded.
Content	Papers with full and detailed content were included.	Papers with limited content were excluded.

3.5.5 Study Quality Assessment Checklist & Procedure

Systematic Literature Review's quality assessment is a part or a phase that aims to evaluate the value of the selected studies to avoid biases. Accordingly, a set of questions in the form of questionnaires is being generated, and the respondents or candidates must answer each question for the chosen study.

As shown in Table 3.7 below, the answers are given based on a certain scale and the questions asked. Each researcher receives the final selected studies. To collect responses from as many other researchers (Respondents or Candidates) as possible, you can choose how many studies you want to distribute. In the field of software engineering, there are various quality assessments, checklists, methods, guidelines, and tools available for assessing the quality of primary research studies. A quality checklist was employed to evaluate these primary research studies, which comprises the following key questions shown in below table 3.6.

Table 3.6: Criteria for quality assessment [56]

NO:	Questions For Quality Assessment
1	Has the research provided a concise statement or definition of its aims, including goals, purposes, problems, motivations, objectives, or questions?
2	Is there sufficient description available regarding the context and background in which the study was carried out?
3	Is the paper research-based?
4	Is your reporting clear and consistent?
5	Is there a clearly articulated set of data that is related to the research's aims?

6	Have the researchers addressed any potential issues or challenges, such as limitations or threats, related to the validity and reliability of their results?
7	Can the study be replicated?
8	Do the findings possess credibility?
9	Has the techniques been validated on a specific scale, either within academic research and/or in an industrial context?
10	Does the study offer an explanation and rationale for the methods used in data analysis?

The scale used for checklist of quality assessment is shown in below table 3.7.

Table 3.7: Scale used for checklist of quality assessment [48]

Answer	**QA Score**
Yes	1
No	0
Partially	0.5

The detail of the results of the Quality Assessment form distribution among various candidates is attached in Appendix Section shown in Appendix B.

Following the establishment of a comprehensive review protocol, complete with keywords and search strings, the process of searching for articles relevant to our research topic started across five distinct data sources. Advanced search features are employed, which included searching for our specified search strings within the titles, abstracts, and keywords of articles. The primary goal of this research is to figure out the challenges encountered by risk management teams in scrum-based software development. Consequently, articles published from the year 2011 onward are specifically chosen for consideration. To extract the most pertinent articles for our research, a set of pre-defined inclusion/exclusion criteria is utilized, and various screening processes are applied to the located articles.

3.5.6 List of derived results

Table 3.8 presents a compilation of selected sources that have been incorporated into the research thesis to address the research gap and accomplish the research study's objectives. The table consists of a total of 6 columns. Column 1 include serial numbers assigned to chosen electronic databases. Column 2 contain names of the data sources utilized. Column 3 consists of total number of papers retrieved from each respective database. Column 4 to Column 6 shows applied filters at different stages of the selection process.

At stage 1: Filtering based on title and keywords, with the corresponding number of papers selected. At stage 2: Filtering based on abstract, indicating papers selected at this stage. At stage 3: snowball sampling was applied on the papers obtained after stage 2. Finally, repeated quality assessment was applied on the papers obtained from preliminary screening and snowball sampling.

The search query was used to search from digital libraries like IEEE, ScienceDirect, Wiley Online Library, ACM Digital Library etc., all of which were searched systematically. A total of 64 papers were found based on the 2011–2020 time frame. Based on the title and keyword searches, we've reached the first stage of the process, with 51 papers in total. Then, after carefully reading the Abstracts of selected primary studies, 42 papers were selected from. Finally, 23 papers were selected as a result of this process. However, IEEE is only one source of information on electronics.

Total 155 papers were obtained after preliminary screening. Then 1st iteration of snowball sampling is applied on these 155 papers. After first iteration 13 new papers are obtained. Then these 13 papers are screened based on the already defined criteria. After screening 9 new papers are obtained. Then 2nd iteration is applied on these 9 papers that are obtained after 1st iteration. These 9 papers are then screened again by applying filters. Based on these filters 8 new papers are obtained. Then in 3rd iteration these 8 papers are screened and no new papers are obtained. So, after snowball sampling 8 new papers that fulfill our research objectives were obtained. So, 155 papers were obtained after initial search and 8 papers were obtained after snowball sampling. Total 203

papers were finalized for quality assessment. After quality assessment 51 papers were finally included.

Following the extraction of articles from databases, a quality assessment is conducted. A checklist applied, incorporating questions as outlined above in this chapter, to evaluate the quality of the chosen articles. Articles that did not meet the criteria are excluded from consideration. Ultimately, a total of 51 articles are retained in the final assessment.

Table 3.8: List of derived results

No.	Name of sources	Preliminary screening	First Filter (Title and keywords)	Second Filter (Abstract)	Third Filter (Snowball sampling and Repeated Quality Assessment)
1	**IEEE**	64	51	42	23
2	**Springer**	48	32	12	4
3	**Wiley's**	91	83	30	3
4	**ACM**	151	27	19	7
5	**Elsevier**	86	32	14	4
6	**Others**	2653	140	38	10
	Total	3093	365	155	51

3.5.7 Data Synthesis and Extraction

Prior to extracting data from the selected articles, the following findings are uncovered during the initial screenings:

i. Each article has cited multiple challenges.

ii. Several articles have depicted similar challenges using different terminology or have employed different names to refer to identical types of challenges.

iii. Only a limited number of articles have organized or categorized the identified challenges. We observed that these articles, with categorized data, are more comprehensible and user-friendly for our purposes.

The data extraction process began by reading the articles selected after quality assessment, with the objective of identifying and extracting various challenges mentioned in the articles. Following the quality evaluation, the necessary papers were obtained, and the next step involved identifying the prevalent challenges faced by members of the risk management team in Scrum software development. It starts with carefully reviewing all the chosen papers as well as all risk management issues and challenges discussed in each paper.

Therefore, it started with carefully reading all of the chosen articles, and all of the difficulties highlighted in all of them were noticed and recorded. Following the recording and documentation of all the mentioned challenges, an analysis was conducted to determine how frequently each challenge or issue was discussed across the research papers. Through this analysis of challenge frequency, a list of commonly occurring challenges was compiled by applying data extraction and synthesis techniques, a list of the most common challenges encountered during scrum development was generated. This list assists in indicating the scope and direction of research. In accordance with that, a Data Extraction Form (Table 3.9) was designed, including 2 columns with 11 entities and their relevant details. These are shown in Appendix B.

Table 3.9: Form for Extracting Data

Entities Name	
Publisher Name:	
Article Title:	
Article Type:	
Year:	
Publisher	
Methodology Applied:	
Contribution and Significance:	
Quality Evaluation Score:	
Exclusion/Inclusion status:	
Answer to Research Question 01:	

3.5.8 Results of Data Synthesis and Extraction

The frequency count of each challenge was recorded to determine how often each challenge was discussed in the articles. A total of 15 challenges were identified, as shown in Table 3.10, which presents an overview of the challenges identified through the systematic literature review (SLR).

Table 3.10: Details of Identified Risk management Challenges

No	Risk Management Challenges	Citation	Frequency Rate N= 51	Percentage (%)
1	**Changing requirements risk prediction issues**	[5], [6], [9-11], [22], [36-42], [44], [46], [48]	19	37%
2	**Planning and documentation issues**	[1], [9], [13-16], [24], [102], [31-34]	12	23%
3	**Risk estimation and Definition Issues**	[31], [37], [51]	3	5%
4	**In sufficient risk identification**	[6], [18-21], [88]	7	13%
5	**High priority risk mitigation Issues**	[1-7], [16-19], [21], [23], [95], [28-37] [41-51]	36	70%
6	**Resource estimation issues**	[8], [17], [74], [46], [49-51]	7	13%
7	**Planning risk response strategy**	[1], [23], [26], [29], [31], [38], [62] [42], [38], [16], [66], [81], [32], [19]	13	25%
8	**Lack of expertise**	[1], [2-9], [11], [14], [16-18], [77] [23], [24-27], [33], [79], [42-48]	29	56%
9	**Schedule cost and quality control issue**	[1-7], [9-31], [33-48], [50], [51]	47	92%
10	**Productivity performance and security issues**	[2-9], [18-20], [24-29], [35-59]	26	50%
11	**Risk Interdependencies issues**	[11-13], [17], [22], [65], [27], [33] [35], [39], [40-42], [50], [51]	15	29%
12	**Mismeasurement of known risks**	[18], [23], [31], [32]	4	7%
13	**Quality Assurance issue**	[9-11], [15], [20], [22], [25], [91], [33] [99], [38-40], [48], [49]	15	29%
14	**Resistance to change**	[11], [25], [46], [49]	4	7%
15	**Communication issues**	[8], [13], [15], [43], [44-47], [49-81] [27], [30], [101]	14	27%

Fig 3.2 shows the percentage of each challenge confronted during the application of the risk management process in scrum software development and from SLR results.

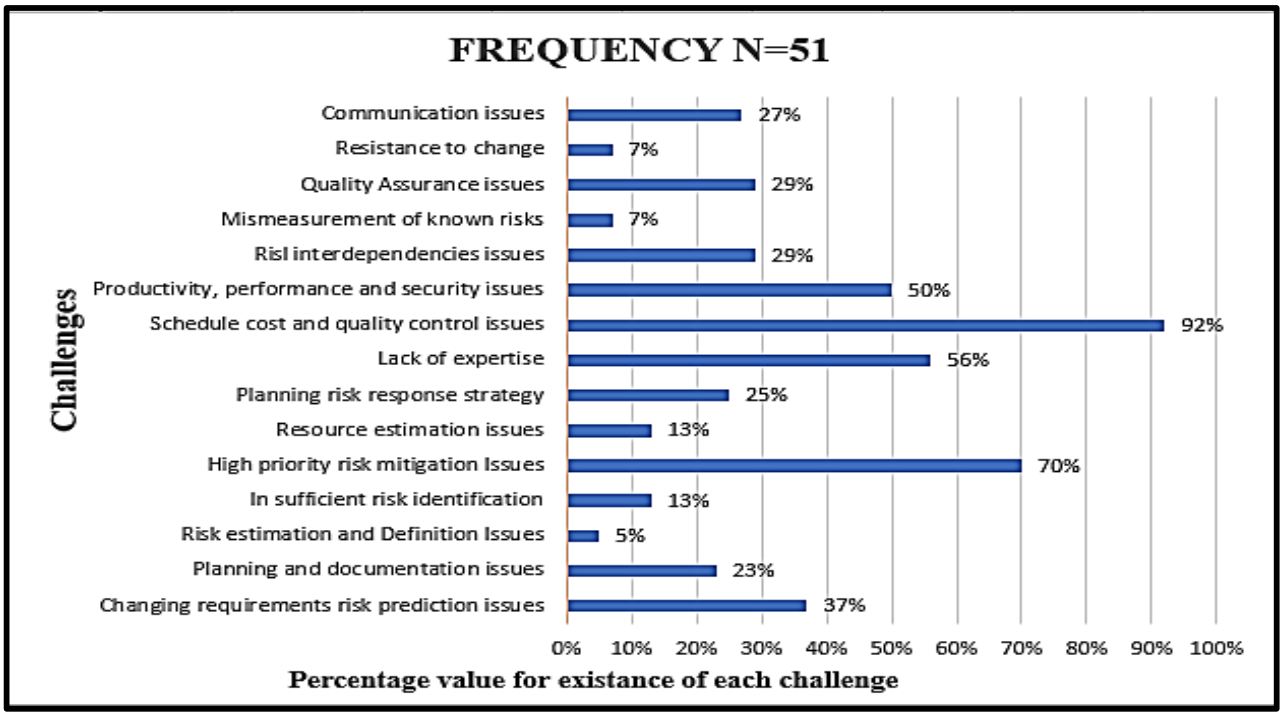

Fig 3.2: Percentage value of challenges identified

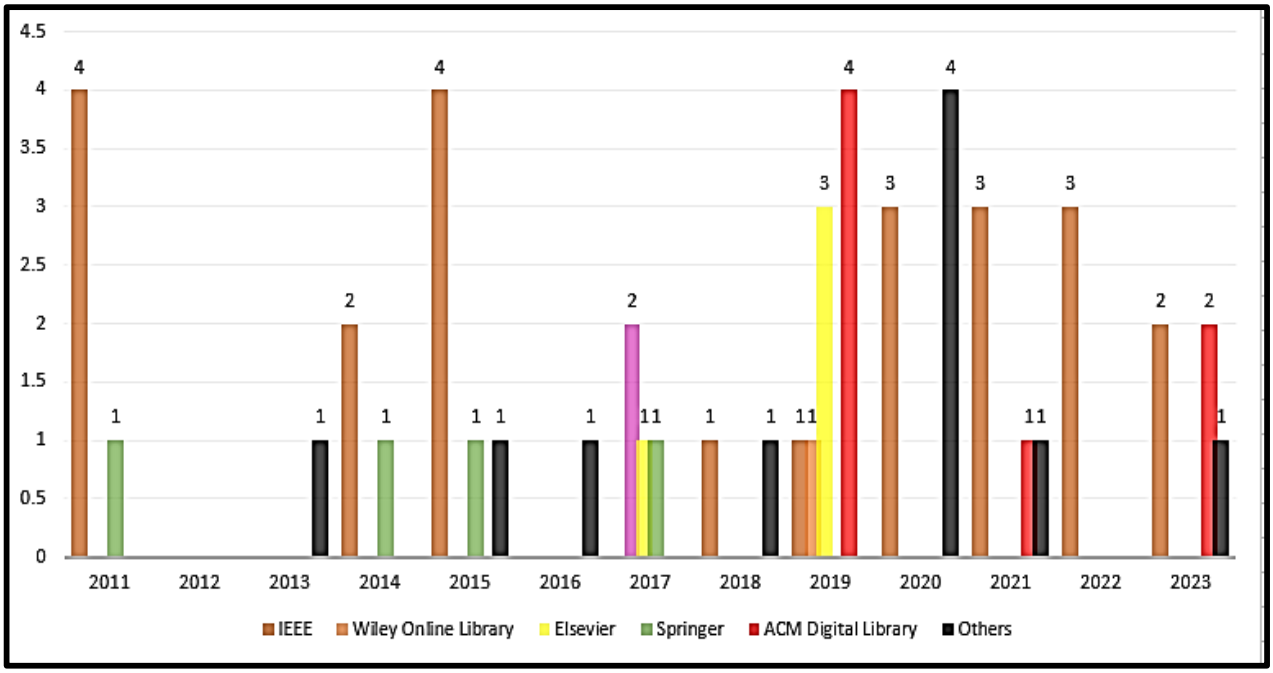

Figure 3.3: Year based studies distribution

Figure 3.3 displays the origins of the articles and the corresponding count of articles retrieved from each source. This pertains to the sources from which articles were gathered, including platforms like Google Scholar and academic forums. Graph include papers from year 2011 to 2023. X-axis shows the name of sources from which the articles are taken and Y-axis represent the number of articles. The sequence of electronic databases is as follows: IEEE with brown, Springer with green, Wiley Online Library with pink, and ACM Digital Library with red, Elsevier with yellow and others with black. It is clearly shown that in the year 2012, no relevant paper is published from any database. In the year 2011, only 1 relevant study is published from Springer and 4 from IEEE. Similarly, the sequence of all-published studies is shown.

3.5.9 Arrangement Based on Research Study Type

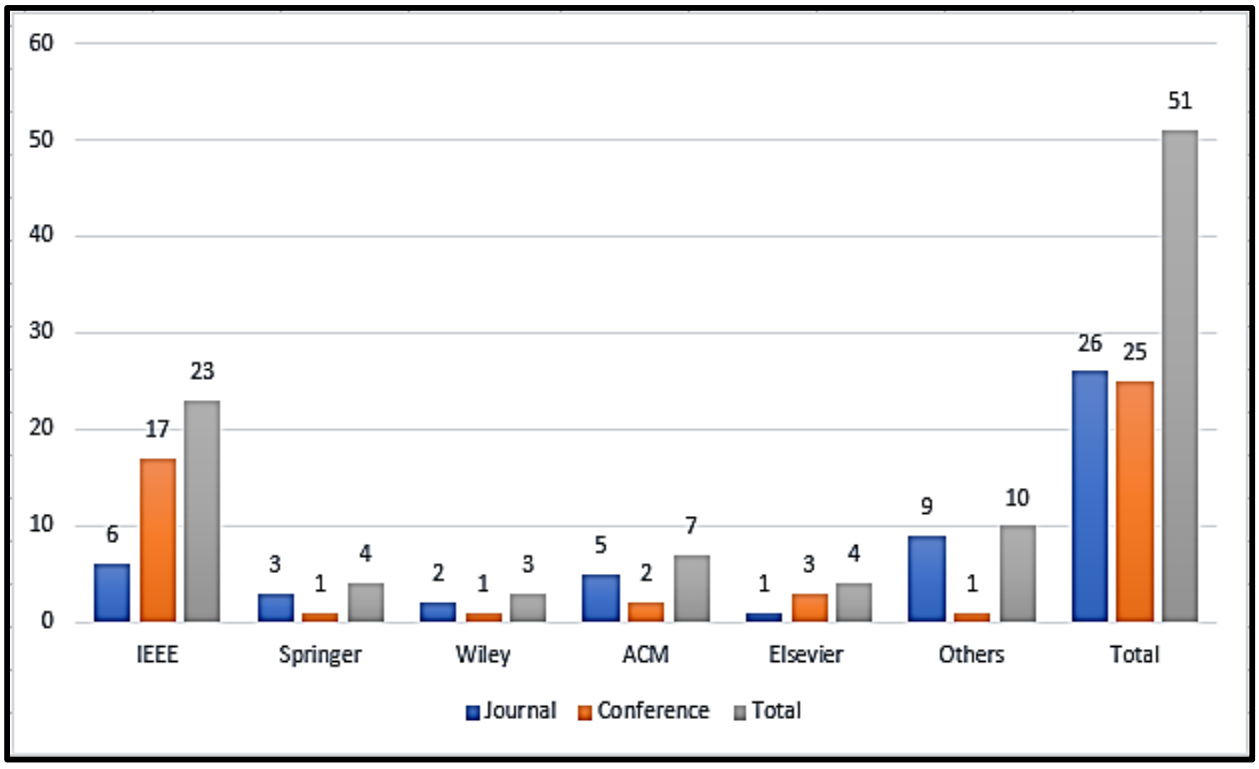

Figure 3.4: Arrangement based on research study type

The graph drawn above is the distribution of research studies based on the type of papers. On the x-axis, the type of papers is being plotted while, on the y-axis, the number of studies is being plotted. The blue shade is showing journal, orange shade is showing conference and grey is showing total.

The sequence of databases is plotted as IEEE, Springer, Wiley Online Library, and ACM Digital Library, Elsevier and others respectively. After that, a total of found studies is plotted. A total of 23 papers are found from IEEE of which 6 are journals while 17 from the conference are there. Similar sequence is shown for all other database. In total, 26 papers were published in a journal while 25 were published in a conference.

3.5.10 List of Conferences

Table shown below is the distribution of included studies based on conferences having 2 columns with entities titled included research studies and name of conferences.

Table 3.11: Distribution of Included Studies based on Conferences

	NAME OF CONFERENCES
001	ICEIS 2021 - 23rd International Conference on Enterprise Information Systems
002	CENTERIS - International Conference on ENTERprise Information Systems
003	2015 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies (AEECT)
005	8th International Conference on Signal Processing and Integrated Networks (SPIN)
006	International Conference on Frontiers of Information Technology (FIT)
009	Proceedings of 3rd International Conference on Reliability, Infocom Technologies and Optimization
012	2014 IEEE international technology management conference
013	The 28th International Conference on Software Engineering & Knowledge Engineering
014	13th International Scientific Conference on Sustainable, Modern and Safe Transport (TRANSCOM 2019)
015	2019 16th Asia-Pacific Software Engineering Conference

019	International Conference on Knowledge-Based Engineering and Innovation (KBEI)
020	2nd International Conference on "Computing for Sustainable Global Development"
021	International conference of Electrical and Computer Engineering (ICECE)
022	International Conference on Electrical and Information Technology (IEIT)
023	International Conference on Electrical and Information Technology (IEIT)
024	International Conference on Management and Service Science
025	International Conference on Computational Modelling, Simulation and Optimization (ICCMSO)
034	2022 International Conference on Electrical and Information Technology (IEIT)
035	Computer Science Society (SCCC) International Conference Chilean
036	The International Journal of Software Engineering & Applications (IJSEA)
037	Proceedings of the 38th ACM/SIGAPP Symposium on Applied Computing
040	International Conference on Reliability, Infocom Technologies and Optimization (ICRITO) (Trends and Future Directions)
044	Proceedings of the XIX Brazilian Symposium on Software Quality
045	Frontiers of Information Technology (FIT)
047	13th International Scientific Conference on Sustainable, Modern and Safe Transport

3.5.11 List of Journals

Table 3.12 is showing the distribution of included studies based on journals. The table comprises 2 columns with Included Research Studies and Name of Journals respectively.

Table 3.12: Distribution of Included Studies based on Journals

	NAME OF JOURNALS
004	PAS journal Science Vision
007	Journal of computer information systems
008	IEEE Software journal
010	International Research Journal of Engineering and Technology (IRJET)
011	Journal of Information Systems
016	International Journal of Software Engineering and Knowledge Engineering
017	International Journal of Advanced Computer Science and Applications
018	Journal of technology management innovation
026	Institute of Advanced Engineering and Science (IAES)
027	International Journal of Electrical and Computer Engineering (IJECE)
028	International journal of software engineering & applications (ijsea)
029	International Journal of Open-Source Software and Processes

030	Indonesian Journal of Information Systems
031	Intl. Conference on Computing and Network Communications (CoCoNet'15), India
032	Journal of Industrial Engineering International
033	IEEE Access journal
038	International Journal of Supply Chain Management
039	ACM Transactions on Software Engineering and Methodology
041	Information Systems Journal
042	Global Transitions Journal
043	Information and Software Technology
046	IEEE access journal
048	Security and Privacy in Cloud-based Systems
049	Proceedings of the 10th International Symposium on Information and Communication Technology
050	Advanced Computing and Systems for Security
051	Australasian Journal of Information Systems

3.6 Reporting Review

3.6.1 Existing Studies on Risk Management Process in Scrum-Based Software Development

There exist a large number of research studies that were carried out in the domain of risk management challenges. The existing studies on the risk management process in scrum-based software development form a critical foundation for understanding the complexities and nuances of managing risks within an agile environment. By examining the existing literature, comprehensive understanding can be provided about how risk management is approached, implemented, and adapted within the scrum framework.

Risk Management in Agile Software Development

The research study [57] proposed structure or framework for mitigating risks in agile projects, detailing the crucial steps and actions for efficient risk management. It involves

identifying potential risks early, evaluating their potential impact on the project, and implementing measures to mitigate or eliminate these risks.

In the research study [1] the framework or model for risk management was developed that directs teams to systematically and effectively control risks associated with product owner roles that may appear in the project. This research study categorizes the possible risks including the PO roles into three categories. This work assists to structure the RIMPRO to help the scrum team members to carry out a systematized way of controlling and managing risks. The main limitation of this effort was that quantitative risk analysis was not carried out due to a lack of numerical data as well as a limited budget. As a result, they are unable to obtain a more realistic picture of risk management.

