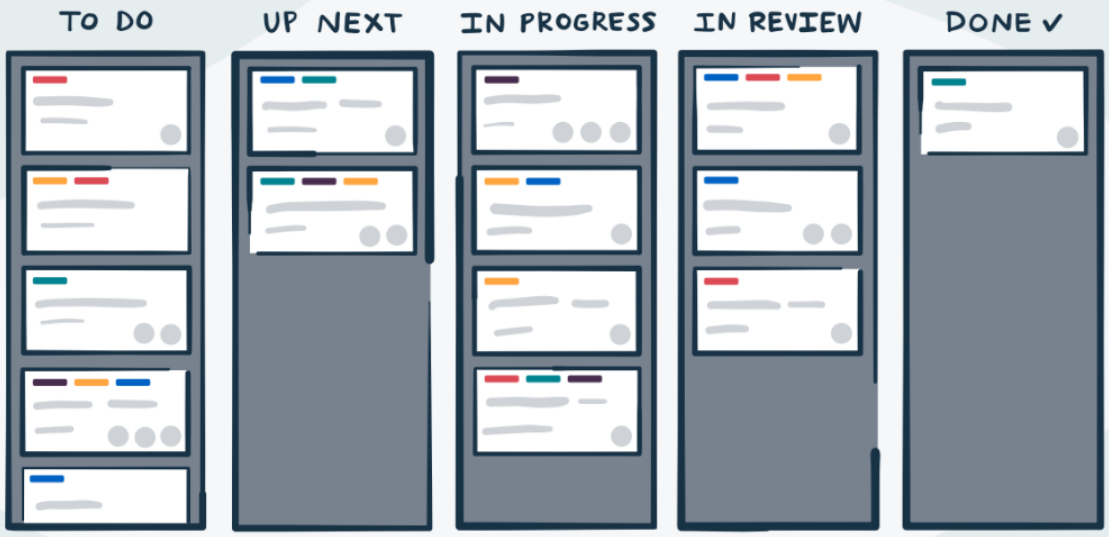
M.Sc. Construction Management and Engineering

Agile risk management: Enhancing the risk management process in projects through agile principles, methods and tools

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TU Delft

Agile risk management: Enhancing the risk management process in projects through agile principles, methods and tools

by

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In partial fulfillment of the requirements for the degree of

Master of Science in Construction Management & Engineering

Specialisation of Projects & People

Faculty of Engineering & Geosciences

at the Delft University of Technology

to be defended publicly on Monday February 26, 2024 at 11:00 AM.

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TU Delft

Preface

These two last years that I have been studying in TU Delft have been challenging and rewarding at the same time. After I finished my bachelor studies in Greece in 2020, I knew that I wanted to continue my Master studies in another European country. The transition from my university in Greece to TU was not smooth in the beginning. The studying rhythms were completely different, and I had to get used to the more frequent exam periods. During the first courses that I followed in TU Delft, the idea of writing my thesis seemed distant. However, looking back at those two years, it seems like they have flown by. Overall, even though these years have been intense in terms of workload, they offered me the chance to believe more in myself about the things that I could achieve and the challenges that I could overcome.

Over the past months that I have been working on my master thesis, I have been confronted with many setbacks and challenging situations. The whole process had its ups and downs but at the same time I had the opportunity to deepen my knowledge and learn new things about risk management and different techniques surrounding it.

I would like to thank all the members of my committee for their guidance throughout this process. More specifically, I would like to thank my first supervisor Afshin, for always being available for giving me feedback, giving me advice on my next steps and providing directions for my research. Finally, I would like to express my gratitude to the company supervisors, for making me feel a part of the team and helping me in my first steps in such a professional environment.

Additionally, I would like to thank my closest friends for their constant support throughout this process. We were all working on our thesis project these past months and we were trying to support each other in every step of the way. I believe that I would not be in this position now without them by my side.

I believe that this thesis project will be helpful and useful for my future as a professional in this industry. I am excited to see what the future holds and experience the new methodologies and techniques that will arise. I am eager to learn new things and continue evolving in the field of risk management and agile project management.

Anastasia Liapi
Delft, February 2024

Executive summary

Introduction A construction project exists in a dynamic environment that involves many stakeholders, extended timeframes and often complicated relationships, which all contribute to a high possibility of project related risks. The increased complexity of construction projects and the fact that a large percentage of projects are still delivered with significant delays and cost overruns has led to the necessity of applying different methods by the project managers and the teams. Agile project management is an example of that as its implementation in construction projects can help increase flexibility, achieve continuous improvement, help the project stay on track without schedule overruns and achieve an overall improved quality through effective collaboration and constant feedback. However, even though agile practices can have positive impact in a project, their integration with risk management is still limited, especially in the construction industry, with existing research primarily focusing on their integration within smaller organizations. This gap highlights the need for a more comprehensive, systematic approach that adapts across different organizational contexts and addresses the unique challenges of implementing agile methods in large-scale construction projects.