The study [41] discusses how not handling risks well can lead to project failure. It explains the major reasons why project management can go wrong and demonstrates how not dealing with risks properly is connected to these major reasons for project management failure. However, the paper does not provide solutions or mitigation strategies to overcome failures due to poor risk management.

The research paper [42] conducted a thorough Systematic Literature Review (SLR) on risk management in agile software development. It explored challenges such as the ambiguity surrounding risk management integration in agile methodologies and put forward potential mitigation strategies. However, it was found to be lacking in forward-looking insights and only presented a limited number of challenges.

The studies [4],[11],[38] suggested a risk management framework based on scrum-based development methods by employing PRINCE 2 technique. A case study was conducted to assess the suggested framework for reducing risks successfully during the scrum process. The model presented did not include all seven principles of risk management for the software development. The risk management planning and risk analysis phases of PMBOK risk management were neglected which led to failure in the formation of a common understanding and knowledge of the

parameters of the project. Studies did not focus on identifying challenges of risk management in scrum-based development.

Studies [20],[21] point out the significance of qualitative and quantitative risk analysis. Strengths, techniques and methods that can be applied to improve and refine the qualitative risk analysis phase were also elaborated. A systematic literature review (SLR) of quantitative risk analysis was carried out for the development and advancement of global mega software projects. The conclusion of these works showed that the application of quantitative and qualitative risk analysis confirmed to enhance decision-making in the process of risk management. The sole drawback was the limited size of the target demographic.

Studies [18],[19] discussed about the effect of a systematic and effective risk management process on the successful delivery of the software project. The author explored whether or not enhancing the risk management planning can result in improved success of high-risk projects. Problems in applying risk management processes were not explored. Studies found that the reasons for the failure of software projects can be directly linked to the level of risk management attempted.

Risk Management Challenges in Agile Software Development

The research studies [36],[6],[25] presented the challenges for managing risks in local and global software design and development. Established the frameworks which are able to overwhelm these challenges. Project schedules, Failure in applying risk management planning and risk monitoring, varying project requirements, and lack of knowledge and expertise for identifying and determining risk in the phase of risk identification were regarded as significant challenges in the risk management process. The major and considerable limitation or constraint was that the studies do not succeed to include complete risk management processes in their proposed frameworks. No mitigation strategies were presented to solve the issues related to the accomplishment of a thorough risk management process.

Studies [12],[14] gave much more attention to how poor or incomplete risk management results in the failure of software projects. In these papers, the authors addressed whether risk

management is reactive or proactive action. As stated by the author, not having senior management involvement, insufficient technological support, inadequate understanding of risk management processes and poor team dynamics are important problems that may lead the risk management processes towards software failure. The paper does not possess solutions or mitigation strategies to help overcome these challenges. These studies indicated that risk management is an important factor that, if not properly handled, may result in project failure.

Studies [45],[46] discuss risk management challenges and the strategies to overcome these challenges in agile development. The importance and significance of these challenges to academic and practical spheres were also discussed. The research study [49] presented a framework for addressing communication obstacles like language barriers, time-zone disparities, and trust-related concerns.

Studies [7],[89],[90] identify risks in scrum-based software development and present risk management activities in agile software development. Identify potential risks associated with globally distributed agile software development and propose a framework for effectively managing these risks. Highlight the primary obstacles arising from the global distribution of projects that limit the application of Scrum and discuss the approaches project managers employ to address these challenges.

After conducting thorough research on the subject of the study, it is clear that the inappropriate use of risk management methods is extremely damaging to the software industry worldwide[58]. The use of effective methods for evaluating the project's performance is critical to the success of any project[59].

The below table shows the summary of existing studies that depict how risk management is done in agile methods. The table comprises five columns: the first column designates serial numbers, the second column displays author names, the third column indicates publication years, the fourth column elucidates the contribution, and the final column delineates the weaknesses of the respective research papers. Table 3.13 shows the summary of existing papers. The complete detail of literature review is shown in Appendix A.

Table 3.13: Summary of Literature review on risk management process

Paper No	Author Name	Year	Contribution	Limitations
01	Mohammad Hadi Zahedi[57]	2023	Suggested framework for managing risks in agile projects, outlining the essential steps and measures for effective risk management.	No issues related to risk management processes were discussed.
02	Samuel de Souza Lopes[1]	2021	Proposed an innovative procedure to control and manage risks including Product Owner's roles by employing risk management phases. Introduced framework RIMPRO, that help and supports teams in efficiently managing software development issues relevant to Product Owner responsibilities.	Quantitative risk analysis is not performed due to limited amounts of numerical data and budget. That's why they do not succeed in getting a more accurate image of risk management.
03	Kaizer Boikanyo Ratsiepe[60]	2019	Talked about how not handling risks well can make projects fail. Explained the big reasons why project management can go wrong. Showed how not dealing with risks properly is connected to these big reasons for project management failure and how to fix it	No solutions or mitigation strategies provided to overcome failures due to poor risk management.
04	Naveed Shahzad[61]	2022	SLR on risk management Risk like lack of clear definition integrating risk management in agile were discussed. Some mitigation strategies are proposed	Paper lack future insight. Limited challenges were discussed.
05	F S Rahayu[62]	2020	Risk mitigation framework for implementing Scrum in internet-based IT companies	focuses on one case study of Tokopedia, which may not be representative of other internet-based IT companies

06	Edzreena Edza Odzaly[63]	2020	An Agile risk management tool that minimizes human effort by utilizing software agents to detect, evaluate, and oversee risks.	Tool was limited to only three risk management processes which was planning, analysis and mitigation.
08	Portia Crowe [39]	2014	Focus on incorporating risk management process throughout life cycle not just the beginning and in the development phases.	Risk areas should be categorized and defined. Risk management plan is not included in RM process.
9	Karollay Giuliani Oliveira Valério[64]	2020	New strategies of risk management and their importance to academic and practical spheres	Only 3 challenges related to risk management are discussed
10	Simran Kaur Khurana[65]	2022	Novel framework that uses metadata requests to manage the risks challenges that arise in large scale scrum (LeSS), such as team collaboration, knowledge sharing, and communication.	Only evaluate framework on two case studies. Do not elaborate how this framework is better than existing ones.
11	Mohammad Esteki[5]	2020	Proposed a risk management framework for distributed scrum projects using the PRINCE2 methodology integrates the agile and traditional approaches to manage the risks	Deals with risks typical for software engineering, such as budget, schedule, and technical risks.
12	Dr. Urvashi Rathod[66]	2017	A framework for risk management in DAD projects, encompassing identified risks, their root causes, and industry-standard methods for risk mitigation	Frameworks did not involve any risk management process. Framework was very generalized.
13	Hycinta Andrat[67]	2015	Examine the agile methodology, specifically Scrum, and assess the degree to which risk is addressed within it. Additionally, a model has been suggested to address its limitations in the risk analysis phase.	Model was only limited to risk analysis phase of risk management process.

14	Kushal Bundhun[68]	2021	A framework for addressing communication obstacles like language barriers, time-zone disparities, and trust-related concerns.	Proposed framework should be based on risk management principles.

3.7 Summary

In this chapter, a comprehensive overview of the context and existing literature pertinent to our research work is provided. The background is studied and analyzed to give a brief understanding of risk management in the application of the scrum process. It is important to understand the failure of proper application of risk management processes. And also, the risks that scrum-based software development projects encounter when risk management is not implemented. A comprehensive SLR was carried out following Kitchenham guidelines and thoroughly read 51 papers from 2011-2022. Basic aim of conducting systematic literature review is to figure out the issues and difficulties faced during process of risk management in scrum projects. Now it is obvious that numerous uncertainties are being addressed and clearly stated to be taken seriously. Every organization, regardless of size, is responsible for carefully monitoring the risk management approach, changes, risks, and the results and to plan accordingly. Strict and clear mitigation strategies are needed to implement in order to solve these kinds of issues [69].

CHAPTER 4

SURVEY AND FOCUS GROUP FINDINGS AND DISCUSSIONS

4.1 Introduction

The subsequent chapter examines the outcomes of each survey and focus group interviews conducted to accomplish the research objectives. Two research questions were formulated in alignment with the research study's aim. Consequently, the results of systematic literature review (SLR) and a survey are instrumental in uncovering the challenges.

Following the identification of these challenges, mitigation strategies are developed through interviews with industrial practitioners. Subsequently, the validation of these mitigation strategies was carried out using the focus group methodology, serving as the ultimate objective of the research. In this section finding from survey, interviews and focus group are discussed.

4.2 Findings from Pilot Study

It is basically to test the designed questionnaires from a small sample from the target audience. Its main purpose is to remove the bugs which leads to further improvement. This was done to further improve the questionnaire and validation in terms of wording and statements. The questionnaire was then forwarded to the 11 members of the target audience. Initially questionnaire was designed consisting of 30 questions. After pilot study 3 questions were eliminated as they seem to be irrelevant for our research objectives. Question number nine, thirteen, six and seven are revised after the pilot study. As these involve phrasing and sentence structuring errors.

4.3 Results from Survey

After carrying out SLR, a list of challenges confronted during risk management in scrum-based software development has been obtained. To determine the practicality of the challenges identified through SLR, a survey is conducted among scrum practitioners using Google Forms and by distributing questionnaires in different software organizations. The questionnaire is designed based on the challenging factors identified through SLR.

A total of 302 respondents participated in the survey. To gain insights into the background of the respondents, a set of demographic questions is included. From the results, it is observed that every respondent had experience in risk management in scrum.

The core questions in the survey are presented using a 5-point Likert scale, which included agreement options such as "Strongly Agree," "Agree", "Neutral," "Disagree," and "Strongly Disagree." These Likert scale items are used to assess the respondent's opinions regarding various challenges.

Table 4.1: Survey Response Results

No.	**Challenging Factors**	**Strongly Agree (2)**	**Agree (1)**	**Neutral (0)**	**Disagree (-1)**	**Strongly Disagree (-2)**	**Total responses (302)**
1	Changing requirements risk prediction issues	85*2=170	167*1=167	30*0=0	13*-1=-13	7*-2= -14	310
2	Planning and documentation issues	74*2=148	168*1=168	28*0=0	20*-1=-20	12*-2= -24	272
3	Risk estimation and Definition Issues	75*2=150	101*1=101	106*0=0	9*-1=-9	11*-2=-11	231
4	In sufficient risk identification	94*2=188	141*1=141	49*0=0	11*-1=-11	7*-2=-14	304

5	High priority risk mitigation Issues	138*2=276	110*1=110	32*0=0	13*-1=-13	9*-2=-18	355
6	Resource estimation issues	72*2=144	154*1=154	37*0=0	32*-1=-32	7*-2=-14	252
7	Planning risk response strategy	82*2=164	159*1=159	34*0=0	20*-1=-20	7*-2=-14	289
8	Lack of expertise	108*2=216	139*1=139	33*0=0	11*-1=-11	11*-2=-22	322
9	Schedule cost and quality control tissue	95*2=230	171*1=171	23*0=0	6*-1=-6	7*-2=-14	381
10	productivity performance and security issue	105*2=210	133*1=133	42*0=0	13*-1=--13	9*-2=-18	312
11	Risk Interdependencies issues	124*2=248	101*1=101	37*0=0	22*-1=-22	18*-2=-36	291
12	Mismeasurement of known risks	45*2=90	160*1=160	63*0=0	26*-1=-26	8*-2= -16	208
13	Quality Assurance issue	125*2=250	94*1=94	36*0=0	30*-1=-30	17*-2= -34	280
14	Resistance to change	29*2=58	143*1=94	89*0=0	28*-1=-28	13*-2=-26	98
15	Communication issues	80*2=160	157*1=157	36*0=0	22*-1= -22	7*-2= -14	281

The survey enabled the collection of quantitative data for each challenging factor. An analysis of the gathered data was conducted to assess the acceptance or rejection of these factors.

4.3.1 Results Obtained from Average Weightage Values

Weightage values represent the average responses collected for each factor. These values play a crucial role in making decisions regarding the acceptance or rejection of each factor. To calculate the average weightage value for each factor, a Mean function was used.

Average Weightage Responses = Weightage numbers or values / Total number of responses

Table 4.2 displays the average weightage responses for each factor, along with the corresponding outcomes, whether they were accepted or rejected.

Table 4.2: Rejected or Accepted Results

No	Challenging Factors	Weightage Scores/values	Mean Weightage value for Response	Results
1	Changing requirements risk prediction issues	310	310/302=1.02	Accepted
2	Planning and documentation issues	272	272/302=0.90	Accepted
3	Risk estimation and Definition Issues	231	231/302=0.76	Rejected
4	Insufficient risk identification	304	304/302=1.00	Accepted
5	High priority risk mitigation Issues	351	351/302=1.16	Accepted
6	Resource estimation issues	252	252/302=0.83	Rejected
7	Planning risk response strategy	289	289/302=0.95	Accepted
8	Lack of expertise	322	322/302=1.06	Accepted
9	Schedule cost and quality control issues	341	381/302=1.26	Accepted
10	Productivity, performance and security issues	312	312/302=1.03	Accepted
11	Risk Interdependencies issues	291	291/302=0.96	Accepted
12	Mismeasurement of known risks	208	208/302=0.68	Rejected
13	Quality assurance issues	280	280/302=0.92	Accepted
14	Resistance to change	98	98/302=0.32	Rejected
15	Communication issues	281	281/302=0.93	Accepted.

4.3.2 Findings in Sequence

Following the determination of average weightage response results, certain factors are accepted while others are rejected, depending on their average weightage scores. Factors with an average value equal to or greater than 0.90 on the Likert scale are accepted. Table 4.3 presents the accepted and rejected factors in a sequential order, constituting the final survey results.

Table 4.3: Rejected and Accepted Outcomes

NO.	Challenging Factors	Weightage Values	Avg. Weightage Responses	Results
1	Changing requirements risk prediction issues	310	1.02	Accepted
2	Planning and documentation issues	272	0.90	Accepted
3	Risk estimation and Definition Issues	231	0.76	Rejected
4	Insufficient risk identification	304	1.00	Accepted
5	High priority risk mitigation Issues	351	1.16	Accepted
6	Resource estimation issues	252	0.83	Rejected
7	Planning risk response strategy	289	0.95	Accepted
8	Lack of expertise	322	1.06	Accepted
9	Schedule cost and quality control issue	341	1.26	Accepted
10	Productivity performance and security issue	312	1.03	Accepted
11	Risk Interdependencies issues	291	0.96	Accepted
12	Mismeasurement of known risks	208	0.68	Rejected
13	Quality Assurance issue	280	0.92	Accepted

14	Resistance to change	98	0.32	Rejected
15	Communication issues	281	0.93	Accepted

Among the 15 factors considered, 11 of them, changing requirements risk prediction issues, planning and documentation issues, insufficient risk identification, High priority risk mitigation issues, planning risk response strategy, lack of expertise, schedule cost and quality control issues, productivity performance and security issues, risk priorities issues, quality assurance issues, and communication challenges meet the defined criteria with values greater than or equal to 0.90. Consequently, these values are considered valid and accepted.

The other four factors include risk estimation and definition issues, resource estimation issues, mismeasurement of known risks and resistance to change possess values that are lower than the defined criteria that is why these are rejected. Fig 4.6 depicts the percentage of average weightage responses for each factor.

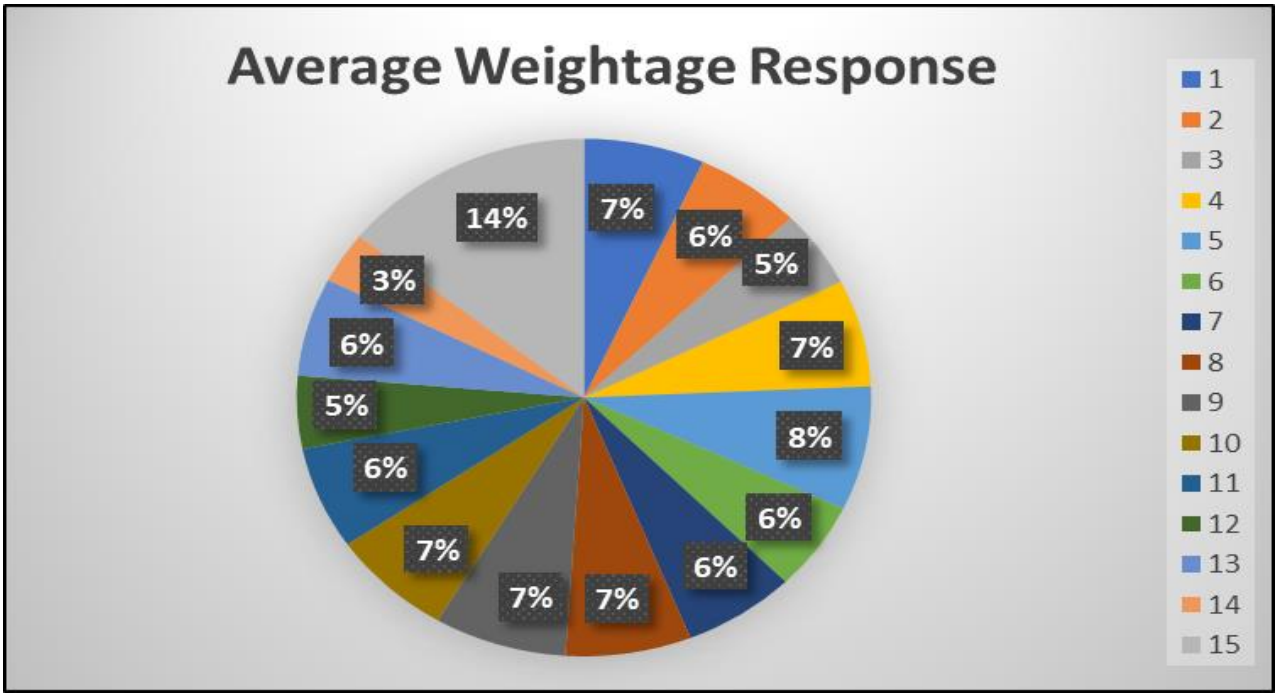

Figure 4.1: Mean value of weightage responses

The figure labeled 4.2 displays a visual representation of the factors that have been accepted and those that have been rejected.

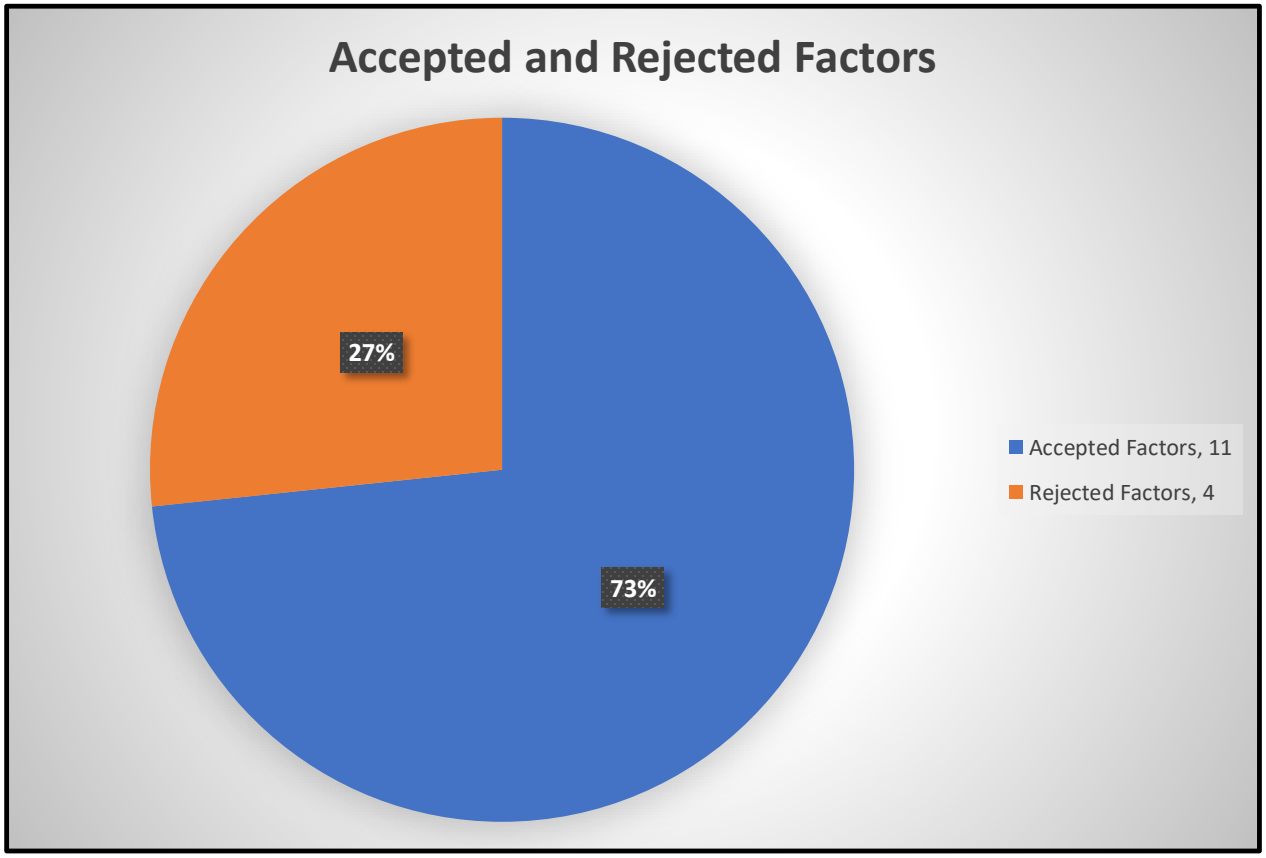

Figure 4.2: Accepted and rejected factors

4.3.3 Explanation of Results

The survey results have been examined using predefined criteria applied to the Likert scale values. Ratings below 1 have been deemed unacceptable, while ratings exceeding 1 have been considered acceptable. Using this criterion, 11 challenges are found to meet the acceptance criteria, while four are determined to fall below it. To ensure the reliability and consistency of the results, Cronbach's Alpha values are computed.

4.3.4 Cronbach's Alpha Method

Ensuring the validity of scales in a survey is crucial. Researchers must assess the reliability and consistency of the scale. The outcomes of the survey are also greatly influenced by how the scale is established and applied during data collection. In this particular study, the values are calculated and compared against the Cronbach's alpha criteria, which confirms the reliability and validity of the 11 challenges. During the analysis of survey results, a specific criterion was established: only factors with a Likert scale value exceeding 0.90 would be considered. Following this defined guideline, a total of 11 factors met the criteria, as their average response scores surpassed 0.90. Conversely, any factors falling below this threshold are excluded from the analysis due to their lower average responses, in accordance with the predefined criteria. To assess the reliability and internal consistency of the survey results and to validate the scale employed in the survey, Cronbach's Alpha values for various items are calculated using MS Excel. In the case of a Likert scale, a Cronbach's Alpha value exceeding 0.80 is typically deemed reliable. The Cronbach's Alpha value for the Likert scale in this study is "0.83," encompassing responses from 15 factors. Cronbach's Alpha values are derived from survey data using a specific formula provided for this purpose.

Cronbach's Alpha Method = [(Total questions / Total questions - 1) x (1 - (Sum of the Variance / Total value of Variance))]

4.3.5 Factors with Low Significance Values

A total of 4 out of the 15 factors were excluded from consideration due to their lower average weightage values. Factors that are rejected include risk estimation and definition issues, resource estimation issues, mismeasurement of known risks, and resistance to change.

i. **Risk estimation and Definition Issues** with an average value of 0.72 are not accepted because large number of responses are neutral (neither disagree nor agree).

ii. **Resource estimation issues** with a value of 0.834 has also been rejected because it does not meet the predefined acceptance and rejection criteria, as it possesses a value less than 0.90.

iii. **Mismeasurement of known risks** with a value of 0.68, has been rejected. These factors were not considered significant because respondents did not believe that they presented challenges in risk management in Scrum development.

iv. **Resistance to change** Resistance to change, with a value of 0.486, was not accepted because the majority of respondents indicated a neutral stance toward it.

4.3.6 Factors with High Significance Values

Among the 15 factors addressed in the survey, a total of 11 factors have been acknowledged or accepted. Changing requirements risk prediction issues, planning and documentation issues, insufficient risk identification, high priority risk mitigation issues, planning risk response strategy, lack of expertise, schedule cost and quality control issues, productivity performance and security issues, risk priorities issues, quality assurance issues, and communication issues

i. **Changing requirements risk prediction issues** is an accepted factor with a value of 1.02. Its acceptance is based on the fact that a majority of respondents either strongly agreed or agreed with it.

ii. **Planning and documentation issues** is the factor number two, which focuses on planning and documentation issues with a value of 0.9, has also been accepted. Respondents confirmed that teams frequently encounter challenges related to planning and documentation in the process of managing risks in Scrum-based software development.

iii. **Insufficient risk identification** is the third factor, as per the Likert scale, has also been accepted. This factor has an average value of 1.00. Survey respondents concurred that their teams often confront this issue in managing risks within Scrum-based development.

iv. **High priority risk mitigation Issues** received an average score of 1.16 and is considered significant. According to respondents, their teams sometimes encounter problems related to requirement engineering in distributed development, leading to the acceptance of this factor.

v. Planning risk response strategy possess value of 2.23, has been acknowledged as important. Survey participants mentioned that their teams sometimes experience difficulties in understanding and addressing these risks, leading to its acceptance.

vi. Lack of expertise with a score of 1.20, is recognized as significant. Survey results showed that teams have often encountered this problem during development, leading to its acceptance as a notable issue.

vii. Schedule cost and quality control issues received an average score of 2.12 and is considered important. Survey responses indicated that development teams sometimes encounter this challenge, and it's important to find a solution for it.

viii. Productivity performance and security issues got an average score of 1.89 on the Likert scale. According to the survey, many times teams have to deal with this issue, and it's important to find solutions for it.

ix. Risk Interdependencies issues scored an average value of 0.96, has been acknowledged. Survey results showed that teams have frequently encountered this problem during development, leading to its acceptance.

x. Quality Assurance issue Another factor that is considered important, with a value of 0.9, is the issue of Quality Assurance. This is accepted because the people surveyed agreed that teams need to handle quality assurance problems in managing risks in Scrum-based software development.

xi. Communication issues possess the average value of 0.93. It is the accepted factor in Likert scale showing that communication is also the challenge in risk management is scrum software developments.

Table 4.4: High and low significance challenges

No	High Significance factors	Low significance factors
1	Changing requirements risk prediction issues	Risk estimation and definition issues
2	Planning and documentation issues	Resource estimation issues
3	Insufficient risk identification	Mismeasurement of known risks
4	High priority risk mitigation Issues	Resistance to change

5	Planning risk response strategy	
6	Lack of expertise	
7	Schedule cost and quality control issues	
8	Productivity performance and security issues	
9	Risk Interdependencies issues	
10	Quality Assurance issue	
11	Communication issues	

4.4 Description of Accepted Challenges

Accepted factors by practitioners are described below:

1. Changing Requirements Risk Prediction Issues

Failure to predict and estimate the risk of evolving requirements is considered as a serious challenge in the process of risk management in scrum-based software development. Scrum process is an iterative software development method that emphasizes on providing an iterative and incremental product [70]. One of the significant features or characteristics of scrum is its flexibility to adapt or adjust to evolving requirements during the whole course of the project lifecycle. But this adaptability can also become challenge if the software project team neglect to plan for changes in requirements [66], [71]. It is crucial for team members to early foresee the risks that will emerge when the requirement change take place. As it allows them to figure out potential hazards and take preventive measures to resolve them earlier then they have a major effect on the project. The purpose of risk identification phase is basically to predict the risk of changing or evolving requirements. If it is neglected, project managers are unable to appropriately evaluate, minimize and stop damage from software risks that can completely destroy the software organization [66]. This inability results in loss of market share by not early predicting the software risks. Organizations may lose enormous amount of dollars when they don't plan to foresee the risk of evolving conditions. It may lead to project schedule delays, cost overrun, lower quality, and eventually project failure. A lack of clarity

in the characterization and definition of evolving software requirements can lead to incorrect identification of software project risks[72]. Unexpected and undefined risks may easily hinder a project from meeting its goals or perhaps failing [73].

2. Planning and Documentation Issues

In scrum-based development, risk management planning and documentation is also regarded as the most critical element of the process of managing risks [74]. Main goal of planning risk management is to create a comprehensive approach to managing risks throughout the project lifecycle. It includes establishing roles and duties, setting up processes, and deciding risk management policies, rules and guidelines [75]. Without proper planning, the project team may not be able to predict all potential issues that affect the project badly. This can leave the project vulnerable to unanticipated risks, which can have significant negative impacts on project performance [76]. A proper risk management plan assists project teams in allocating sufficient resources to manage identified risks. This ensures that the project team has the necessary resources to address risks effectively, reducing the overall project risk. The planning document yields a clear and concise framework for reporting risks and the activities for risk management to the stakeholders of the project [77]. This enhances stakeholder understanding and buy-in, increasing the chances of project success. By methodically identifying, defining, assessing, managing and analyzing risks, a risk management plan can help in reducing the high impact as well as likelihood of project risks. This enhances the chances of project success, ensuring that project goals are met within specified resources, and the predefined and required standards for quality [78].

3. Insufficient Risk Identification

Insufficient identification of risks is also termed as an important issue in the application of risk management process. The objective of risk identification is to find out all potential software risks that badly effect the project's goals, resources, stakeholders, or timeline [79]. This involves identifying both unknown risks and known risks, also risks that may emerge from external or internal sources [80]. Unknown risks can result in unanticipated events that were not planned for,

potentially causing project delays, cost overruns, or even project failure[79]. When risks are not identified, there is no preparation made for them, which can make it difficult to respond appropriately when they do occur. Unidentified risks or events can also be more critical and have a more remarkable impact than identified risks. This is due to the fact they may be sudden and catch individuals off guard, finding it difficult to respond effectively[64]. Without risk identification, it become difficult to mitigate them, resulting in damage to the project or organization. Failure to identify risks can also result in poor decision-making, as important factors are left out of the planning process. Therefore, it's necessary to identify and analyze risks before undertaking any important project or activity to minimize their negative impact [81].

4. High Priority Risk Mitigation Issues

Qualitative risk analysis is a phase that entails assessing and analyzing the likelihood and impact of risks using proper subjective measures and expert judgment, rather than quantitative data. This procedure aids in risk prioritization on the basis of severity and the level of damage they offer to the organization. High priority risks must be identified and eliminated first as they have the highest likelihood to cause severe damage to the project or organization [82]. High priority risks possess high level of probability of occurring and have a severe impact if they do occur. Without qualitative analysis of risks, there is a higher chance of overestimating or underestimating the risks, which can lead to inadequate or excessive risk management measures[83]. By mitigating these risks, organizations can lower their chance and severity if they do occur. This can also help to avoid project delays, cost overruns, and even failure. Poor risk analysis also has an impact on risk response planning, because developing effective risk response plans can be difficult without a thorough grasp of the possibility and impact of various hazards [84]. As a result, the risk management process may become reactive, rather than proactive, which can lead to unnecessary costs and delays. Without appropriate analysis, processes for decision making can be compromised and may lead to inadequate choices being made that undermine the overall performance of an organization [85]. Qualitative risk analysis is very crucial step in managing risks in scrum. If a project team does not carry out this analysis, it may have strong negative impacts on the success of project.

5. Planning Risk Response Strategy

Planning risk response strategies can be a leading challenge in the managing risks in scrum methodology because of rapid as well as incremental nature of the scrum development process [86]. Agile methodologies such as scrum focus on prioritizing adaptation and flexibility instead of rigidly sticking to a predefined plan. This implies that strategies for responding to risks must be flexible and adaptable to changing circumstances, which can make planning more difficult [87]. Because they require a more flexible and adaptable approach to risk management. Instead of relying on fixed plans and predetermined responses, flexible strategies require ongoing monitoring and analysis of risks, as well as the ability to quickly adjust response plans as needed. Scrum projects typically involve short iterations or sprints, with a focus on delivering working software quickly. This can leave little time for detailed risk analysis and planning. Scrum teams have the ability to organize themselves and have members with various skills and abilities often responsible for multiple roles[88]. This can make it challenging to allocate specific resources to risk management and response planning. Risks in software development can be complex and multifaceted, and can involve technical, organizational, and external factors. Identifying and assessing these risks need a clear project understanding and broader context in which it is being developed.

6. Lack of Expertise

Lack of expertise in risk management ca be a significant challenge because it can lead to ineffective risk identification, analysis, and mitigation[89]. Without expertise in risk management, it can be challenging to identify all potential risks involved in a project or activity. This can result in overlooking significant risks that could cause significant harm. Inaccurate risk analysis can result from a lack of knowledge about how to evaluate risks, including probability, severity, and impact. This can lead to incorrect prioritization of risks and inappropriate mitigation strategies [89].

Without expertise, it can be difficult to develop effective risk mitigation strategies that take into account the specific risks involved, available resources, and organizational goals. Contingency planning may be limited, and there may be insufficient preparation for unexpected risks and potential impacts [90]. Expertise of risk management practitioners enable them to identify and analyze risks accurately and develop effective risk mitigation strategies. Experienced professionals are often familiar with the risks that are common in their industry or field, and they can identify potential risks quickly. They also have a better understanding of the different strategies for mitigating risks and can determine which strategy is best suited for a particular risk. Their experience allows them to understand what risk management strategies have worked in the past and what strategies have been less effective [91]. This knowledge helps them to make better decisions in the present. Expertise enables professionals to implement risk management processes effectively, ensuring that all risks are identified, analyzed, and mitigated appropriately [92].

7. Schedule Cost and Quality Control Issues

Schedule, cost and quality issues arises when risk is not monitored properly. Risk monitoring is basically the process that is performed to observe the execution of the project, so that the potential problems can be identified in a timely manner [93]. If risks are not monitored properly then it will decrease the performance speed which will then affect the schedule of the project. Quality control issues arises when the project under execution did not provide expected outcomes. If risks are not identified or monitored properly, they may be overlooked or underestimated. This could result in a risk event occurring unexpectedly, which could cause delay to the project schedule [94]. Project stakeholders may not have visibility into the current risk status of the project. This could make it difficult to identify potential schedule issues that may arise from unmitigated risks. Incomplete risk monitoring can also lead to inaccurate cost estimates. If risks are not monitored regularly, the original cost estimate may become outdated and inaccurate. This can lead to incorrect assumptions being made about the cost impact of a risk event occurring, which could result in insufficient budget reserves or inappropriate contingency plans being put in place[95]. Failure of risk monitoring can also lead to inadequate testing. If risks are not identified or monitored properly, it can lead to

insufficient testing of project deliverables. This can result in quality issues being discovered later in the project lifecycle, which can be costly to fix.

8. Productivity Performance and Security Issues

Productivity, performance, and security can pose significant challenges in risk management in scrum software development[96]. Risks related to productivity can arise from factors such as unclear requirements, inadequate communication, or inefficient development practices. These risks can result in project delays, missed deadlines, and decreased team morale, leading to lower productivity levels. Risks related to performance can include issues such as slow response times, system crashes, or software bugs[97]. Risk monitoring in scrum help solve issues related to productivity, performance, and security. It is a crucial part of risk management in scrum because it helps scrum teams to identify potential risks and take proactive measures to mitigate them. By monitoring risks, teams can identify areas where their techniques for managing risks can be improved. Like, if team consistently underestimates the impact of certain risks, they may need to revise their risk analysis process[98].

9. Risk Interdependencies Issues

While implementing risk management in scrum, one of the challenges that arise is related to risk interdependencies. Risk interdependencies refer to the relationships and dependencies between different risks within a project[99], [100]. These risks can be influenced by or have an impact on each other. In Scrum, requirements evolve and emerge throughout the project lifecycle. This iterative nature can make it challenging to conduct a comprehensive risk analysis upfront and address all potential risks. Adopt an iterative risk analysis approach that aligns with the Scrum framework. Prioritize the most critical risks for each sprint or release, and conduct periodic risk reviews to identify new risks and assess the evolving impact of existing risks[100].

10. Quality Assurance Issues

Quality assurance can be an issue in the process of managing risks in scrum software development because of the dynamic behavior of the scrum process. In Scrum, requirements can change frequently, which can make it challenging to ensure that risk management strategies are up-to-date and relevant. In scrum, requirements can change frequently, which can make it difficult to ensure that risk management strategies are up-to-date and relevant [33]. Scrum places less emphasis on documentation than traditional software development methodologies, so it become hard to capture and document all potential risks and their corresponding risk management strategies. Beside all that quality assurance is necessary in managing risks in scrum development to make sure that product being developed possess good quality and fulfill the expectations of the stakeholders [101]. Quality assurance promotes a culture of continuous improvement by encouraging regular evaluation and optimization of processes and practices, which can help to identify and address potential risks before they become major issues.

11. Communication Issues

In any type of development, whether it's spread out across different places or happening in one location, communication between teams and the people involved is extremely important. [102]. Communication is the method we use to share information with one another, and it can happen in formal settings like meetings or informally through casual conversations [58]. We often recognize that when communication doesn't work well, it's usually the main reason why software projects don't succeed [103]. Risk managers have an important job. They tell the top bosses and the board of a company about the risks the company might face. The big bosses use this information to figure out how to deal with those risks. But if a risk manager can't explain things well, the big bosses might make bad choices or think things are safer than they really are. So, good communication from risk managers is crucial to make wise decisions about the company's risks [104]. Less communication between participants of the project leads to misunderstanding of the project requirements, mismeasurement of known risks as well as many project management issues. A risk management plan lets us talk about all the different situations that could happen with the people involved like stakeholders, the project team, customers, or suppliers. When we communicate well, it helps us

make sure everyone knows what's going on, and this prevents a bunch of problems in managing the project.

The scrum methodology acknowledges the crucial role of communication in the software development process and offers an effective means of facilitating it [95]. All interviewees unanimously agree that daily Scrum meetings enhance communication among team members within their respective teams. However, it's worth noting that each team within the company tends to operate somewhat independently, resulting in limited communication across teams. This lack of inter-team communication could potentially lead to issues like duplicated work. To address or at least alleviate this problem, the company could consider organizing a daily scrum meeting, where Scrum masters from each team ensure there is no redundant effort. Figure 4.3 illustrates a graphical representation of factors of varying significance.

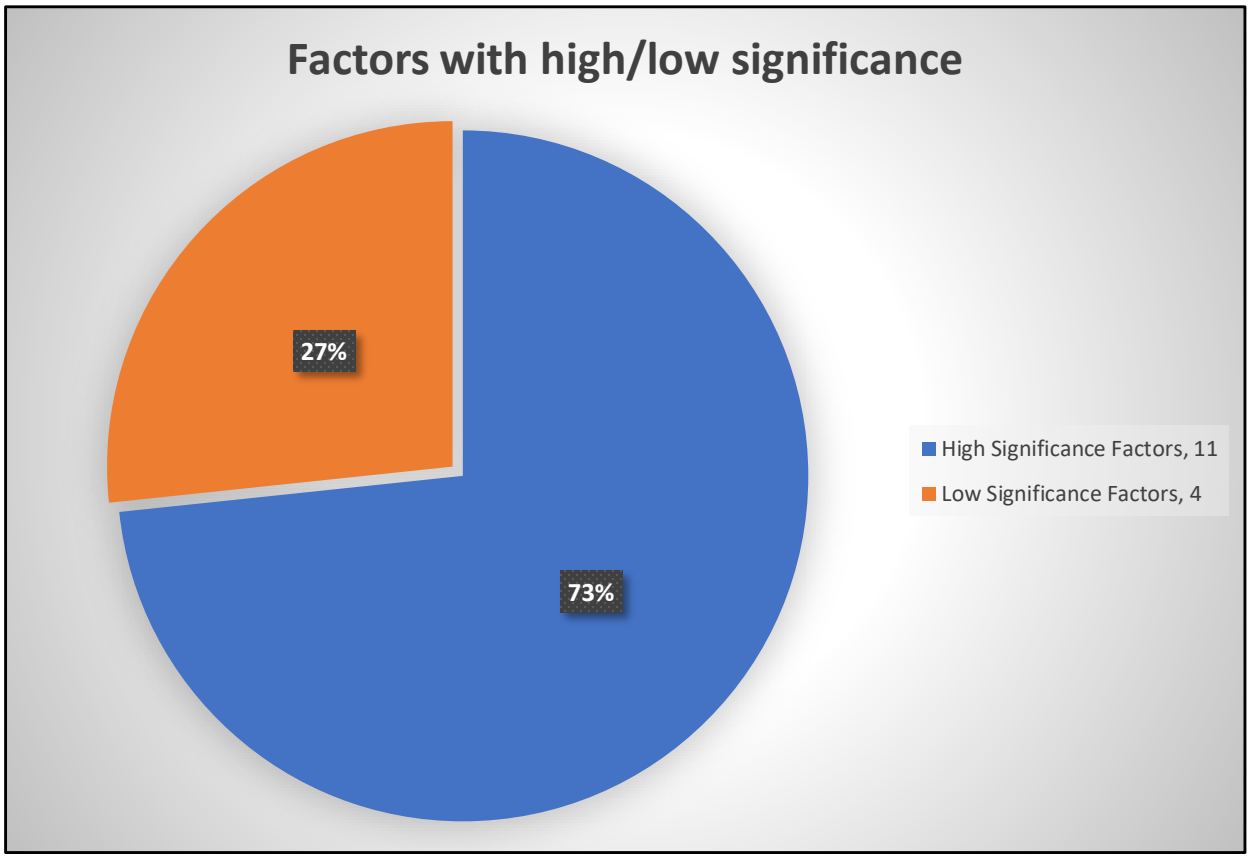

Figure 4.3: Factors with low and high value of significance

4.5 Interviews

After identifying high and low-significance challenges from survey analysis. Semi-structured interviews have been conducted for getting scrum-based risk management mitigation strategies based on the identified challenges. There were ten experts involved in this interview, each belonging to a software development team and holding different roles: project manager, testing team members, and quality assurance analysts. More structures interviews sound more valid and reliable.

4.5.1 Interviews Respondent Profile

After collecting and analyzing all the data from existing sources as well as from questionnaires. Data include risk management challenges in scrum-based software development methods in Pakistani software industry. Based on these challenges interviews are conducted to acquire mitigation strategies from the target respondents which include Testers, Quality Assurance Engineers, Risk Managers and Project Managers. Online and face to face interviews were conducted from total of 29 industry practitioners in which 4 risk managers, 11 testers, 9 quality assurance engineers, 5 project managers. The duration of these interviews was 20 – 25 minutes.

4.5.2 Interview Results

This chapter or section include the proposed mitigation strategies gathered from interviews with different industrial practitioners. Experts have suggested some mitigation strategies for the risk management challenges in scrum-based software development. Furthermore, the mitigation strategies proposed are validated by focus group interviews. Questions asked in interviews are shown in Appendix D.

4.5.3 Proposed Mitigation Strategies

Conceptual strategies have been identified and proposed in the research on the basis of identified risk management challenges gathered from the existing literature.

4.5.4 Mitigation Strategies Development Process

Several predetermined steps are followed during the development of risk mitigation strategies.

In Chapter 3, a systematic literature review was undertaken to pinpoint the difficulties encountered by software development teams when risk management processes are absent in Scrum software development. To identify conceptual mitigation strategies, one on one semi-structured interviews are conducted from industrial practitioners. Below Table 4.5 shows the mitigation strategies for adopting proper risk management in scrum-based software development.

Table 4.5: Mitigation strategies against 11 major risk management issues

No.	Mitigation strategies against 11 major risk management issues
01	**CHANGING REQUIREMENTS RISK PREDICTION ISSUES**
1	Use appropriate risk identification methods like checklists, brainstorming sessions, interviews, and scenario analysis to systematically identify risks.
2	Identify connections between components of project and customer requirements.
3	Regularly review and upgrade the process of risk identification to find any new risks that arise as requirements change.
4	Engage all key stakeholders, such as end-users, customers, subject matter experts, product owners, early in the project.
5	Utilize feedback loops, like sprint retrospectives or regular reviews with stakeholders to identify requirements changes.
7	Refine and review the product backlog periodically.
8	Engage both external and internal stakeholders who possess the knowledge about changing requirements.
02	**PLANNING AND DOCUMENTATION ISSUES**
1	Clearly define and articulate the goal of conducting risk management in the project.
2	Design a comprehensive and detailed structure for risk management that clearly define the overall approach, roles, processes, and responsibilities for risk management.

3	Use appropriate templates and standardized formats
4	Promote a culture of proper documentation
5	Regularly improve planning processes
6	Try to seek guidance from external experts
7	Try to involve the whole project team
8	Establish clear team member's roles and responsibilities to ensure that everyone is well aware of what is expected from them.
9	Document all decisions and activities at a centralized place to make sure that all member are aware of the risk status and mitigation methods.
03	**IN SUFFICIENT RISK IDENTIFICATION**
1	Avoid Scope creep
2	Consider major project's objectives while identifying risks to make sure that the risks that can affect project outcome are identified.
3	Maintain risk register regularly.
04	**HIGH PRIORITY RISK MITIGATION ISSUES**
1	Assess each identified risk on the basis of its likelihood as well as impact. Make use of already defined ranking system or qualitative analysis scale to assign ranking.
2	Direct your focus towards addressing as well as analyzing the high-priority risks at first. These types of risks should be given immediate focus to mitigate their negative consequences.
3	Spend less amount of effort and time on less-priority risks or the risks that can easily be managed.
4	No need to define ownership for high priority risks.
5	Utilize the right tools and methods for assessing risks,
05	**PLANNING RISK RESPONSE STRATEGIES**
1	Test the risk response procedures by using scenario planning to make sure that they are very effective and the team is ready to apply them when they are needed.
2	Tailor risk response techniques to the specific risk to make sure that the response to risk is is suitable and effective.
06	**LACK OF EXPERTISE**
1	Encourage team members to share their ideas and suggestions for enhancing expertise and effectiveness in risk response implementation
2	Engage external industry experts what are expert in implementation of risk responses. Take advice, guidance and support for implementing risk responses. Seek their guidance, advice, and support during the implementation phase.
3	Provide targeted training and expertise and organize skill development programs such as seminars and workshops etc to improve the skills of the team members that are involved in implementation of risk responses.
4	Find experienced practitioners in your organization who have successfully applied risk responses in the previous projects in past and learn from them.
5	review previous existing projects in detail and identify best practices and lesson learned during the implementation of risk responses.
07	**SCHEDULE COST AND QUALITY CONTROL ISSUES**
1	Frequently review project deadlines, quality control measures and cost estimates, against the predetermined baselines.

2	Specify clear risk monitoring objectives for cost, schedule and quality
3	Carry out frequent quality audits to assess and evaluate adherence to the measures of quality control.
4	A structured process defining the procedures and roles for scheduling, budgeting, and quality control must be established.
08	**PRODUCTIVITY PERFORMANCE AND SECURITY ISSUES**
2	Ensure that every team member are well aware of their position functions with respect to performance, productivity as well as security.
3	For tracking performance and productivity throughout the software development build metrics and measures.
4	Use automated tools for, security scans, testing and other features of the software development process to enhance productivity.
09	**RISK INTERDEPENDENCIES ISSUES**
1	Analyze the possible interdependencies among risks. Observe how the exposure or reduction of one risk affect the or impact or likelihood of other risks.
2	Conduct quantitative risk analysis and examine the interdependencies among risks when estimating their impacts and likelihood by applying decision trees and Monte Carlo simulations.
3	Apply scenario analysis technique.
4	expert interviews, brainstorming, and workshops should be conducted to figure out how one risk affect or be affected by other risks in the organizational context.
10	**QUALITY ASSURANCE ISSUES**
1	Continuously carry out risk response strategies within different components of the project.
2	Ensure adherence to the defined protocols and procedures of risk response implementation.
3	Perform periodic quality checks like reviews, inspections, or audits to assess the effectiveness of risk response implementation.
4	Develop a quality assurance plan that outlines how quality objectives will be achieved and how quality risks will be addressed.
11	**COMMUNICATION ISSUES**
1	Address language and cultural barriers by providing translation services within the project team.
2	Set up appropriate communication channels such as regular meetings, project management software, email updates, and document repositories to facilitate information sharing.
3	Clearly communicate the objectives, scope, and expected outcomes of the risk management planning phase to all relevant stakeholders.
4	Involve key stakeholders from the beginning of the risk management planning phase. Seek their input, gather their perspectives, and address their concerns.

4.6 Focus Group

For validating our proposed guidelines, a focus group is engaged. In this research 8 professionals participated in focus group interviews. A focus group sample size of 8 respondents is chosen to ensure comprehensive responses to all questions. The details about the focus group participants and their selection criteria are discussed below.

4.6.1 Focus Group Respondent Profile

The selection of participants for the focus group discussions aimed at including individuals with diverse roles and experiences related to Scrum-based software development and risk management within the Pakistani software industry. The focus group consisted of 8 professionals, including Testers, quality assurance engineers, and risk management experts and project managers with more than 5 years of experience and each contributing unique insights and perspectives. The profiles of focus group respondents will be determined based on their educational background, employment history and domain knowledge.

Respondents were selected that possess qualification of atleat masters in related field such as risk management, agile software development and project management. The duration of interviews was 10 – 15 minutes. The discussion was made on each proposed mitigation strategy proposed through semi-structured interviews. Practitioners shared their views and insights on the proposed mitigation strategies and their opinions and views are noted that helped in accepting and rejecting them.

4.6.2 Focus Group Results

For validating our proposed guidelines, focus group is conducted. Eight experts participated in it. The group briefly talked about the topic and share their ideas, thoughts, information as well as insights. Questions asked in focus group are shown in Appendix F. The Likert scale values for focus group responses are represented in Appendix G. After transforming values into a Likert scale

and calculating the average weighted value, you can determine the overall average value by dividing the total average value by the total number of average weight values, which equates to 1.1972. So, threshold value was set which was 1.1972 and the factors below these values are rejected and above this value are accepted. From total 50 values, 42 are accepted and 8 are rejected. Table 4.6 shows the rejected mitigation strategies.

Table 4.6: Results of Focus Group

1	No need to define ownership for high priority risks.
2	Ensure adherence to the defined protocols and procedures of risk response implementation.
3	Carry out frequent quality audits to assess and evaluate adherence to the measures of quality control.
4	Utilize feedback loops, like sprint retrospectives or regular reviews with stakeholders to identify requirements changes.
5	Design a comprehensive and detailed structure for risk management that clearly define the overall approach, roles, processes, and responsibilities for risk management.
6	Try to involve the whole project team
7	Utilize the right tools and methods for assessing risks
8	Engage external industry experts what are expert in implementation of risk responses. Take advice, guidance and support for implementing risk responses. Seek their guidance, advice, and support during the implementation phase.

Through focus group total 84% of total are accepted values and other are rejected.

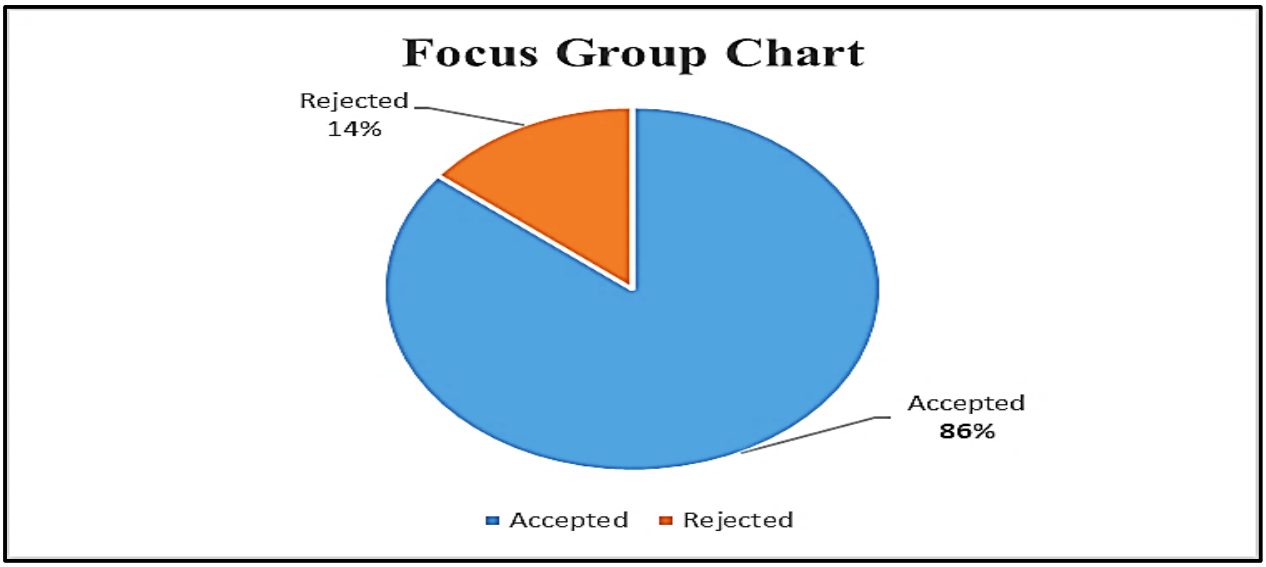

Figure 4.4: Percentage of accepted and rejected values

4.7 Modifying the Agile Board: Integrating PMBOK Risk management Steps in Agile Technique

In this part of the thesis, practical strategies were presented for modifying the agile board to enhance risk management practices in agile-based software development. The agile methodology, known for its iterative approach to project management, provides a robust foundation for software development. Integrating phases of risk management in agile board increases awareness and encourages a proactive mindset towards risk identification and mitigation. It enables every member to get a complete understanding of the identified risks, as well as their status, and the related mitigation strategies.

However, the traditional Scrum board, as shown in figure 4.5 consisting of columns such as "To Do," "In Progress," and "Done," lacks specific provisions for comprehensive risk management. By incorporating risk management steps into the agile board, the risk management process becomes seamlessly integrated with the overall Agile development approach. This ensures that risk management activities are not treated as standalone processes but are part of the team's regular workflow, leading to better alignment and collaboration. Figure below shows the standard scrum board.

Figure 4.5: Standardized Agile Board [67]

It is beneficial to integrate phases of risk management derived from the Project Management Body of Knowledge (PMBOK) into the agile board. The PMBOK is a widely recognized standard for project management that offers a proper systematic guide for identification, analysis, and responding to risks throughout the project lifecycle.

Identify Risks:

Within the "To Do" column, create a subsection specifically dedicated to identifying risks. Team members can add sticky notes or cards to represent identified risks in this section.

Perform Qualitative Risk Analysis:

Move the identified risks from the column named "To Do" to the second "In Progress" column when the team begins the qualitative risk analysis process. Assign a specific color code or label to represent the risk severity or impact level.

Perform Quantitative Analysis of Risks:

Once the risks are analyzed qualitatively, move the risks that require further quantitative analysis from the "In Progress" column to a separate subsection within the same column. This subsection represents the ongoing quantitative risk analysis process.

Develop Risk Response Strategies:

Within the "In Progress" column, create a subsection for developing risk response strategies. As the team identifies appropriate response strategies for each risk, move the risks and their corresponding response plans into this subsection.

Implement Risk Response Plans:

Move the risks with their associated response plans from the "In Progress" column to the "Done" column as the team implements the response plans. This indicates that the response plans are completed or in progress.

Within the "In Progress" column, create another subsection specifically for monitoring and controlling risks. Move the risks that require ongoing monitoring into this subsection. The team can update the status of risks, track progress, and take necessary actions to control or mitigate the risks. Figure 4.6 shows the standardized agile board.

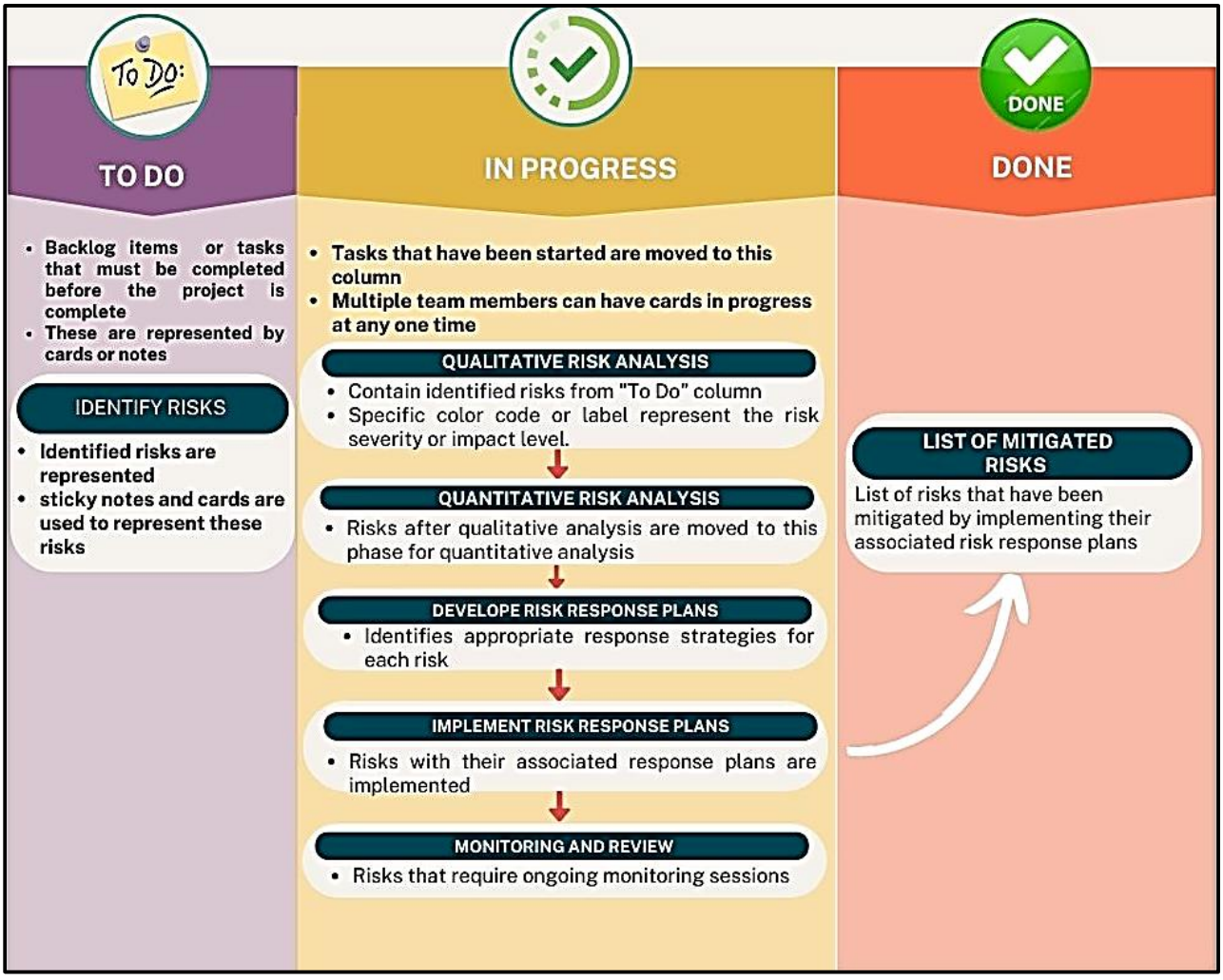

Figure 4.6: Modified agile board

This approach enables the team to visually track and manage risks within the established framework. It promotes transparency, collaboration, and alignment with scrum practices while incorporating risk management guidelines.

Our strategy outlines specific modifications to the agile board, ensuring the seamless integration of PMBOK risk management principles within the existing agile framework. By incorporating these strategies, software practitioners can actively find, analyze, and respond to risks, leading to improved project outcomes and increased stakeholder satisfaction. The proposed modifications to the agile board include the addition of dedicated sections or subsections to capture identification of risk, qualitative analysis and quantitative analysis of risk, response strategy development, risk response plan implementation, and ongoing monitoring risk and control. These modifications provide a visual representation of the risk management process, enhancing transparency, collaboration, and accountability within the Scrum team.

Through this research, the focus is to bridge the gap between agile methodologies and established risk management practices, fostering a holistic approach to software development. By integrating PMBOK risk management steps into the agile board, software development teams can effectively address potential risks, mitigate their impact, and achieve successful project outcomes in a dynamic and evolving environment.

4.8 Threats to Validity

In conducting this research study, we need to be focused on several factors while generalizing the results.

4.8.1 Internal Validity

To maintain the internal validity of our research, various experiments and methods such as structured interviews, questionnaires, and focus group discussions are utilized. Furthermore,

research variables are carefully defined and controlled to ensure that other factors did not influence our findings. Our choice of data analysis techniques, was deliberate to uphold the accuracy and reliability of our results.

4.8.2 External Validity

In order to uphold the external validity of our research, it was endeavored to apply the findings to different contexts. Diverse demographic groups and geographic areas were included to support the generalizability of the results. Additionally, we designed our research and methodology in ways that could be useful to other researchers, enhancing the credibility and external generalizability of our findings.

4.9 Summary

In this chapter analysis on survey results is performed in order to accept or reject the factors that are identified through SLR. On the basis of acceptance and rejection criteria factors that fulfilled the defined criteria got accepted and remaining factors got rejected. After acceptance and rejection of each factor the reason of acceptance and rejection of each factor with average weightage value against each factor is illustrated. After explaining the reason behind acceptance and rejection against each factor the accepted factors are discussed in detail in order to get a deep insight of those factors. The proposed approaches aimed at addressing the challenges uncovered during the systematic literature review (SLR) are explored. A comprehensive discussion was done on each strategy designed to alleviate the identified challenges, providing a detailed account of how each strategy contributes to mitigating these issues. Following the in-depth elucidation of these mitigation guidelines, focus group interviews are employed to assess the efficacy of the proposed strategies.

CHAPTER 5

CONCLUSION AND FUTURE RECOMMENDATIONS

5.1 Conclusion

This section summarizes all findings of the study as well as the brief contributions provided in the thesis in the form of RQ1 and RQ2. This chapter discusses the study's future directions. The study was carried out in order to recognize the PMBOK risk Management process issues during its application in scrum-based software development.

In this study, issues that arise as a result of lack of implementation of risk-management processes in scrum-based development of software. Key challenges are identified by conducting a comprehensive literature review and by surveying software organizations, and then mitigation strategies are proposed by carrying out semi-structured interviews with industry professionals. This study's findings contribute to the improved knowledge about successful risk management in scrum-based projects.

Our research has emphasized the significance of integrating risk management practices within the scrum framework. Organizations can improve their abilities to successfully identify, evaluate, monitor, and respond to risks by adopting the risk management approach outlined in the PMBOK and adapting it to incremental and iterative nature of scrum method. The suggested strategies, that are based on the experiences of industry professionals, provide practical solutions for easily incorporating risk management in scrum-based software projects.

5.2 Reviewing Research Questions

There are two main questions that divide the research. Finding solutions to these research questions is the major objective of this study. The main aim was to figure out the answers to these two questions, which are:

RQ1: What are the risk management challenges in scrum-based software development?
RQ2: What risk management guidelines will be helpful in mitigating risks in software development in Pakistani software development?

5.2.1 Examining RQ1

The first question of the research was the critical step in determining the number of significant challenges or issues encountered by development teams while practicing PMBOK risk management processes in scrum methodology.

The goal of the study question was to generate a list of issues that the scrum teams face as a result of a missing risk management techniques. To answer the study questions, a suitable research approach using a variety of techniques was used.

During the first phase of SLR, a total of 51 main papers are chosen by searching digital libraries such as Science Direct, IEEE Xplore, ACM, and Wiley Online Digital Library etc. Results of SLR were list of 15 serious challenges. Understanding the problems resulting from the absence of risk management methods is greatly aided by the methodical review of existing literature.

Moreover, a survey was carried out to collect the data needed to answer the first question of the research. It was carried out to gather information needed to answer the first research questions. As a result, the questionnaire was carefully designed with the criteria in mind. 302 people from all across Pakistan who work in the software industry and have many years of expertise

in various team positions have replied to the poll. Survey facilitated in determining and validating difficulties or challenges.

The survey's findings are greatly significant as the regional community of Pakistan responded to it. The results of survey have been evaluated, organized and presented in a tabular form. Out of 15 challenges encompassing the important areas of process of risk management in agile, the average weightage values were calculated to determine which challenges should be accepted and which should be rejected for the next research. Eleven challenges were accepted and four were rejected.

The accepted challenges were Planning and documentation issues, Changing requirements risk prediction issues, High priority risk mitigation Issues, In sufficient risk identification, Lack of expertise, Planning risk response strategy, Schedule cost and quality control issue, Lack of productivity performance, Lack of expertise, and the security issues. The rejected challenges were Resource estimation issues, Risk estimation and Definition Issues, Resistance to change, Mismeasurement of known risks.

The outcomes needed to address the first question of research are the issues that have been determined and accepted, but the number of risk management issues and challenges can be countless. Those found in the research study are carefully chosen and thoughtfully arranged to prevent recurrence.

5.2.2 Examining RQ2

The 2nd research question, focuses on finding solutions to the problems it discovered in its first research question, is built on further planning. The survey and the interviews both included the research question. It was crucial to understand that the majority of the software companies lacked policies for reducing risks associated with managing risk.

Interviews with experts in different roles, involving project managers, risk managers, quality assurance engineers, and testing team members, were used to generate the proposed guidelines. Each one of them has more than five years of expertise in their respective industries. Semi-structured questions were used during the interviews. Following that, focus group interviews were used to validate these risk mitigation strategies.

5.3 Research Contribution

Due to the lack of application of risk management techniques in agile techniques, the study has helped to highlight important issues faced by development teams. Proposed mitigation strategies will be very helpful in addressing scrum risk management issues and their growing causes, as well as for getting the finest outcomes for scrum. Study also provides practical guidelines for implementing risk management by modifying agile board by integrating risk management in the standardized agile board. As soon as issues are identified, suggested strategies for solving them are also provided.

5.4 Limitations

Even though the accepted key challenges and the recommended mitigation strategies are carefully researched, reviewed and approved by experts in the field, the study has following limitations:

1. Since only one researcher conducted the literature review of this study, it's possible that some important facts, articles, or case studies were left out.

5.5 Future Work

There exist numerous directions for future work that can further enhance this topic, even though this research paper has made great progress in identifying the difficulties and suggesting mitigation strategies for the process of risk management in scrum-based development.

On the basis of experiences of professionals that the research study has missed something due to any reason, more risk management challenges may also be identified and added in the detailed list of recognized issues or challenges, and different mitigation strategies can be identified and provided for each risk management challenge.

5.6 Summary

Chapter 5 wraps up a study on challenges in managing risks in scrum-based software development, focusing on two key questions (RQ1 and RQ2). The research, involving a thorough literature review and a survey of 302 professionals in the Pakistani software industry, pinpoints 11 major challenges like planning, documentation, changing requirements, and security. The rejection of four challenges underscores careful selection to avoid repetition. For RQ2, the study suggests solutions through guidelines derived from interviews with industry experts, emphasizing the need to integrate risk management into the scrum framework for successful projects. The study sheds light on issues caused by the absence of risk management in agile methods, providing practical strategies for scrum projects and acknowledging limitations while proposing avenues for future research.

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Appendix A

Table A: Existing studies on risk management in scrum-based software development

No	Author name	Year	Contribution	Limitations
01	Syrine Chaouch[2]	2019	Six phase structure was presented that directs how RM can be combined with agile while taking scrum as an agile technique.	Merged qualitative and quantitative risk analysis in single phase thinking that quantitative has limited use.
02	Aalaa Albaderneh [7]	2015	Identify risks scrum software development. RM activities in agile development.	Additional search could be done on the Risk Management failure, why failure occur and how to solve it, Found limited strategies to reduce risks.
03	Muneeb Ali[105]	2016	Framework for risk management in a collocated environment. Framework involves nine phases.	RM planning phase was excluded which resulted in failure in establishment of common understanding of parameters/metrics.
04	Suprika Vasudeva[106]	2019	Identify potential risks associated with globally distributed agile software development and propose a framework for effectively managing these risks.	The paper lacks future insight. Limited risk areas are identified. Framework did not follow proper risk management principles.
05	Emam Hossain[107]	2019	Highlight the primary obstacles arising from the global distribution of projects that limit the application of Scrum and discuss the approaches project managers employ to address these challenges. Framework designed to overcome challenges.	No proper RM principles are applied in designing a framework.

06	Nitin Uikey[108]	2015	A conceptual model or framework named Risk based Scrum Method (RBSM).	The model provided focuses on a high-level overview of risk management in Scrum, rather than delving into a detailed breakdown of every aspect of the process. Risk Management planning and risk response implementation phase is not included in this framework.
07	Esha Khanna[109]	2021	Novel AI framework for risk management in DASD. Framework will automate RM process in DASD.Current challenges in risk management in agile processes are highlighted.	No guidelines were presented to support the work.
08	Breno Gontijo Tavares[41]	2019	Emphasizes the significance of risk management practices during daily meetings, increment development, prototype creation, product backlog management, and Sprint planning as crucial for enhancing overall risk management effectiveness. Challenges in agile software development.	Limited practices are considered. No solutions provided for overcoming these challenges.
09	Mahdi Mousaei[110]	2018	Outline a framework that integrates PRINCE2 risk management principles into the Scrum development process for effective risk management.	The absence of expertise and team knowledge leads to outcomes that are not universally applicable across all teams due to variations in organizational culture. Model failed to use RM principles.
10	Roque Rabechini Junior[101]	2013	Risk management practices boost project success. Emphasized the value of soft skills in risk management.	The study used a non-random sample and relied on how respondents personally saw project success, which might introduce bias into the research findings.

11	Rahul V. Dandage, Shankar S. Mantha[111]	2017	Describes risk categories and obstacles in local and global projects. Key barriers include lack of top management support, training, and addressing cultural differences	Neglected service sector project management, missing potential risk management opportunities.
12	Marcel Vieira Jean C. R. Hauck Santiago Matalonga[85]	2020	Integration of risk management in Agile. Scrum as a popular Agile method for risk management. Agile methods support risk management practices.	Lacks future perspective.
13	Mohammad Kishk and Chioma Ukaga [19]	2018	Examine the impact of effective risk management on project success. Findings show project failures are linked to risk management levels. Continuous risk management enhances project success throughout the lifecycle.	Lacks future perspective. Fails to address the why of risk management. Omits challenges in implementation.
14	Risto Tiusanen[112]	2017	Importance of qualitative risk analysis, Strengths, methods, and techniques used for qualitative risk analysis.	The paper did not discuss the impacts of missing qualitative risk analysis.
15	Muhamed Nabawy Laila M. Khodeir[84]	2020	Systematic review of quantitative analysis in global Mega Projects construction. Benefits for practitioners and contractors using quantitative risk analysis. Quantitative risk analysis enhances decision-making in risk management.	Targeted research work should be greater.
16	Vanita Bhoola, S B Hiremath[83]	2014	Examines risk response strategies in Indian software projects. Discusses ATMA risk management approach: Avoidance, Transference, Mitigation, and Acceptance.	Methods used to implement risk response strategies were not discussed.
17	Bibhash Roy, Ranjan Dasgupta[91]	2016	Determine significant risk factors and types at each stage of the Software Development Life Cycle (SDLC).	The paper lacks future insights.

			Align risk management models with distinct SDLC phases.	
18	Benjamin Gold Clive Vassell[31]	2015	Discuss the effective integration of risk management with agile methodologies to maintain balance. Examine potential benefits and limitations when applying risk management in Scrum projects.	Risks that can arise in scrum software development were not listed.
19	Muhammad Hammad Irum Inayat Maryam Zahid[43]	2019	Examine the risks encountered by Agile practitioners and the strategies employed for mitigation. Findings indicate that practitioners most commonly face risks related to project deadlines and changing requirements.	Major limitations is the biasness in population selection.
20	Muhammad Akil Rafeek[113]	2019	SLR was conducted to identify techniques for risk mitigation in agile GSD.	Collected data is on the individual level.
21	Ana Beatriz Chiste Brandao[114]	2014	Elaborate both technical and managerial risk management issues in scrum software development. Discuss the impact of employing the Scrum methodology on the outcomes of the risk management process within software projects.	The analysis of the risks associated with changing project methodologies is not taken into account. No solutions provided for resolving issues.
22	Farwah Aizaz[115]	2021	Identify the elements contributing to scope creep within the context of Agile Global Software Development (AGSD) and examine its impact on the risk management process. Propose a model designed to aid Agile practitioners in efficiently managing scope creep.	The efficiency of the proposed model may face challenges when applied in real-world scenarios
23	Mohammed Neamah Ahmed[12]	2019	Suggested a risk management framework for construction projects that is constructed upon the principles of Agile management.	Framework was not evaluated. No risk management challenges were highlighted.
24	Breno Gontijo Tavares, Carlos Eduardo Sanches da Silva [44]	2016	Survey was conducted to assess how risk management is implemented in Scrum.	Framework was not properly designed. Challenges due to incomplete risk

			Present risk management practices and principles to get the reliable product.	management were not mentioned.
25	Le Gia Cuong[116]	2019	Suggest a model for the integration of Risk Management into Agile projects, with its effectiveness demonstrated through a case study. Risk due to improper risk management processes were highlighted.	Model did not use proper risk management processes for agile projects.
26	Breno Gontijo Tavares, Mark Keil[9]	2021	Create and assess a software tool designed for risk management in software development projects employing agile methodologies.	Tool did not support risk response planning process or risk management.
27	Muhammad Hammad[117]	2019	Integrate risk management process in Scrum framework, Controlled experiments were performed to validate framework.	Target population was small. No RM principles were highlighted.
29	Victor Muntés Mulero[87]	2018	The primary difficulties associated with risk management in agile software development. Propose framework that support continuous development and solve challenges.	Framework was not based on risk management principles.
30	Martin Tomanek [118]	2015	A survey was undertaken to explore prevailing practices in agile project management, while also introducing a novel integration framework that emphasizes risk management, combining Scrum and PRINCE2.	Results obtained from survey were not generalizable.
31	Katarína Buganova[53]	2019	Risk management and project management challenges were elaborated. Discussed challenges in agile and traditional development.	Mitigation strategies for these challenges were not given.
32	Breno Gontijo Tavares[119]	2017	A qualitative survey was conducted to examine the execution of Risk Management (RM) within the Scrum framework. RM challenges and scrum practices were identified.	Limited RM challenges discussed.

33	Bassam A. Hussein[78]	2014	Qualitative analysis was done to find RM issue in scrum software development.	No model was given for the implementation of proper risk management practices to overcome these issues.
34	Sharon Coyle[120]	2019	Compare RM process between traditional and agile development. Risk factors for various project types were identified.	No specific limitations were found.
35	Shahla Ghobadi[73]	2017	Risk elements and corresponding resolution actions have been identified, along with a proposed model for mitigating risks associated with knowledge sharing in agile software development.	Only two software companies were targeted. Findings were limited to only four agile projects.
36	Er. Jaspreet Kaur[121]	2020	Risk management processes and risk categories are discussed. Types of risks in agile software development methodologies.	All the challenges do not have their mitigation strategies discussed.
37	Sunil Kumar Khatri[32]	2014	A case study was employed to uncover problems and obstacles within Scrum software development.	Only five main issues and challenges of scrum were highlighted.

Appendix B

Table B: Data Extraction Form for SLR conduction

Entities Name	Relevant Details
Reference ID:	001
Publisher Name:	SCITEPRESS – Science and Technology
Article Title:	A risk management framework for scrum projects
Article Type:	Conference Paper
Year:	2021
Article published in:	ICEIS 2021 - 23rd International Conference on Enterprise Information Systems
Methodology Applied:	Literature Review
Contribution and Significance:	RIMPRO framework for risk management
Quality Evaluation Score:	0.78
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Requirement gathering and quality related issues

Entities Name	Relevant Details
Reference ID:	002
Publisher Name:	ELSEVIER
Article Title:	A framework for risk management in Scrum development process
Article Type:	Conference Paper
Year:	2019
Article published in:	CENTERIS - International Conference on ENTERprise Information Systems
Methodology Applied:	Case study
Contribution and Significance:	Framework for risk management in agile is proposed.
Quality Evaluation Score:	0.60
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Requirement prioritization related challenges.

Entities Name	Relevant Details
Reference ID:	003
Publisher Name:	IEEE
Article Title:	Risk management in agile software development: a comparative study

Article Type:	Conference Paper
Year:	2015
Article published In:	2015 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies (AEECT)
Methodology Applied:	Literature Review
Contribution and Significance:	Comparative study of risk management in traditional and agile software development.
Quality Evaluation Score:	0.56
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Traditional and agile risk management related challenges.

Entities Name	**Relevant Details**
Reference ID:	004
Publisher Name:	Pak Academy of Sciences
Article Title:	An Empirical Study and a Framework for Effective Risk Management in Scrum
Article Type:	Research Article
Year:	2016
Article published In:	PAS journal Science Vision
Methodology Applied:	Empirical study
Contribution and Significance:	Type of risks faced by scrum teams and framework proposed for risk management.
Quality Evaluation Score:	0.9
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Traditional and agile risk management related challenges.

Entities Name	**Relevant Details**
Reference ID:	005
Publisher Name:	IEEE
Article Title:	Artificial Intelligence based risk management framework for distributed agile software development
Article Type:	Conference Paper
Year:	2021
Article published In:	8th International Conference on Signal Processing and Integrated Networks (SPIN)
Methodology Applied:	Literature Review
Contribution and Significance:	AI based framework for managing risks in agile software development.
Quality Evaluation Score:	0.66
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Current challenges in risk management in DASD

Entities Name	Relevant Details
Reference ID:	006
Publisher Name:	IEEE
Article Title:	Integrating Risk Management in Scrum Framework
Article Type:	Conference Paper
Year:	2018
Article published In:	International Conference on Frontiers of Information Technology (FIT)
Methodology Applied:	Literature Review and case study
Contribution and Significance:	Practical framework for integrating risk management into the Scrum framework
Quality Evaluation Score:	0.74
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Failures in risk management

Entities Name	Relevant Details
Reference ID:	007
Publisher Name:	Taylor and Francis Group
Article Title:	A Risk Management Tool for Agile Software Development
Article Type:	Research Paper
Year:	2020
Article published In:	Journal of computer information systems
Methodology Applied:	Experimental Study
Contribution and Significance:	Tool for managing risks aligned with agile principles and practices, that can improve effectiveness of risk response planning.
Quality Evaluation Score:	0.63
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Problems due to lack of risk response planning

Entities Name	Relevant Details
Reference ID:	008
Publisher Name:	IEEE
Article Title:	People over Process: Key Challenges in Agile Development
Article Type:	Research Article
Year:	2011
Article published In:	IEEE Software journal

Methodology Applied:	Case Study
Contribution and Significance:	Addresses relevant and timely issue in the software industry, i.e. adoption and sustainability of agile methods
Quality Evaluation Score:	0.93
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Key people challenges faced by organizations that used agile methods

Entities Name	**Relevant Details**
Reference ID:	009
Publisher Name:	IEEE
Article Title:	Best Practices for Managing Risk in Adaptive Agile Process
Article Type:	Conference paper
Year:	2011
Article published In:	Proceedings of 3rd International Conference on Reliability, Infocom Technologies and Optimization
Methodology Applied:	Literature review
Contribution and Significance:	Proposed agile risk documentation practices
Quality Evaluation Score:	0.88
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Types of risks, challenges, or issues related to agile methodologies and risk management

Entities Name	**Relevant Details**
Reference ID:	010
Publisher Name:	IEEE
Article Title:	Models, techniques and metrics for managing risk in Software Engineering
Article Type:	Research article
Year:	2020
Article published In:	International Research Journal of Engineering and Technology (IRJET)
Methodology Applied:	Literature review and experimental study
Contribution and Significance:	Comprehensive and systematic review of various models, techniques, and metrics for managing risk
Quality Evaluation Score:	0.89
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Categories of risks are discussed

Entities Name	Relevant Details
Reference ID:	011
Publisher Name:	WILEY
Article Title:	Risks to effective knowledge sharing in agile software teams
Article Type:	Research article
Year:	2017
Article published In:	Journal of Information Systems
Methodology Applied:	Case study, qualitative research
Contribution and Significance:	Practical model for assessing and mitigating knowledge sharing risks in agile software development
Quality Evaluation Score:	0.63
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Communication issues of risk management in agile are discussed

Entities Name	Relevant Details
Reference ID:	012
Publisher Name:	IEEE
Article Title:	Practical insight about risk management process in agile software projects in Norway
Article Type:	Conference paper
Year:	2014
Article published In:	2014 IEEE international technology management conference
Methodology Applied:	Qualitative interviews
Contribution and Significance:	Identifies methods and practices used by practitioners to handle risks and share risks with customers
Quality Evaluation Score:	0.96
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Lack of formal documentation, communication issues, and contract ambiguity.

Entities Name	Relevant Details
Reference ID:	013
Publisher Name:	WILEY
Article Title:	Risk management analysis in software projects which use the scrum framework
Article Type:	Conference Paper
Year:	2019

Article published In:	The 28th International Conference on Software Engineering & Knowledge Engineering
Methodology Applied:	Case study
Contribution and Significance:	Risk management model based on the Scrum consists of four phases: identification, analysis, response, and monitoring.
Quality Evaluation Score:	0.82
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Risks like poor identification, analysis, response, and monitoring, flexibility and adaptability

Entities Name	Relevant Details
Reference ID:	014
Publisher Name:	ELSEVIER
Article Title:	Risk management in traditional and agile r**isk** management
Article Type:	Conference Paper
Year:	2019
Article published In:	13th International Scientific Conference on Sustainable, Modern and Safe Transport (TRANSCOM 2019)
Methodology Applied:	Comparative analysis of traditional and agile risk management
Contribution and Significance:	Comparative analysis on how agile project management can offer more benefits for managing risks in complex and uncertain environments.
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Risks like scope creep, vague requirements definition etc

Entities Name	Relevant Details
Reference ID:	015
Publisher Name:	ACM
Article Title:	Risk Identification and Mitigation Processes for Using Scrum in Global Software Development: A Conceptual Framework
Article Type:	Conference Paper
Year:	2019
Article published In:	2019 16th Asia-Pacific Software Engineering Conference
Methodology Applied:	SLR
Contribution and Significance:	Conceptual framework and scrum practices and mitigation strategies
Quality Evaluation Score:	0.64
Exclusion/Inclusion status:	Included

Answer to Research Question 01:	Temporal, geographical and socio-cultural distance challenges in DASD

Entities Name	Relevant Details
Reference ID:	016
Publisher Name:	ACM
Article Title:	Practices to Improve Risk Management in Agile Projects
Article Type:	Research article
Year:	2019
Article published In:	International Journal of Software Engineering and Knowledge Engineering
Methodology Applied:	SLR
Contribution and Significance:	RM practices for daily meetings, increment, prototype, product backlog and Sprint planning
Quality Evaluation Score:	0.73
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Quality assurance and technology related challenges

Entities Name	Relevant Details
Reference ID:	017
Publisher Name:	The Science and Information Organization
Article Title:	A New Project Risk Management Model based on Scrum Framework and Prince2 Methodology
Article Type:	Research article
Year:	2018
Article published In:	International Journal of Advanced Computer Science and Applications
Methodology Applied:	SLR
Contribution and Significance:	Propose model by combining scrum framework and prince 2 to improve risk management
Quality Evaluation Score:	0.98
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Risk identification related challenges are discussed

Entities Name	Relevant Details
Reference ID:	018
Publisher Name:	Journal of technology management innovation
Article Title:	Understanding the Impact of Project Risk Management on Project Performance: an Empirical Study
Article Type:	Research article
Year:	2013

Article published In:	Journal
Methodology Applied:	Empirical Study
Contribution and Significance:	Empirical evidence that risk management practices have a positive impact on project performance, measured by cost, time, quality, and customer satisfaction
Quality Evaluation Score:	0.77
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Uncertainties and complexities in project environment

Entities Name	Relevant Details
Reference ID:	019
Publisher Name:	IEEE
Article Title:	Using risk management to balance agile methods
Article Type:	Conference Paper
Year:	2015
Article published In:	International Conference on Knowledge-Based Engineering and Innovation (KBEI)
Methodology Applied:	Mixed method approach
Contribution and Significance:	The study proposes a conceptual framework for integrating risk management into Scrum projects
Quality Evaluation Score:	0.69
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	lack of a clear definition of risk, Difficulty of identifying and assessing risks, the trade-off between flexibility and stability

Entities Name	Relevant Details
Reference ID:	020
Publisher Name:	IEEE
Article Title:	Risk Based Scrum Method: A Conceptual Framework
Article Type:	Conference Paper
Year:	2015
Article published In:	2nd International Conference on “Computing for Sustainable Global Development”
Methodology Applied:	Literature review, case study
Contribution and Significance:	General model for integrating risk management into Scrum
Quality Evaluation Score:	0.71
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Lack of guidelines, techniques, roles, processes, mechanisms, strategies

Entities Name	Relevant Details
Reference ID:	021
Publisher Name:	IEEE
Article Title:	Risk management framework in Agile software development methodology
Article Type:	Conference Paper
Year:	2023
Article published In:	International conference of Electrical and Computer Engineering (ICECE)
Methodology Applied:	Experimental approach
Contribution and Significance:	Propose framework that define risk management guidelines and principles
Quality Evaluation Score:	0.91
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Risk interdependencies problems

Entities Name	Relevant Details
Reference ID:	022
Publisher Name:	IEEE
Article Title:	Criticism of the Risk Management Process in Scrum Methodology
Article Type:	Conference Paper
Year:	2023
Article published In:	International Conference on Electrical and Information Technology (IEIT)
Methodology Applied:	Experimental approach
Contribution and Significance:	Propose framework that define risk management guidelines and principles
Quality Evaluation Score:	0.89
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Risk estimation problems

Entities Name	Relevant Details
Reference ID:	23
Publisher Name:	IEEE
Article Title:	A Review of Risk Management in Agile Development
Article Type:	Conference Paper
Year:	2022

Article published In:	International Conference on Electrical and Information Technology (IEIT)
Methodology Applied:	SLR
Contribution and Significance:	Strengths and limitations of risk management
Quality Evaluation Score:	0.66
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Risk definition issues, failure in integrating RM activities, Scaling RM between multiple team

Entities Name	Relevant Details
Reference ID:	024
Publisher Name:	IEEE
Article Title:	Poor Risk Management as One of the Major Reasons Causing Failure of Project Management
Article Type:	Conference Paper
Year:	2011
Article published In:	International Conference on Management and Service Science
Methodology Applied:	Literature Review
Contribution and Significance:	Strategic efforts to overcome poor risk management
Quality Evaluation Score:	0.98
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Challenges in dealing with poor RM

Entities Name	Relevant Details
Reference ID:	025
Publisher Name:	IEEE
Article Title:	A Review on Risk Management Framework for large scale scrum
Article Type:	Conference Paper
Year:	2022
Article published In:	International Conference on Computational Modelling, Simulation and Optimization (ICCMSO)
Methodology Applied:	Literature Review and comparative analysis
Contribution and Significance:	Novel framework that uses metadata requests to manage the risks
Quality Evaluation Score:	0.79
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Challenges in large scale agile projects

Entities Name	Relevant Details

Reference ID:	026
Publisher Name:	Institute of Advanced Engineering and Science (IAES)
Article Title:	A Risk Management Framework for Distributed Scrum using PRINCE2 Methodology
Article Type:	Journal paper
Year:	2020
Article published In:	ICASA
Methodology Applied:	Literature Review and comparative analysis
Contribution and Significance:	Provide hybrid model to mitigate risks
Quality Evaluation Score:	0.81
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Risk management challenges

Entities Name	Relevant Details
Reference ID:	027
Publisher Name:	This journal is published by the Institute of Advanced Engineering and Science (IAES)
Article Title:	A novel risk management model in the Scrum and extreme programming hybrid methodology
Article Type:	Journal paper
Year:	2023
Article published In:	International Journal of Electrical and Computer Engineering (IJECE)
Methodology Applied:	Case study
Contribution and Significance:	Practical implications and recommendations ti improve RM
Quality Evaluation Score:	0.84
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Lack of documentation, frequent changes and flexibility

Entities name	Relevant details
Reference id:	028
Publisher name:	Aircc publishing corporation
Article title:	Project risk management model based on prince2 and scrum frameworks
Article type:	Journal paper
Year:	2015
Article published in:	International journal of software engineering & applications (ijsea)
Methodology applied:	Case study, literature review and survey

Contribution and significance:	Practical implications and recommendations for software developers, managers, and researchers who want to adopt or improve risk management
Quality evaluation score:	0.65
Exclusion/inclusion status:	Included
Answer to research question 01:	Communication and response strategies planning issues

Entities Name	Relevant Details
Reference ID:	029
Publisher Name:	IGI GLOBAL
Article Title:	Risk Management in Software Development Projects: Systematic Review of the State-of-the-Art Literature
Article Type:	Journal paper
Year:	2020
Article published In:	International Journal of Open-Source Software and Processes
Methodology Applied:	SLR
Contribution and Significance:	analysis. The paper also proposes new strategies and perspectives for risk management in software development
Quality Evaluation Score:	0.97
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Challenges related to risk analysis are discussed

Entities Name	Relevant Details
Reference ID:	030
Publisher Name:	IEEE
Article Title:	Risk Mitigation Strategies in Implementing Scrum Framework for Internet-Based IT Companies in Indonesia
Article Type:	Journal paper
Year:	2020
Article published In:	Indonesian Journal of Information Systems
Methodology Applied:	Literature Review
Contribution and Significance:	Risk mitigation framework for implementing Scrum in internet-based IT companies
Quality Evaluation Score:	0.80
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Lack of Scrum knowledge and training, resistance to change etc

Entities Name	Relevant Details
Reference ID:	031
Publisher Name:	IEEE

Article Title:	An Alternative Approach for Risk Assessment in Scrum
Article Type:	Conference Paper
Year:	2015
Article published In:	Intl. Conference on Computing and Network Communications (CoCoNet'15), India
Methodology Applied:	Case study
Contribution and Significance:	enhance the quality and success of Scrum projects by reducing the uncertainty and complexity associated with software development
Quality Evaluation Score:	0.75
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Formal risk analysis, ignoring interdependencies, imbalance between agility and risk management

Entities Name	Relevant Details
Reference ID:	032
Publisher Name:	Springer
Article Title:	Analysis of interactions among barriers in project risk management
Article Type:	Journal Paper
Year:	2017
Article published In:	Journal of Industrial Engineering International
Methodology Applied:	Interpretive structural modelling (ISM) and MICMAC analysis to analyze the interactions among the barriers and prioritize them.
Contribution and Significance:	Identify various risk categories enhance the effectiveness and efficiency of project risk management by using a systematic and rigorous approach.
Quality Evaluation Score:	0.66
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Lack of awareness and knowledge, lack of adequate resources and support, lack of integration and coordination

Entities Name	Relevant Details
Reference ID:	033
Publisher Name:	IEEE
Article Title:	People Over Process: Key People Challenges in Agile Development
Article Type:	Journal Paper
Year:	2011
Article published In:	IEEE Access journal
Methodology Applied:	Case Study

Contribution and Significance:	Challenges faced by organizations that have used agile methods for more than three years
Quality Evaluation Score:	0.66
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Challenges related to implementing agile

Entities Name	Relevant Details
Reference ID:	034
Publisher Name:	IEEE
Article Title:	Criticism of the Risk Management Process in Scrum Methodology
Article Type:	Conference Paper
Year:	2022
Article published In:	2022 International Conference on Electrical and Information Technology (IEIT)
Methodology Applied:	Case study
Contribution and Significance:	Use of Long Short-Term Memory (LSTM) and Multinomial Naive Bayes (MNB) for risk prioritization
Quality Evaluation Score:	0.77
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Challenges related to integrating scrum and prioritizing risk in risk management framework

Entities Name	Relevant Details
Reference ID:	035
Publisher Name:	IEEE
Article Title:	A List of Risks and Mitigation Strategies in Agile Projects
Article Type:	Conference Paper
Year:	2021
Article published In:	Computer Science Society (SCCC) International Conference Chilean
Methodology Applied:	SLR
Contribution and Significance:	To assist project managers and teams to address potential challenges
Quality Evaluation Score:	0.84
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Common risk in agile software development

Entities Name	Relevant Details
Reference ID:	036
Publisher Name:	IEEE
Article Title:	PROJECT RISK MANAGEMENT MODEL BASED ON

	PRINCE2 AND SCRUM FRAMEWORKS
Article Type:	Journal Paper
Year:	2015
Article published In:	The International Journal of Software Engineering & Applications (IJSEA)
Methodology Applied:	Survey
Contribution and Significance:	Current practices in agile project management, Integration framework of Scrum and PRINCE2 with focus on risk management.
Quality Evaluation Score:	0.74
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Challenges associated with risk management practices

Entities Name	Relevant Details
Reference ID:	037
Publisher Name:	ACM
Article Title:	Towards a Recommender System-based Process for Managing Risks in Scrum Projects
Article Type:	Research Article
Year:	2023
Article published in:	Proceedings of the 38th ACM/SIGAPP Symposium on Applied Computing
Methodology Applied:	Design science research methodology
Contribution and Significance:	Novel process to complement Scrum framework using a recommender system to recommend risks and response plans for a target project, given the risks registered for similar projects
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Technical, Process, Project management and Stakeholder

Entities Name	Relevant Details
Reference ID:	038
Publisher Name:	ACM
Article Title:	Risk Mitigation Techniques in Agile Development Processes
Article Type:	Journal Article
Year:	2019
Article published in:	Int. J Sup. Chain. Mgt
Methodology Applied:	SLR
Contribution and Significance:	Risk mitigation technique for sustainable development is designed to achieve time efficiency improvements to obtain greater resources at lower cost and thereby gain and maintain a competitive advantage.

Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Geographical Distance, Socio-Cultural Distance, Temporal Distance

Entities Name	Relevant Details
Reference ID:	039
Publisher Name:	ACM
Article Title:	A Theory of Scrum Team Effectiveness
Article Type:	Journal Paper
Year:	2023
Article published in:	ACM Transactions on Software Engineering and Methodology
Methodology Applied:	M**ixed-method investigation**
Contribution and Significance:	Factors that contribute to the success of Scrum teams, Focuses on the effectiveness of scrum teams and provides insights into how they can be more productive and efficient.
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Team effectiveness related challenges

Entities Name	Relevant Details
Reference ID:	040
Publisher Name:	IEEE
Article Title:	Best practices for managing risk in adaptive agile process
Article Type:	Conference Paper
Year:	2014
Article published in:	International Conference on Reliability, Infocom Technologies and Optimization (ICRITO) (Trends and Future Directions)
Methodology Applied:	SLR
Contribution and Significance:	Analyzing agile methodologies and risk management model, amount of risk handling capabilities in agile and requirement of merging risk management in agile. Define the best practices to document risk in agile process
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Team structure/ Optimization of Velocity, Effort Estimation, Defining Ownership

Entities Name	Relevant Details
Reference ID:	041

Publisher Name:	WILEY
Article Title:	Risks to Effective Knowledge Sharing in Agile Software Teams: A Model for Assessing and Mitigating Risks
Article Type:	Research Article
Year:	2017
Article published in:	Information Systems Journal
Methodology Applied:	Empirical Study
Contribution and Significance:	Empirically-grounded and theoretically-informed model for the assessment and mitigation of risks to effective knowledge sharing in agile development
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Risks associated with knowledge sharing in agile software teams

Entities Name	Relevant Details
Reference ID:	042
Publisher Name:	Springer
Article Title:	Developing a framework to overcome communication challenges in agile distributed teams – Case study of a Mauritian-based IT service delivery centre
Article Type:	Journal Article
Year:	2021
Article published in:	Global Transitions Journal
Methodology Applied:	Case Study
Contribution and Significance:	Framework to overcome communication challenges
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Communication challenges such as language barriers, time-zone differences and trust issues

Entities Name	Relevant Details
Reference ID:	043
Publisher Name:	Elsevier
Article Title:	A Risk Management Framework for Distributed Agile Projects
Article Type:	Journal Article
Year:	2017
Article published in:	Information and Software Technology
Methodology Applied:	exploratory study
Contribution and Significance:	Risk management framework that comprises the perceived risks in DAD projects, their causes and the methods used in industry for managing those risks.
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Trust and expertise related issues

Entities Name	Relevant Details
Reference ID:	044
Publisher Name:	ACM
Article Title:	How Explicit Risk Management is Being Integrated into Agile Methods: Results from a Systematic Literature Mapping
Article Type:	Conference Paper
Year:	2021
Article published in:	Proceedings of the XIX Brazilian Symposium on Software Quality
Methodology Applied:	Systematic Literature Mapping (SLM)
Contribution and Significance:	integrating explicit risk management with Agile methods are positive, encompassing improved communication, improved product quality, increased risks visibility, cost reduction, improved team efficiency and time-to-market reduction.
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	improved communication, improved product quality, increased risks visibility, cost reduction, improved team efficiency, and time-to-market reduction.

Entities Name	Relevant Details
Reference ID:	045
Publisher Name:	IEEE
Article Title:	Risk Management in Agile Software Development: A Survey
Article Type:	Conference Paper
Year:	2019
Article published in:	Frontiers of Information Technology (FIT)
Methodology Applied:	Survey
Contribution and Significance:	Risks faced by agile practitioners and the mitigation strategies used
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Risks faced by agile teams

Entities Name	Relevant Details
Reference ID:	046
Publisher Name:	IEEE
Article Title:	An Empirical Investigation of Factors Causing Scope Creep in Agile Global Software Development Context: A Conceptual Model for Project Managers
Article Type:	Research Article
Year:	2021
Article published in:	IEEE access journal

Methodology Applied:	SLR, Empirical study
Contribution and Significance:	Conceptual model for managing scope creep
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Impact of scope creep in agile development

Entities Name	Relevant Details
Reference ID:	047
Publisher Name:	Elsevier
Article Title:	Risk management in traditional and agile project management
Article Type:	Research Article
Year:	2019
Article published in:	13th International Scientific Conference on Sustainable, Modern and Safe Transport
Methodology Applied:	Comparative analysis
Contribution and Significance:	Importance of risk management and the possibilities of its implementation in traditional and agile approaches to project management.
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Challenges in implementing risk management in agile

Entities Name	Relevant Details
Reference ID:	048
Publisher Name:	IET Software
Article Title:	Agile risk management for multi-cloud software development
Article Type:	Research Article
Year:	2020
Article published in:	Security and Privacy in Cloud-based Systems
Methodology Applied:	Literature review
Contribution and Significance:	framework to manage risks in agile software development
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Challenges in risk management for agile software development

Entities Name	Relevant Details
Reference ID:	049
Publisher Name:	ACM
Article Title:	Risk Management for Agile Projects in Offshore Vietnam
Article Type:	Research Article
Year:	2019

Article published in:	Proceedings of the 10th International Symposium on Information and Communication Technology
Methodology Applied:	Mixed methods research
Contribution and Significance:	Risk management framework that is tailored to the specific needs of offshore agile projects in Vietnam.
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	challenges of risk management in agile projects

Entities Name	Relevant Details
Reference ID:	050
Publisher Name:	Springer
Article Title:	A Study on Software Risk Management Strategies and Mapping with SDLC
Article Type:	Research Article
Year:	2015
Article published in:	Advanced Computing and Systems for Security
Methodology Applied:	Literature Review
Contribution and Significance:	Comprehensive analysis of risk management strategies and their mapping with the SDLC
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	key risk factors and risk types for each phase of the SDLC

Entities Name	Relevant Details
Reference ID:	051
Publisher Name:	Springer
Article Title:	An Assessment of Risk Response Strategies Practiced in Software Projects challenges
Article Type:	Journal Article
Year:	2014
Article published in:	Australasian Journal of Information Systems
Methodology Applied:	Literature Review
Contribution and Significance:	Explore four fundamental treatments to risk response - Avoidance, Transference, Mitigation, and Acceptance (ATMA) - and analyze the risk response factors that lead to successful achievement of project scope & quality, schedule, and cost targets.
Quality Evaluation Score:	0.61
Exclusion/Inclusion status:	Included
Answer to Research Question 01:	Risk related to response strategies

Appendix C

Table C: Survey questionnaire for industrial practitioners

DEMOGRAPHIC INFORMATION

1. **Your Age?**
   - <30
   - 30 – 40
   - 40-50
   - Above 50
2. **Gender**
   - Male
   - Female
3. **Size of your team**
   - <15
   - 154
   - 25-35
4. **Size of your team**
   - <15
   - 165
   - 25-35
   - 36-45
   - 45>
5. **Experience in Scrum Methodology**
   - 0-3 Year
   - 4-7 Year
   - 8DA0 Year
   - More than 10 Years

CORE QUESTIONS

6. Failure in estimating risks of changing requirements weakens the process of risk management.

i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

7. Proper documentation of risks associated with requirement changes allows software to run consistently and efficiently.

i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

8. Risk management process becomes more effective with clear and concise estimation of expected risks.
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

9. Incomplete identification of risks leads to software failure.
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

10. Estimation and allocation of resources becomes more efficient by removing the risks with higher impacts at priority.
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

11. Failure in identifying proper risk reduction strategies leads to resource estimation issues.
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

12. Do you think that improper planning for how a risk should be removed will cause damage to the company's reputation.
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

13. Improper planning to respond to risk results in more risk happening which can cause damage to the software product.
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

14. Failure to analyze the interdependencies of risks in risk management in scrum-based software development results in more risk happening and leads the risk management process towards failure.
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

15. Inability of team to avoid and minimize risks leads the software product to end up with unpredictable outcomes.
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

16. Lack of schedule, cost and quality control make the software product unreliable.
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

17. Failure to evaluate the effectiveness of the risk management process reduces software system productivity, performance, and security.
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

18. Risk management is more difficult when there are multiple projects involved because the high priority risks associated with each project must be prioritized.
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

19. Failing to consider already identified risks during the risk management process can cause enough harm in software development?
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

20. Quality Assurance is a challenge while working in an agile environment.
i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

21. Resistance to change causes many significant challenges in scrum-based software development?

i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

22. Which risk management process in your opinion is difficult to incorporate in scrum-based Software Development.

a. Risk management planning
b. Risk identification
c. Qualitative risk analysis
d. Quantitative risk analysis
e. Risk response planning
f. Risk response implementation
g. Risk monitoring

23. What are the common risks that your team has faced during scrum software development methodology.

1. Schedule risks
2. Budget risk
3. Technology risk
4. Architectural risk
5. Security risk
6. Deployment risk
7. People risk
8. requirement change risk
9. Other

24. Is risk management in Scrum based Software Development projects challenging?

a. Yes
b. No

25. What kind of technical issues has your team ever faced?

i)Lack of effective tools to support scrum processes
ii)Lack of effective communication tools
iii)Lack of organizational infrastructure
iv)Lack of trainings
v)Lack of globally shared product and sprint backlog
vi)Others

26. Failure in communicating risks to top management is very important for effective risk management. How often your team have faced this issue in agile software development?

i) Strongly Agree ii) Agree iii) Neutral iv) Disagree v) Strongly Disagree

Appendix D

Table D: Respondents responses from survey

	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	
R1	N	A	A	SDA	A	SA	DA	A	SDA	N	A	N	A	DA	SA	SDA	SA
R2	SA	DA	SA	DA	SA	A	DA	A	A	SA	SA	N	SA	A	DA	DA	A
R3	A	A	N	A	SA	A	A	N	N	A	A	A	SA	N	SDA	N	A
R4	DA	A	A	A	SDA	A	A	SA	A	A	A	A	SDA	A	A	A	N
R5	SA	SDA	N	SDA	SDA	DA	DA	N	A	SDA	A	SDA	SDA	DA	SA	N	N
R6	SA	A	A	A	A	A	SA	A	SA	N	SA	SA	A	N	SA	SA	SA
R7	N	A	N	A	SA	N	SA	A	SA	SA	N	A	SA	A	A	N	SA
R8	A	A	SA	SA	A	A	A	A	A	A	A	A	A	A	A	A	A
R9	A	SA	SA	SA	SA	A	DA	A	A	SA	A	A	SA	SA	A	A	A
R10	A	A	A	A	A	A	DA	DA	A	A	A	A	A	A	SA	A	A
R11	A	A	DA	A	A	DA	A	N	A	N	A	N	SA	A	A	N	N
R12	A	SA	A	SA	A	A	SA	A	SA	SA	SA	SA	SA	A	SA	A	A
R13	SA	A	N	SA	A	A	A	A	SA	A	A	A	A	A	SA	A	A
R14	SDA	DA	SD-	N	DA	DA	SD-	A	SA	SA	SDA	A	SA	N	SA	N	DA
R15	SDA	SD-	SD-	SDA	SA	DA	SD-	A	A	SA	SA	SA	SA	SA	SA	SA	A
R16	A	SA	N	A	DA	N	SDA	A	SA	N	SA	SA	SA	DA	SA	N	SA
R17	A	A	A	A	A	A	N	DA	SA	SDA	A	A	A	A	A	N	A
R18	A	DA	A	A	DA	DA	N	A	N	SA	SA	A	SA	DA	A	A	N
R19	A	SA	N	A	A	A	N	A	SA	SA	A	DA	SA	SA	SA	A	N
R20	SA	A	A	A	A	A	N	A	A	A	SA	A	SA	A	N	A	N

R43	R42	R41	R40	R39	R38	R37	R36	R35	R34	R33	R32	R31	R30	R29	R28	R27	R26	R25	R24	R23	R22	R21
A	N	A	A	A	A	SA	SA	SA	A	A	SA	A	SA	SA	A	N	SA	A	A	A	SA	A
DA	DA	A	SA	A	A	N	A	SA	A	SA	A	A	A	SA	SA	N	SA	SA	N	A	SA	N
A	N	N	SA	A	A	N	SA	A	A	N	A	SA	A	N	A	A	N	A	A	SA	SA	A
DA	A	SA	A	N	A	N	N	SA	A	N	SA	A	A	SA	SA	SA	SA	SA	A	N	SA	A
A	SA	A	A	A	A	SA	A	A	DA	DA	DA	A	A	A	N	A	A	DA	SDA	DA	SA	A
A	A	A	N	DA	A	N	DA	A	A	A	DA	A	A	SA	A	SA	N	A	DA	A	A	A
A	A	A	N	A	SA	N	N	DA	A	N	A	SA	SA	SA	SA	DA	SA	A	A	A	SA	N
A	SA	A	A	N	DA	A	A	N	A	N	N	A	A	A	SA	A	A	SA	A	A	SA	N
SA	N	A	SA	SA	SA	SA	SA	A	A	SDA	A	SA	A	SA	A	SA	A	A	SA	A	SA	SA
SA	SA	SA	SA	SA	A	N	SA	SA	SA	SA	SA	SA	A	SA	SA	SA	A	SA	N	SA	SA	DA
SA	SA	N	SA	A	A	A	A	A	A	A	SA	A	A	SA	A	A	A	SA	SA	A	SA	N
SA	SA	A	A	A	SDA	N	N	SA	A	A	A	SA	A	SA	N	SA	SA	SA	SA	A	SA	A
A	SA	A	A	A	A	SA	A	A	SA	SA	SA	A	SA	A	N	A	SA	SA	SDA	SA	SA	A
A	N	A	N	DA	A	N	A	N	A	N	DA	A	A	SA	DA	DA	N	SA	DA	A	SA	A
SDA	A	SA	A	SA	SA	SA	SA	SA	A	SA	SDA	A	SA	SA	DA	SA	SDA	SA	A	A	SA	SA
A	A	SDA	N	A	A	N	DA	N	A	SA	A	A	A	SA	N	DA	N	SA	A	A	SA	A
N	N	A	SA	SA	SA	A	SA	N	A	SA	A	N	A	A	SA	A	DA	A	A	A	N	A

R66	R65	R64	R63	R62	R61	R60	R59	R58	R57	R56	R55	R54	R53	R52	R51	R50	R49	R48	R47	R46	R45	R44
A	A	A	A	N	A	SA	A	SA	N	A	N	SA	N	A	SA	A	SA	DA	A	A	SA	SA
A	A	A	A	A	A	A	SDA	N	SA	N	SDA	SA	A	A	A	A	SDA	DA	A	A	A	SA
N	N	A	SA	N	SA	N	DA	A	SA	N	SDA	SA	DA	A	N	SA	SDA	N	A	N	N	SA
A	A	A	A	SA	A	A	N	DA	SA	SA	SA	SA	A	A	SA	A	SDA	N	N	A	A	A
A	SA	SA	A	A	A	A	SA	A	A	SA	DA	A	N	SA	A	A	A	SA	A	A	N	A
A	SA	A	A	N	A	A	A	A	N	DA	A	A	DA	A	A	A	SDA	DA	A	A	A	A
SA	A	SA	SA	SA	SA	SA	DA	A	SA	SA	N	SA	SDA	N	A	A	SDA	N	SA	SA	SA	SA
N	A	A	A	A	N	SA	DA	A	A	N	DA	SA	A	N	N	A	SA	A	A	A	N	N
N	A	A	A	SDA	SA	A	N	A	A	SDA	N	SDA	A	A	A	SA	SA	N	SA	A	DA	A
A	A	A	SA	SA	A	A	SA	A	A	SA	SA	SA	DA	DA	SA	A	SDA	DA	SA	SA	SA	SA
N	A	A	SA	A	A	A	A	A	A	A	DA	SA	A	A	A	SA	SDA	A	A	A	DA	A
A	SA	N	SA	SA	A	N	SA	SA	N	N	SDA	SA	DA	A	A	SA	SA	SA	N	N	N	A
A	SA	SA	A	A	A	A	SA	SA	SA	SA	DA	SA	N	SA	A	A	A	SA	A	A	N	A
A	A	A	SA	N	A	N	SDA	A	N	DA	A	SA	N	A	A	SA	SDA	DA	N	A	A	N
A	N	A	N	N	A	A	SA	SA	DA	A	SA	SA	SA	DA	A	N	SDA	A	A	SA	N	A
A	N	A	A	N	A	N	DA	A	N	SA	SDA	N	N	A	A	DA	SDA	N	A	N	A	A
A	A	A	SA	DA	N	A	A	N	N	A	N	N	N	A	A	SA	A	A	A	A	A	A

R92	R91	R90	R89	R88	R87	R86	R85	R84	R83	R82	R81	R80	R79	R78	R77	R76	R75	R74	R73	R72	R71	R70	R69	R68	R67
A	A	A	A	SA	A	N	A	SA	N	SA	A	DA	A	A	A	A	A	SA	A	A	A	A	A	A	A
SA	SA	N	A	SA	A	A	A	DA	A	A	A	A	A	A	A	A	SA	SA	SA	A	SA	SA	A	N	A
SA	SA	A	N	SA	N	A	N	N	A	SA	N	A	N	N	SA	N	N	SA	A	N	N	SA	N	A	N
A	A	N	A	SA	A	N	A	DA	N	SA	N	SA	SA	SA	SA	A	A	SA	N	A	N	A	A	N	SA
A	N	SDA	DA	DA	SDA	A	A	A	N	SA	A	A	A	A	A	SA	A	A	A	A	A	SA	A	SA	N
A	N	A	N	SA	N	SA	A	N	A	SA	A	N	A	A	A	A	SA	A	N	A	SA	A	A	N	A
SA	SA	A	A	SA	N	N	A	DA	SA	SA	SA	SA	SA	SA	SA	A	SA	SA	A	N	N	SA	A	A	SA
A	A	A	A	A	N	A	A	SDA	A	A	N	DA	A	A	A	N	N	A	A	A	A	N	N	A	A
A	A	A	DA	SA	DA	DA	A	A	N	A	N	A	A	SA	SA	A	SA	SA	A	A	A	N	A	SA	SA
A	A	A	SA	SA	A	A	SA	DA	A	A	SA	SA	A	SA	A	SA	DA	A	A	A	A	N	A	A	SA
A	A	DA	A	SA	A	A	SDA	N	A	A	A	A	A	A	SA	SA	A	SA	SA	A	SA	SA	A	A	SA
A	A	SA	A	SA	A	A	SA	DA	SA	SA	A	A	A	A	A	A	N	SA	A	A	SDA	SA	A	A	N
A	N	SDA	DA	SA	SDA	A	A	A	N	SA	SA	SA	A	A	A	N	A	A	A	A	A	SA	A	SA	N
A	A	A	SA	SA	A	A	N	N	SA	A	A	A	A	A	A	A	A	A	SA	A	N	N	A	A	N
SA	SA	SA	SA	A	SA	DA	A	N	DA	N	SA	A	SA	SA	A	SA	SA	A	A	N	A	SD	SA	DA	SA
A	A	A	A	SA	SD	DA	A	N	N	A	N	N	A	A	DA	A	N	A	N	N	N	DA	A	N	A
DA	A	A	A	N	A	A	A	A	SA	SA	N	A	A	A	N	A	A	N	A	A	A	SA	A	A	N

R114	R113	R112	R111	R110	R109	R108	R107	R106	R105	R104	R103	R102	R101	R100	R99	R98	R97	R96	R95	R94	R93
A	SA	A	A	A	DA	A	SA	A	SA	A	N	N	A	DA	A	SA	A	SA	SA	SA	A
A	SA	A	A	A	A	A	SA	A	SA	SA	SA	A	A	A	A	A	N	DA	A	SA	A
SA	SA	A	N	N	A	N	SA	N	N	N	N	A	N	SA	SA	A	A	SDA	A	N	N
SA	SA	A	A	A	A	N	SA	A	A	SA	SA	A	A	A	SA	A	A	DA	A	N	A
A	SA	A	A	A	A	DA	A	A	DA	A	A	A	A	SA	SA	A	A	A	DA	DA	DA
N	A	A	A	N	A	SA	SA	A	A	DA	SA	A	A	A	A	A	A	A	A	A	A
SA	SA	SA	SA	SA	SA	SA	SA	A	SA	SA	SA	N	A	N	SA	SA	SA	DA	A	A	A
A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	SDA	A	A	A
SA	SA	A	A	A	A	A	SA	A	SA	A	A	N	A	SA	DA	A	A	SDA	DA	A	A
A	SA	A	SA	A	SA	SA	DA	A	SA	SA	SA	SA	A	N	A	A	A	SA	A		A
A	SA	A	A	SA	SA	SA	A	A	A	SA	SA	A	A	A	A	SA	A	A	N	A	A
N	SA	SA	A	SA	SA	A	SA	SDA	A	A	SA	SA	A	DA	SA	A	A	DA	SA	A	A
A	SA	A	A	A	A	SA	A	A	SA	A	A	A	A	SA	SA	A	A	A	N	SA	SA
A	SA	A	A	A	A	A	A	A	SA	A	SA	SDA	A	A	A	N	A	N	A	SA	A
A	SDA	SA	N	SDA	N	SA	A	SDA	SA	SA	SA	SA	A	SA	DA	SA	SA	SA	N	DA	A
A	SA	SA	A	N	A	A	A	A	SA	A	A	SDA	A	DA	A	N	DA	DA	N	A	A
SA	SA	A	N	A	A	A	A	A	A	A	A	A	A	A	A	A	SA	A	DA	A	A

R133	R132	R131	R130	R129	R128	R127	R126	R125	R124	R123	R122	R121	R120	R119	R118	R117	R116	R115
A	N	A	A	SA	DA	A	A	A	SA	SA	SA	A	A	SA	A	A	SA	A
A	A	A	SA	SA	A	A	A	N	SA	SA	A	SA	A	SA	A	A	SDA	A
A	N	A	SA	N	N	A	N	A	A	SA	SA	SA	A	SA	SA	SA	N	A
A	A	A	SA	SA	A	A	SA	A	A	SA	A	A	A	A	N	A	N	A
A	A	A	DA	DA	DA	DA	DA	A	A	SA	A	N	A	SA	DA	A	A	A
A	A	A	A	A	A	A	SA	A	A	A	A	N	N	A	A	A	SA	SA
SA	SA	SA	SA	A	SA	A	A	N	A	SA	SA	N	A	SA	SA	N	SA	SA
A	A	A	SA	A	A	A	A	A	A	A	A	A	A	SA	A	A	A	DA
A	SA	A	SA	A	A	N	SA	A	A	SA	SA	A	A	A	A	A	N	A
A	A	A	A	SA	SA	SA	SA	A	A	SA	DA	A	A	SA	SA	SA	SA	SA
A	SA	A	SA	A	SA	N	SA	SA	A	SA	A	SA	A	SA	SA	SA	A	A
A	SA	A	SA	SA	A	A	A	A	A	SA	SA	A	A	SA	A	A	SA	A
A	A	A	SA	SA	SA	SA	SA	A	A	SA	A	N	A	SA	SA	A	A	A
A	A	A	SA	A	A	A	SA	A	A	SA	DA	N	A	SA	A	A	A	A
A	SA	A	A	A	SA	SA	SA	SA	SA	DA	SA	SA	A	DA	DA	DA	SA	SA
A	DA	A	SA	A	N	N	A	A	A	SA	A	A	N	A	SA	N	SA	N
SA	SA	SA	SA	SA	A	SA	A	A	SA	A	A	A	A	A	N	A	A	A

R151	R150	R149	R148	R147	R146	R145	R144	R143	R142	R141	R140	R139	R138	R137	R136	R135	R134
A	A	A	SA	A	A	N	N	SA	SA	SA	A	A	SA	SA	SA	A	SDA
N	N	A	SA	A	A	N	DA	SA	SA	A	A	A	SA	SA	SA	A	DA
SA	A	SA	SA	SA	N	N	A	SA	SA	N	SA	SA	SA	SA	N	A	DA
N	DA	A	SA	SA	SA	N	SA	SA	SA	A	N	A	SA	A	N	A	SDA
SDA	A	SA	SA	A	SA	SA	A	SA	A	A	A	SA	SA	SA	A	A	DA
SDA	SA	A	SA	SA	A	N	A	SA	A	A	A	A	A	A	A	A	DA
DA	N	SA	SA	SA	SA	SA	SA	A	SA	A	A	SA	SA	SA	SA	A	N
A	A	A	A	A	A	A	A	A	SA	A	A	A	A	A	A	A	A
N	A	A	SA	A	SA	N	N	A	SA	A	SA	SA	SA	A	SA	A	A
SA	SA	SA	SA	N	A	SA	SA	SA	SA	A	A	SDA	SA	DA	A	SA	DA
SA	A	A	SA	A	A	A	SA	SA	A	A	A	A	SA	A	SA	A	A
N	N	A	SA	A	SA	N	SA	A	SA	A	SA	SA	SA	A	A	A	A
SDA	A	SA	SA	A	SA	SA	A	SA	A	A	A	SA	SA	SA	A	A	DA
DA	N	A	SA	A	A	N	N	A	SA	A	SA	SDA	SA	A	A	A	SDA
SDA	SA	N	A	N	A	SA	A	A	A	SA	SA	SA	A	DA	SA	SA	SA
SDA	N	A	A	N	N	N	A	A	A	A	N	A	A	A	N	A	A
A	SA	N	SA	A	SA	SA	SA	SA	A	A	A	A	A	A	N	SA	N

R168	R167	R166	R165	R164	R163	R162	R161	R160	R159	R158	R157	R156	R155	R154	R153	R152
SA	A	A	A	A	A	A	A	A	DA	A	DA	N	SA	A	SA	A
A	A	A	DA	N	SDA	A	A	N	A	A	N	A	A	A	A	A
A	N	A	DA	A	SDA	A	N	A	A	N	N	A	N	SA	A	N
A	A	SA	SA	A	SA	N	SA	SA	N	A	N	A	A	SA	A	SA
SA	A	SA	N	A	N	SA	SA	N	A	SA	A	N	SA	SA	N	A
A	DA	A	A	A	A	DA	A	A	N	A	A	A	SA	A	DA	A
SA	SA	SA	SA	SA	N	N	SA	A	DA	SA	DA	SA	SA	SA	SA	SA
A	A	A	SDA	SDA	A	A	A	A	DA	A	A	A	N	A	A	A
N	SA	A	N	N	SA	A	A	N	SA	A	A	SA	N	A	SA	SA
A	N	A	SDA	A	SA	A	A	SA	A	SA	SDA	SA	A	N	N	A
A	A	A	SA	SA	N	A	A	N	A	A	N	N	SA	SA	SA	A
N	SA	A	A	A	A	A	A	SA	SA	SA	N	SA	A	A	SA	A
SA	A	SA	N	A	N	SA	SA	N	A	SA	A	N	SA	SA	N	A
N	A	A	A	A	N	A	A	N	A	SA	N	A	N	N	DA	N
SA	N	SA	SA	SA	SA	A	SA	SA	DA	SA	SA	A	SA	A	SA	A
N	N	A	SA	A	A	N	A	N	A	A	A	A	N	DA	DA	A
N	DA	SA	SA	SA	A	DA	N	SA	SA	A	A	A	SA	A	A	SA

R186	R185	R184	R183	R182	R181	R180	R179	R178	R177	R176	R175	R174	R173	R172	R171	R170	R169
SA	N	N	A	A	A	A	A	A	A	A	A	SA	SDA	SA	SA	A	A
SA	A	A	A	A	A	A	A	A	A	A	A	SA	N	A	A	A	A
SA	A	N	A	N	N	N	A	A	N	A	N	SA	A	SA	N	SA	A
SA	A	A	N	A	A	N	SA	A	N	A	A	SA	A	A	A	A	A
A	DA	A	A	N	N	A	SA	SA	SA	A	SA	N	A	SA	SA	SA	A
N	A	A	A	A	A	A	A	A	A	A	A	A	N	DA	N	A	A
SA	DA	A	N	SA	SA	A	A	N	A	A	A	SA	SA	DA	SA	SA	SA
A	A	A	A	A	A	N	A	A	A	A	A	A	A	SDA	A	A	A
SA	SA	N	A	A	A	A	A	SA	A	SA	SA	SA	DA	SA	A	A	A
A	SDA	A	N	SA	N	N	A	A	A	A	A	A	SA	SA	SA	SA	A
A	N	A	A	SA	SA	N	A	A	A	SA	SA	N	SA	DA	A	A	A
SA	N	A	A	N	N	N	A	A	A	A	A	SA	SA	N	N	N	A
A	DA	A	A	N	N	A	SA	SA	SA	A	SA	N	A	SA	SA	SA	A
SA	N	N	A	A	A	N	A	A	A	A	A	SA	N	A	A	A	A
SA	N	SA	N	SA	SA	A	SA	A	A	SA	DA	SA	A	SA	N	SA	N
SA	DA	SA	A	A	A	SA	A	N	A	N	A	SA	DA	DA	A	N	A
A	A	A	A	SA	A	A	N	A	A	A	SA	SA	A	A	DA	A	A

R204	R203	R202	R201	R200	R199	R198	R197	R196	R195	R194	R193	R192	R191	R190	R189	R188	R187
A	SA	SA	SA	SA	A	SA	N	A	N	A	N	A	A	SA	SA	SA	A
A	A	A	SDA	A	A	DA	A	A	N	SA	A	A	SA	SA	DA	N	SA
SA	N	A	N	A	A	SA	A	A	A	SA	N	A	A	SA	DA	A	N
SA	A	A	SA	A	A	SA	SA	SA	A	A	SA	A	SA	A	N	SA	N
SA	SA	A	DA	A	N	SA	A	SA	SA	SA	SA	N	A	SA	A	SA	DA
A	N	A	DA	A	A	A	N	A	N	SA	A	A	A	SA	A	A	N
A	N	N	DA	A	A	A	DA	SA	A	A	SA	SA	A	A	SDA	A	DA
A	A	A	DA	A	DA	A	A	A	DA	A	A	A	A	A	A	N	A
A	SA	A	A	A	N	A	SA	SA	N	SA	A	A	A	N	SA	SA	A
A	SA	N	SDA	A	A	SA	SA	A	SA	SA	A	A	A	SA	SDA	N	A
A	N	SA	SDA	A	A	SA	A	SA	A	SA	A	SA	SA	SA	A	A	A
A	A	SA	SDA	A	A	N	N	SA	A	SA	SA	N	SA	SA	SA	SA	A
SA	SA	A	DA	A	N	SA	A	SA	SA	SA	SA	N	A	SA	A	SA	DA
A	A	N	DA	A	N	A	DA	DA	A	N	N	A	SA	N	A	A	N
SA	A	SA	A	A	SA	DA	SA	SA	A	SA	A	SA	SA	N	A	A	SA
A	N	SA	N	A	N	DA	SDA	A	N	A	N	N	N	N	N	N	A
SDA	A	SDA	A	A	SDA	SDA	A	A	A	A	SA	N	A	SA	A	A	SA

R222	R221	R220	R219	R218	R217	R216	R215	R214	R213	R212	R211	R210	R209	R208	R207	R206	R205
SA	A	A	A	SA	A	SA	A	A	A	A	SDA	SA	SA	SA	A	A	A
SA	SA	N	A	SA	N	A	SA	DA	A	SA	SDA	DA	A	SA	A	A	SA
N	N	A	SA	SA	N	N	A	N	A	N	SDA	SDA	SA	A	DA	A	SA
SA	SA	A	N	SA	A	SA	A	SA	A	A	SDA	N	SA	SA	A	A	SA
SA	SA	A	A	SA	SA	A	N	SA	SA	SA	A	SDA	A	SA	A	SA	SA
N	A	DA	A	N	N	N	SA	DA	A	N	DA	DA	A	A	DA	A	A
SA	A	A	A	SA	A	A	A	A	SA	A	A	SDA	A	SA	A	A	A
A	SA	N	A	A	DA	A	A	A	DA	A	A	A	A	A	DA	A	SA
A	A	SA	A	SA	SA	A	SA	N	SDA	SA	A	SA	SA	SA	A	A	A
A	SA	N	A	SA	SA	A	SA	A	SA	N	SA	SA	A	SA	N	A	A
A	SA	SA	A	SA	N	SA	A	SA	N	SA	SA	A	A	SA	A	A	A
SA	SA	SA	A	SA	A	A	SA	A	A	SA	SA	SA	A	SA	SA	A	A
SA	SA	A	A	SA	SA	A	N	SA	SA	SA	A	SDA	A	SA	A	SA	SA
N	SA	DA	A	SA	A	A	SA	DA	A	DA	SA	N	A	A	A	A	SA
SA	SA	A	A	SA	SDA	N	DA	A	A	A	A	A	N	SA	SA	SA	A
N	SA	A	A	SA	A	A	A	A	N	N	SA	N	A	A	N	A	A
A	A	N	SA	SA	SA	SA	A	A	DA	A	A	A	A	A	SA	SA	A

R240	R239	R238	R237	R236	R235	R234	R233	R232	R231	R230	R229	R228	R227	R226	R225	R224	R223
SA	A	N	A	A	A	A	SA	SA	SA	A	A	SA	A	SA	SA	A	N
SA	DA	DA	A	SA	A	A	N	A	SA	A	SA	A	A	A	SA	SA	N
SA	A	N	N	SA	N	A	N	SA	N	A	N	N	SA	A	N	A	N
A	DA	A	SA	A	N	A	N	N	DA	A	N	SA	A	A	SA	SA	SA
A	SA	SA	SA	SA	DA	SA	N	SA	DA	SA	SA	N	A	SA	A	SA	SDA
A	A	A	A	N	DA	SA	N	DA	A	A	SA	DA	A	A	N	A	A
SA	A	A	A	A	A	SA	SA	SA	DA	A	A	A	SA	SA	SA	SA	DA
DA	A	SA	A	A	A	SA	A	A	A	A	A	A	SA	A	SA	SA	A
A	SA	N	A	SA	N	SA	SA	SA	A	A	SA	A	N	A	SA	A	SA
A	N	SA	A	A	DA	A	SA	SA	A	A	A	A	A	A	SA	A	N
A	SA	SA	N	SA	A	A	A	A	A	A	A	SA	SA	A	SA	A	SDA
A	DA	SA	A	A	A	SA	SA	SA	SA	A	A	A	N	A	SA	N	SA
A	SA	SA	SA	SA	DA	SA	N	SA	DA	SA	SA	N	A	SA	A	SA	SDA
N	A	N	A	N	DA	A	N	A	N	A	N	DA	A	A	SA	DA	DA
A	SDA	A	SA	A	A	A	N	SDA	DA	A	SA	SDA	A	A	N	SA	SA
A	A	A	SDA	N	A	A	N	DA	N	A	SA	A	A	A	SA	N	DA
A	SA	SA	SA	SA	DA	A	SA	A	N	SA	A	SA	A	A	SA	A	SA

R260	R259	R258	R257	R256	R255	R254	R253	R252	R251	R250	R249	R248	R247	R246	R245	R244	R243	R242	R241
A	A	SA	A	N	A	SA	N	A	N	SA	N	A	DA	A	SDA	DA	A	A	SA
A	A	A	A	A	SDA	N	SA	N	SDA	SA	A	A	A	A	SDA	DA	A	A	A
A	SA	A	SA	N	DA	A	SA	A	SDA	SA	DA	A	A	SA	SDA	N	A	A	N
A	A	SA	A	A	N	SA	SA	SA	SA	SA	A	A	SA	A	SDA	N	N	A	A
A	SA	SA	SA	A	N	SA	SA	DA	DA	SA	N	N	A	DA	DA	SA	SA	SA	N
A	A	N	SA	A	A	SA	N	DA	A	SA	DA	A	A	A	SDA	DA	SA	A	A
N	A	A	A	A	DA	A	SA	SA	N	SA	SDA	A	A	A	SDA	N	A	A	N
SA	A	A	A	A	SA	A	SA	A	DA	SA	A	A	A	A	SA	A	A	A	A
A	A	SA	SA	A	N	A	A	SDA	N	SDA	A	A	A	SA	SA	N	SA	A	SA
A	SA	DA	A	A	SA	N	A	SA	A	SA	A	A	A	A	SDA	DA	A	A	A
A	SA	A	A	A	SDA	A	A	A	DA	SA	A	A	A	SA	A	A	A	A	A
SA	SA	N	A	N	SDA	DA	SA	SA	SA	SA	DA	A	A	SA	SDA	SA	N	N	SA
A	SA	SA	SA	A	N	SA	SA	DA	DA	SA	N	N	A	DA	DA	SA	SA	SA	N
A	SA	N	A	N	SDA	A	N	DA	A	SA	N	A	A	SA	SDA	DA	N	A	A
A	N	N	A	A	SDA	SA	DA	A	SA	SA	SA	DA	A	N	SA	SA	SA	DA	N
A	A	N	A	N	DA	A	N	SA	SDA	N	N	A	A	DA	SDA	N	A	N	A
SDA	A	SA	A	A	SA	A	N	A	SA	SA	DA	A	DA	A	SA	SA	SA	DA	A

R279	R278	R277	R276	R275	R274	R273	R272	R271	R270	R269	R268	R267	R266	R265	R264	R263	R262	R261
SA	SA	A	DA	A	A	A	A	A	SA	A	A	A	SA	A	A	A	A	A
A	A	A	A	A	A	A	A	SA	SA	SA	A	SA	SA	A	N	A	A	A
A	SA	N	A	N	N	SA	A	N	SA	A	N	A	SA	A	A	N	A	N
N	SA	N	SA	SA	SA	SA	A	A	SA	N	A	N	SA	A	N	SA	A	A
N	A	N	SA	SA	SA	SA	N	SA	SA	SA	A	SA	SA	A	SA	SA	SA	SA
A	SA	A	N	A	SA	SA	A	SDA	A	N	A	A	A	A	N	A	A	SA
N	A	A	SA	A	SA	A	A	A	SA	A	N	N	SA	A	A	SA	A	A
SA	SA	N	DA	A	SA	SA	A	SA	A	SA	A	SA	SA	A	A	SA	A	SA
N	A	N	A	A	SA	SA	A	DA	SA	A	A	A	N	A	SA	SA	SA	A
A	A	SA	DA	A	SA	A	SA	SA	A	A	A	A	N	A	A	N	A	A
N	A	N	A	A	A	SA	SA	A	SA	SA	A	SA	SA	A	A	SA	N	A
N	SA	A	A	A	A	A	A	SA	SA	A	A	SA	SA	A	A	N	A	N
N	A	N	SA	SA	SA	SA	N	SA	SA	SA	A	SA	SA	A	SA	SA	SA	SA
SA	A	A	A	A	A	A	A	A	A	SA	A	N	N	A	A	N	A	A
DA	N	DA	SA	SA	N	A	A	A	A	A	N	A	SDA	DA	DA	N	A	N
N	A	N	N	A	A	DA	A	N	A	N	N	N	DA	A	N	A	A	N
A	SA	A	A	DA	SA	DA	A	SA	SA	N	DA	A	SA	A	SA	A	SA	DA

R30	R29	R298	R297	R296	R295	R294	R293	R292	R291	R290	R289	R288	R287	R286	R285	R284	R283	R282	R281	R280
A	N	N	A	DA	A	SA	A	SDA	N	SA	A	A	A	A	A	SA	A	SA	A	DA
SA	SA	A	A	A	A	A	N	DA	A	SA	A	SA	SA	N	A	SA	A	A	A	DA
N	A	N	N	SA	SA	N	A	SDA	A	N	N	SA	SA	A	N	SA	A	N	N	N
SA	DA	A	A	A	DA	A	A	SA	A	N	A	A	A	N	A	SA	A	N	A	DA
SA	SA	SA	SA	SA	SA	A	A	A	SA	N	N	SA	N	SA	SDA	SA	A	A	SA	DA
DA	A	A	A	A	A	A	A	SDA	A	A	A	A	N	A	N	SA	N	SA	A	N
SA	SA	N	A	N	A	A	A	DA	A	A	A	N	SA	A	A	SA	N	N	A	DA
A	SA	SA	SA	A	A	A	SA	A	A	A	A	A	A	A	SA	SA	SA	A	SA	SA
A	A	N	A	N	SA	A	A	SA	SA	A	A	A	A	A	SA	SA	SA	SA	A	A
SA	SA	SA	A	N	A	A	A	SDA	A	A	A	A	A	A	N	SA	A	A	N	N
SA	SA	A	A	A	DA	SA	A	SDA	N	A	A	A	A	A	A	SA	A	A	A	N
A	SA	SA	A	DA	DA	A	A	DA	N	A	A	A	A	DA	A	SA	A	A	N	DA
SA	SA	SA	SA	SA	SA	A	A	A	SA	N	N	SA	N	SA	SDA	SA	A	A	SA	DA
A	SA	SDA	A	A	A	N	A	N	A	SA	A	A	A	A	SA	SA	A	A	N	N
DA	A	SA	A	A	SA	N	SA	SA	N	DA	A	SA	A	DA	SA	SA	A	DA	A	N
A	A	SDA	A	DA	A	N	DA	DA	N	A	A	A	A	A	A	SA	SDA	DA	A	N
SDA	A	A	DA	N	SA	SA	A	SA	SA	DA	A	A	DA	A	SDA	A	SA	A	SA	DA

R30	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	DA
R302	A	A	N	A	SA	A	A	A	A	A	A	SDA	SA	A	SDA	A	A

Appendix E

Table E: Questions asked in Interviews

NO.	QUESTIONS ASKED IN INTERVIEWS FROM INDUSTRIAL PRACTITIONERS
1	Which techniques or approaches have you identified to be useful in detecting and reducing risks related to changing the project's specifications or requirements throughout Scrum development?
2	Can you provide examples of where poor risk estimations due to changing requirements caused challenges, and how these issues were resolved?
3	Have you come across any effective strategies or methods for solving and addressing communication problems in teams using Scrum in order to improve the risk management process?
4	What techniques or procedures have you found to be useful in eliminating or minimizing quality assurance issues in Scrum development?
5	In your perspective, how can organizations foster an open and efficient communication environment in order to enhance risk management processes in scrum projects?
6	How can Scrum teams make sure that their efforts to maintain high quality in their work don't slow down the project or cause delays, while also handling risks effectively?
7	Which standards or factors do you take into account when ranking and prioritizing risks in a the scrum process, and how do they affect the risk management procedure?
8	In your view, what steps can organizations take in advance to tackle productivity and performance problems so that they don't negatively affect the quality or timely delivery of software products in the Scrum framework?
9	What's your perspective on how problems related to scheduling, budgeting, and maintaining quality can influence the overall management of project risks in a scrum framework?
10	Do you use particular methods or software tools to keep an eye on and manage the timing, budget, and quality aspects within Scrum teams?
11	What steps can organizations take to close the knowledge and skill gaps among team members, ensuring they have the required expertise for successful Scrum-based development?
12	Have you come across instances where insufficient planning or documentation caused challenges in recognizing and handling project risks? Could you share examples and insights on how these problems were resolved?
13	How do you assess the impact of inadequate risk identification on entire risk management in a Scrum framework?
14	What strategies or methods can organizations implement to improve the effectiveness of risk identification during the Scrum methodology?
15	What strategies or methods can organizations implement to improve the effectiveness of risk identification during the Scrum methodology?

16	How do you know if the risk response techniques you've devised are indeed decreasing risks inside the Scrum framework?
17	What steps can organizations take to make sure that they plan and carry out risk response strategies effectively in the scrum development process?

Appendix F

Table F: Questions asked in focus group

NO.	QUESTIONS ASKED IN FOCUS GROUP
1	Changing requirements risk prediction issues in risk management in scrum-based development could be resolved by employing activities like brain-storming sessions, interviews, scenario analysis and checklists. What are your views regarding this?
2	By updating the planning process regularly and by reviewing previous similar projects the planning and documentation issues in risk management. Do you agree?
3	Risk identification issues can be resolved by avoiding scope creep and making sure that risks that can affect the outcome of the project have been identified? Please provide your opinion about this.
4	Do you think that high-priority risk mitigation issues can be resolved by using already defined ranking system and spending less resources on low priority risks?
5	Planning risk response strategies issues can be resolved scenario planning and by tailoring risk responses to the specific risks. What is your opinion about that?
6	Periodic quality checks and continuously applying response strategies between project components help resolve quality assurance issues in risk management in scrum-based software development?
7	Productivity performance and security issues can be solved by establishing metrics and measures and by using automated tools. Do you agree on that?
8	Can we resolve risk interdependencies related issues by analyzing risk interdependencies and by using decision trees and scenario analysis? Please provide your opinion on this.
9	Schedule, cost and quality control issues can be resolved by reviewing quality control measures, deadlines and cost estimates against pre-defined baselines? Do you agree on this?
10	Establishing appropriate communication channels and removing language and cultural barriers help in solving communication issues? Please provide your views on this.
11	Taking guidance from skilled professionals and conducting skill development programs help resolve expertise related issues in risk management in scrum-based software development? Do you agree on that?

Appendix G

Table G: Responses gathered from focus group

NO.	MITIGATION STRATEGIES AGAINST 11 MAJOR RISK MANAGEMENT ISSUES							
01	**CHANGING REQUIREMENTS RISK PREDICTION ISSUES**							
1	Use appropriate risk identification methods like checklists, brainstorming sessions, interviews, and scenario analysis to systematically identify risks.	N	DA	A	SA	A	SA	SA
2	Identify connections between components of project and customer requirements.	SA	SA	SA	SA	SA	SA	SA
3	Regularly review and upgrade the process of risk identification to find any new risks that arise as requirements change.	SA	SA	A	A	A	SA	A
4	Engage all key stakeholders, such as end-users, customers, subject matter experts, product owners, early in the project.	A	A	A	A	N	SA	A
5	Utilize feedback loops, like sprint retrospectives or regular reviews with stakeholders to identify requirements changes.	N	DA	SDA	N	N	N	N
6	Refine and review the product backlog periodically.	A	SA	A	A	A	A	A
7	Engage both external and internal stakeholders who possess the knowledge about changing requirements.	SA	A	SA	A	SA	A	A
02	**PLANNING AND DOCUMENTATION ISSUES**							
1	Clearly define and articulate the goal of conducting risk management in the project.	A	N	SDA	A	A	A	SA
2	Design a comprehensive and detailed structure for risk management that clearly define the overall approach, roles, processes, and responsibilities for risk management.	A	N	SA	SDA	N	DA	N
3	Use appropriate templates and standardized formats	A	N	SDA	A	A	A	SA
4	Promote a culture of proper documentation	SA	A	A	SA	A	N	N
5	Regularly improve planning processes	A	SA	A	A	A	SA	SA
6	Try to seek guidance from external experts	SA	SA	SA	A	SA	A	SA
7	Try to involve the whole project team	DA	N	A	N	SDA	SA	A

8	Establish clear team member's roles and responsibilities to ensure that everyone is well aware of what is expected from them.	A	SA	A	A	A	SA	SA
9	Document all decisions and activities at a centralized place to make sure that all members are aware of the risk status and mitigation methods.	SA	SA	SA	SA	SA	SA	SA
03	**IN SUFFICIENT RISK IDENTIFICATION**							
1	Avoid Scope creep	A	A	A	A	A	A	A
2	Consider the main objective of the project while identifying risks to make sure that risk that can affect project outcome are identified.	A	N	SDA	A	A	A	SA
3	Maintain risk register regularly.	SA	A	A	SA	A	N	N
04	**HIGH PRIORITY RISK MITIGATION ISSUES**							
1	Assess each identified risk based on its potential impact and likelihood of occurrence. Make use of already defined ranking system or qualitative analysis scale to assign ranking.	SA	A	SA	SA	N	DA	A
2	Direct your focus towards addressing as well as analyzing the high-priority risks at first.	SA	SA	A	SA	A	SDA	A
3	Spend less amount of effort and time on less-priority risks or the risks that can easily be managed.	SA	A	SA	SA	N	DA	A
4	No need to define ownership for high priority risks.	SA	SA	A	SA	A	SDA	A
5	Utilize the right tools and methods for assessing risks,	SA	A	SA	SA	N	DA	A
05	**PLANNING RISK RESPONSE STRATEGIES**							
1	Test the risk response procedures by using scenario planning to make sure that they are very effective and the team is ready to apply them when they are needed.	N	SA	SA	A	SA	A	DA
2	Tailor risk response techniques to the specific risk to make sure that the response to risk is is suitable and effective.	SA	SA	SA	A	A	SA	A
06	**LACK OF EXPERTISE**							
1	Encourage team members to share their ideas and suggestions for enhancing expertise and effectiveness in risk response implementation	SA	DA	A	N	A	SA	A
2	Engage external industry experts what are expert in implementation of risk responses. Take advice, guidance and support for implementing risk responses.	DA	SA	N	DA	N	DA	DA

3	Provide targeted training and expertise and organize skill development programs such as seminars and workshops etc to improve the skills of the team members that are involved in implementation of risk responses.	A	A	N	SA	SA	SDA	A
4	Find experienced practitioners in your organization who have successfully applied risk responses in the previous projects in past and learn from them.	A	SA	N	A	DA	A	A
5	review previous existing projects in detail and identify best practices and lesson learned during the implementation of risk responses.	SA	A	A	DA	A	N	SA
07	**SCHEDULE COST AND QUALITY CONTROL ISSUES**							
1	Frequently review project deadlines, quality control measures and cost estimates, against the predetermined baselines.	DA	SA	N	A	N	A	A
2	Specify clear risk monitoring objectives for cost, schedule and quality	A	A	A	A	A	A	A
3	Carry out frequent quality audits to assess and evaluate adherence to the measures of quality control.	A	N	DA	SA	A	SA	SA
4	A structured process defining the procedures and roles for scheduling, budgeting, and quality control must be established.	A	N	DA	SA	A	SA	SA
08	**PRODUCTIVITY PERFORMANCE AND SECURITY ISSUES**							
1	Ensure that every team member are well aware of their position functions with respect to performance, productivity as well as security.	SA	SA	A	A	SA	SA	2
2	For tracking performance and productivity throughout the software development build metrics and measures.	A	A	SA	N	SA	SA	N
3	Use automated tools for, security scans, testing and other features of the software development process to enhance productivity.	A	A	A	N	SA	SA	N
09	**RISK INTERDEPENDENCIES ISSUES**							
1	Analyze the possible interdependencies among risks. Observe how the exposure or reduction of one risk affect the or impact or likelihood of other risks.	SA	A	A	SA	A	N	N
2	Conduct quantitative risk analysis and examine the interdependencies among risks when estimating their impacts and likelihood by applying decision trees and Monte Carlo simulations.	SA	A	A	SA	A	N	N

3	Apply scenario analysis technique.	A	SA	A	A	A	SA	SA
4	expert interviews, brainstorming, and workshops should be conducted to figure out how one risk affect or be affected by other risks in the organizational context.	SA	SA	SA	A	SA	A	SA
10	**QUALITY ASSURANCE ISSUES**							
1	Continuously carry out risk response strategies within different components of the project.	SA	N	A	SA	N	A	A
2	Ensure adherence to the defined protocols and procedures of risk response implementation.	A	A	N	SA	SA	SDA	A
3	Perform periodic quality checks like reviews, inspections, or audits to assess the effectiveness of risk response implementation.	A	SA	N	A	DA	A	A
4	Develop a quality assurance plan that outlines how quality objectives will be achieved and how quality risks will be addressed.	SA	A	A	DA	A	N	SA
11	**COMMUNICATION ISSUES**							
1	Address language and cultural barriers by providing translation services within the project team.	A	N	DA	SA	A	SA	SA
2	Set up appropriate communication channels such as regular meetings, project management software, email updates, and document repositories to facilitate information sharing.	SA	SA	A	A	A	A	SA
3	Clearly communicate the objectives, scope, and expected outcomes of the risk management planning phase to all relevant stakeholders.	A	N	DA	SA	A	SA	SA
4	Involve key stakeholders from the beginning of the risk management planning phase. Seek their input, gather their perspectives, and address their concerns.	A	N	DA	SA	A	SA	SA

Appendix H

Table H: Likert Scale Values for Focus Group Responses

No.	Mitigation strategies against 11 major risk management issues	R1	R2	R3	R4	R5	R6	R7	Agree (*2)	Disagree (*-2)	Result	Avg weightag
01 CHANGING REQUIREMENTS RISK PREDICTION ISSUES												
1	Use appropriate risk identification methods like checklists, brainstorming sessions, interviews, and scenario analysis to systematically identify risks.	0	-1	1	2	1	1	2	5*2=10	1*-2= -2	10-2=8	1.1428
2	Identify connections between components of project and customer requirements.	2	2	2	2	2	2	2	7*2=14	0*-2= 0	14+0=14	2.0000
3	Regularly review and upgrade the process of risk identification to find any new risks that arise as requirements change.	2	2	1	1	1	2	1	7*2=14	0*-2= 0	14+0=14	2.0000
4	Engage all key stakeholders, such as end-users, customers, subject matter experts, product owners, early in the project.	1	1	1	1	0	2	1	6*2=12	0*-2= 0	12+0=12	1.7142
5	Utilize feedback loops, like sprint retrospectives or regular reviews with stakeholders to identify requirements changes.	0	-1	-2	0	0	0	0	0*2=0	2*-2= -4	0-4= -4	-0.5714
6	Refine and review the product backlog periodically.	2	0	1	2	0	1	1	5*2=10	0*-2= 0	10+0=10	1.4285
7	Engage both external and internal stakeholders who possess the knowledge about changing requirements.	1	2	1	1	1	1	1	7*2=14	0*-2= 0	14+0=14	2.0000
02 PLANNING AND DOCUMENTATION ISSUES												
1	Clearly define and articulate the goal of conducting risk management in the project.	1	0	-2	1	1	1	2	5*2=10	1*-2= -2	8	1.1428
2	Design a comprehensive and detailed structure for risk management that clearly define the overall approach, roles, processes, and responsibilities for risk management.	1	0	2	-2	0	-1	0	2*2=4	2*-2= -4	0	0.0000

3	Use appropriate templates and standardized formats	1	0	-2	1	1	1	2	5*2= 10	1*-2= -2	8	1.1428
4	Promote a culture of proper documentation	2	1	1	2	1	0	0	5*2 =10	0*-2= 0	10	1.4285
5	Regularly improve planning processes	1	2	1	1	1	2	2	7*2 =14	0*-2= 0	14	2.0000
6	Try to seek guidance from external experts	2	2	2	1	2	1	2	7*2 =14	0*-2= 0	14	2.0000
7	Try to involve the whole project team	-1	0	1	0	-2	2	1	3*2 =6	2*-2= -4	2	0.2857
8	Establish clear team member's roles and responsibilities to ensure that everyone is well aware of what is expected from them.	1	2	1	1	1	2	2	7*2 =14	0*-2= 0	14	2.0000
9	Document all decisions and activities at a centralized place to make sure that all member are aware of the risk status and mitigation methods.	2	2	2	2	2	2	2	7*2 =14	0*-2= 0	14	2.0000
03	**IN SUFFICIENT RISK IDENTIFICATION**											
1	Avoid Scope creep	1	1	1	1	1	1	1	7*2 =14	0*-2= 0	14	2.0000
2	Consider the main objective of the project while identifying risks to make sure that risk that can affect project outcome are identified.	1	0	-2	1	1	1	2	5*2 =10	1*-2= -2	8	1.1428
3	Maintain risk register regularly.	2	1	1	2	1	0	0	5*2= 10	0*-2= 0	10	1.4285
04	**HIGH PRIORITY RISK MITIGATION ISSUES**											
1	Assess each identified risk based on its potential impact and likelihood of occurrence. Make use of already defined ranking system or qualitative analysis scale to assign ranking.	2	1	2	2	0	-1	1	5*2 =10	1*-2= -2	8	1.1428
2	Direct your focus towards addressing as well as analyzing the high-priority risks at first. These types of risks should be given immediate focus to mitigate their negative consequences.	2	2	1	2	1	-2	1	6*2 =12	1*-2= -2	10	1.4285
3	Spend less amount of effort and time on less-priority risks or the risks that can easily be managed.	2	1	2	2	0	-1	1	5*2 =10	1*-2= -2	8	1.1428
4	No need to define ownership for high priority risks.	0	-1	-2	0	0	0	0	0*2 =0	2*-2= -4	-4	-0.5714
5	Utilize the right tools and methods for assessing risks,	0	-1	-2	0	0	0	0	0*2 =0	2*-2= -4	-4	-0.5714

05 PLANNING RISK RESPONSE STRATEGIES												
1	Test the risk response procedures by using scenario planning to make sure that they are very effective and the team is ready to apply them when they are needed.	0	2	2	1	2	1	-1	5*2 =10	1*-2= -2	8	1.1428
2	Tailor risk response techniques to the specific risk to make sure that the response to risk is is suitable and effective.	2	2	2	1	1	2	1	7*2 =14	0*-2= 0	14	2.0000
06 LACK OF EXPERTISE												
1	Encourage team members to share their ideas and suggestions for enhancing expertise and effectiveness in risk response implementation	2	-1	1	0	1	2	1	5*2 =10	1*-2= -2	8	1.1428
2	Engage external industry experts what are expert in implementation of risk responses. Take advice, guidance and support for implementing risk responses.	-1	2	0	-1	0	-1	-1	1*2= 2	4*-2= -8	-6	-0.8571
3	Provide targeted training and expertise and organize skill development programs such as seminars and workshops etc to improve the skills of the team members that are involved in implementation of risk responses.	2	2	2	2	2	2	2	7*2 =14	0*-2= 0	14	2.0000
4	Find experienced practitioners in your organization who have successfully applied risk responses in the previous projects in past and learn from them.	1	1	0	2	2	-2	1	5*2 =10	1*-2= -2	8	1.1428
5	review previous existing projects in detail and identify best practices and lesson learned during the implementation of risk responses.	1	2	0	1	-1	1	1	5*2 =10	1*-2= -2	8	1.1428
07 SCHEDULE COST AND QUALITY CONTROL ISSUES												
1	Frequently review project deadlines, quality control measures and cost estimates, against the predetermined baselines.	-1	2	0	1	0	1	1	4*2 =8	1*-2= -2	6	0.8571
2	Specify clear risk monitoring objectives for cost, schedule and quality	1	1	1	1	1	1	1	7*2 =14	0*-2= 0	14	2.0000
3	Carry out frequent quality audits to assess and evaluate adherence to the measures of quality control.	0	-1	-2	0	0	0	0	0*2 =0	2*-2= -4	-4	-0.5714
4	A structured process defining the procedures and roles for scheduling, budgeting, and quality control must be established.	1	0	-1	2	1	2	2	5*2= 10	1*-2= -2	8	1.1428

08	**PRODUCTIVITY PERFORMANCE AND SECURITY ISSUES**											
1	Ensure that every team member are well aware of their position functions with respect to performance, productivity as well as security.	1	0	-1	2	1	2	2	5*2= 10	1*-2= -2	8	1.1428
2	For tracking performance and productivity throughout the software development build metrics and measures.	2	2	1	1	2	2	2	7*2 =14	0*-2= 0	14	2.0000
3	Use automated tools for, security scans, testing and other features of the software development process to enhance productivity.	1	1	2	0	2	2	0	5*2 =10	0*-2= 0	10	1.4285
09	**RISK PRIORITIES ISSUES**											
1	Analyze the possible interdependencies among risks. Observe how the exposure or reduction of one risk affect the or impact or likelihood of other risks.	2	1	1	2	1	0	0	5*2= 10	0*-2= 0	10	1.4285
2	Conduct quantitative risk analysis and examine the interdependencies among risks when estimating their impacts and likelihood by applying decision trees and Monte Carlo simulations.	2	1	1	2	1	0	0	5*2 =10	0*-2= 0	10	1.4285
3	Apply scenario analysis technique.	1	2	1	1	1	2	2	7*2 =14	0*-2= 0	14	2.0000
4	expert interviews, brainstorming, and workshops should be conducted to figure out how one risk affect or be affected by other risks in the organizational context.	2	2	2	1	2	1	2	7*2 =14	0*-2= 0	14	2.0000
10	**QUALITY ASSURANCE ISSUES**											
1	Continuously carry out risk response strategies within different components of the project.	2	0	1	2	0	1	1	5*2 =10	0*-2= 0	10	1.4285
2	Ensure adherence to the defined protocols and procedures of risk response implementation.	-1	0	-1	0	2	2	-1	2*2 =4	3*-2= -6	-2	-0.2857
3	Perform periodic quality checks like reviews, inspections, or audits to assess the effectiveness of risk response implementation.	1	2	0	1	-1	1	1	5*2 =10	1*-2= -2	8	1.1428
4	Develop a quality assurance plan that outlines how quality objectives will be achieved and how quality risks will be addressed.	2	1	1	-1	1	0	2	5*2 =10	1*-2= -2	8	1.1428
11	**COMMUNICATION ISSUES**											
1	Address language and cultural barriers by providing translation services within the project team.	1	0	-1	2	1	2	2	5*2 =10	1*-2= -2	8	1.1428

2	Set up appropriate communication channels such as regular meetings, project management software, email updates, and document repositories to facilitate information sharing.	2	2	1	1	1	1	2	7*2 =14	0*-2= 0	14	2.0000
3	Clearly communicate the objectives, scope, and expected outcomes of the risk management planning phase to all relevant stakeholders.	1	0	-1	2	1	2	2	5*2 =10	1*-2= -2	8	1.1428
4	Involve key stakeholders from the beginning of the risk management planning phase. Seek their input, gather their perspectives, and address their concerns.	1	0	-1	2	1	2	2	5*2 =10	1*-2= -2	8	1.1428

Appendix I

Table I: Accepted and Rejected values from focus group

No.	Mitigation strategies against 11 major risk management issues	Average weightage	Result
01	**CHANGING REQUIREMENTS RISK PREDICTION ISSUES**		
1	Use appropriate risk identification methods like checklists, brainstorming sessions, interviews, and scenario analysis to systematically identify risks.	1.1428	Accepted
2	Identify connections between components of project and customer requirements.	2.0000	Accepted
3	Regularly review and upgrade the process of risk identification to find any new risks that arise as requirements change.	2.0000	Accepted
4	Engage all key stakeholders, such as end-users, customers, subject matter experts, product owners, early in the project.	1.7142	Accepted
5	Utilize feedback loops, like sprint retrospectives or regular reviews with stakeholders to identify requirements changes.	-0.5714	Rejected
6	Refine and review the product backlog periodically.	1.4285	Accepted
7	Engage both external and internal stakeholders who possess the knowledge about changing requirements.	2.0000	Accepted
02	**PLANNING AND DOCUMENTATION ISSUES**		
1	Clearly define and articulate the goal of conducting risk management in the project.	1.1428	Accepted
2	Design a comprehensive and detailed structure for risk management that clearly define the overall approach, roles, processes, and responsibilities for risk management.	0.0000	Rejected
3	Use appropriate templates and standardized formats	1.1428	Accepted
4	Promote a culture of proper documentation	1.4285	Accepted
5	Regularly improve planning processes	2.0000	Accepted
6	Try to seek guidance from external experts	2.0000	Accepted
7	Try to involve the whole project team	0.2857	Rejected
8	Establish clear team member's roles and responsibilities to ensure that everyone is well aware of what is expected from them.	2.0000	Accepted
9	Document all decisions and activities at a centralized place	2.0000	Accepted
03	**IN SUFFICIENT RISK IDENTIFICATION**		
1	Avoid Scope creep	2.0000	Accepted
2	Consider the main objective of the project while identifying risks to make sure that risk that can affect project outcome are identified.	1.1428	Accepted
3	Maintain risk register regularly.	1.4285	Accepted
04	**HIGH PRIORITY RISK MITIGATION ISSUES**		
1	Assess each identified risk based on its potential impact and likelihood of occurrence. Make use of already defined ranking system or qualitative analysis scale to assign ranking.	1.1428	Accepted

2	Direct your focus towards addressing as well as analyzing the high-priority risks at first. These types of risks should be given immediate focus to mitigate their negative consequences.	1.4285	Accepted
3	Spend less amount of effort and time on less-priority risks or the risks that can easily be managed.	1.1428	Accepted
4	No need to define ownership for high priority risks.	-0.5714	Rejected
5	Utilize the right tools and methods for assessing risks	-0.5714	Rejected
05	**PLANNING RISK RESPONSE STRATEGIES**		
1	Test the risk response procedures by using scenario planning to make sure that they are very effective and the team is ready to apply them when they are needed.	1.1428	Accepted
2	Tailor risk response techniques to the specific risk to make sure that the response to risk is suitable and effective.	2.0000	Accepted
06	**LACK OF EXPERTISE**		
1	Encourage team members to share their ideas and suggestions for enhancing expertise and effectiveness in risk response implementation	1.1428	Accepted
2	Engage external industry experts what are expert in implementation of risk responses. Take advice, guidance and support for implementing risk responses. Seek their guidance, advice, and support during the implementation phase.	-0.8571	Rejected
3	Provide targeted training and expertise and organize skill development programs such as seminars and workshops etc to improve the skills of the team members that are involved in implementation of risk responses.	2.0000	Accepted
4	Find experienced practitioners in your organization who have successfully applied risk responses in the previous projects in past and learn from them.	1.1428	Accepted
5	review previous existing projects in detail and identify best practices and lesson learned during the implementation of risk responses.	1.1428	Accepted
07	**SCHEDULE COST AND QUALITY CONTROL ISSUES**		
1	Frequently review project deadlines, quality control measures and cost estimates, against the predetermined baselines.	0.8571	Accepted
2	Specify clear risk monitoring objectives for cost, schedule and quality	2.0000	Accepted
3	Carry out frequent quality audits to assess and evaluate adherence to the measures of quality control.	-0.5714	Rejected
4	A structured process defining the procedures and roles for scheduling, budgeting, and quality control must be established.	1.1428	Accepted
08	**PRODUCTIVITY PERFORMANCE AND SECURITY ISSUES**		
1	Ensure that every team member is well aware of their position functions with respect to performance, productivity as well as security.	1.1428	Accepted
2	For tracking performance and productivity throughout the software development build metrics and measures.	2.0000	Accepted
3	Use automated tools for, security scans, testing and other features of the software development process to enhance productivity.	1.4285	Accepted
09	**RISK INTERDEPENDENCIES ISSUES**		
1	Analyze the possible interdependencies among risks. Observe how the exposure or reduction of one risk affect the or impact or likelihood of other risks.	1.4285	Accepted

2	Conduct quantitative risk analysis and examine the interdependencies among risks when estimating their impacts and likelihood by applying decision trees.	1.4285	Accepted
3	Apply scenario analysis technique.	2.0000	Accepted
4	expert interviews, brainstorming, and workshops should be conducted to figure out how one risk affect or be affected by other risks in the organizational context.	2.0000	Accepted
10	**QUALITY ASSURANCE ISSUES**		
1	Continuously carry out risk response strategies within different components of the project.	1.4285	Accepted
2	Ensure adherence to the defined protocols and procedures of risk response implementation.	-0.2857	Rejected
3	Perform periodic quality checks like reviews, inspections, or audits to assess the effectiveness of risk response implementation.	1.1428	Accepted
4	Develop a quality assurance plan that outlines how quality objectives will be achieved and how quality risks will be addressed.	1.1428	Accepted
11	**COMMUNICATION ISSUES**		
1	Address language and cultural barriers by providing translation services within the project team.	1.1428	Accepted
2	Set up appropriate communication channels such as regular meetings, project management software, email updates, and document repositories to facilitate information sharing.	2.0000	Accepted
3	Clearly communicate the objectives, scope, and expected outcomes of the risk management planning phase to all relevant stakeholders.	1.1428	Accepted
4	Involve key stakeholders from the beginning of the risk management planning phase. Seek their input, gather their perspectives, and address their concerns.	1.1428	Accepted