Acknowledging this, the objective of this research project is to bridge the theoretical and practical divide, offering a comprehensive framework that integrates agile practices with risk management. This framework is designed to offer versatility, allowing for its application across various organizational environments. It aims to make the risk management process more adaptive and the risk identification and mitigation more proactive. Through this approach, the research seeks not only to contribute to the academic knowledge but also to equip industry professionals with a practical tool, that enables project teams to implement it with ease. The main research question guiding this study is as follows:

How can agile methodologies be implemented in the risk management process?

Research design Firstly, a literature review regarding risk management, APM and its implementation in the risk management process was conducted. Additionally, several exploratory interviews were conducted in an engineering company in order to determine the perspective of various employees regarding the risk management that is followed in the company, its positive elements and its inefficiencies. Based on the results of the interviews and the literature review a framework was developed, proposing the implementation of agile principles and methods in the risk management process. The last step was the evaluation and validation of the framework which was done through the implementation of the framework in a project of the company, accompanied with the conduction of a questionnaire, a focus group and expert judgement session. These steps are part of the DSR approach, which focuses on development and evaluation of artifacts aiming at giving solutions to problems in real-life situations.

Results The suggested framework was implemented in a project over a set period and subsequently underwent evaluation through a questionnaire and a focus group session with both providing feedback and insights on the period and the different elements of the framework. The analysis indicated that the framework effectively increased risk awareness and encouraged collaboration between different disciplines. However, it was noted that not all framework elements were fully implemented as planned, leading to challenges in drawing concrete conclusions regarding the framework's overall effectiveness.

In response to these challenges, an expert judgment session was organized to dive deeper into the framework's practicality and identify suggestions for further improvement. The analysis of the expert judgement session showed that the framework contributes positively to the proactive identification and management of risks while confirming the increased awareness and collaboration that was mentioned in the analysis of the questionnaire and focus group session.

Besides the identified positive aspects, possible areas for improvement were also highlighted, suggesting the need to incorporate a clearer representation of risk impact and a more explicit explanation of the framework's vision and objectives. These findings underscore the framework's potential benefits while also pointing out crucial aspects that require further modifications in order to ensure a successful implementation. Some of the elements that were considered crucial for a successful implementation were employee training sessions focused on risks and the impact that they could have in combination with a clear communication of the vision and the added value of what is proposed, guidance provided from the project manager and risk coordinator as well following a step-by step approach.

Conclusions Overall, this thesis project presents the potential enhancement of the risks management process with the use of a framework that incorporates agile principles. The suggested framework combines agile's flexible, iterative approach and aims to improve engagement with risks, facilitate better communication and collaboration among team members, and encourage a proactive culture of risk awareness. While the framework's evaluation showed the benefits that it could have, it also shed light to the areas that need refinement and the steps that need to be taken in order to ensure that its implementation is successful.

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Nomenclature

Abbreviations

Abbreviation	Definition
APM	Agile Project Management
EPC	Engineering, Procurement, and Construction
EW	Early Warnings
DSR	Design Science Research

1

Introduction

The first section of this chapter will introduce the research topic and will elaborate on the problem statement. The following section will outline the research objective and the research questions. The last two sections will then explain the practical and scientific relevance of the research and the expected outcomes and deliverables.

1.1. Research background

The construction industry operates in a dynamic environment characterized by constantly changing conditions and factors that can have an impact on the project's outcome (Levitt, 2011; Collyer, 2016; Padala and Maheswari, 2022). Construction projects often involve multiple stakeholders with varying interests and priorities, which increases the level of complexity of the project and can have negative results if not managed effectively. Additionally, dynamic environments are often characterized by rapid changes, which remain one of the biggest threats for projects. Therefore, construction projects also involve a high number of risks and unpredictable conditions and suffer from schedule delays and cost overruns despite the advancements in construction management techniques (Lee et al., 2006; Rastogi and Trivedi, 2016).

In order to tackle the potential risks, the implementation of an effective and flexible risk management is necessary (Ozorhon et al., 2022). An effective risk management process does not imply the removal of risk altogether, but actually aims at minimizing the negative consequences and taking advantage of the possible opportunities (Szymański, 2017). Risk management is considered critical for the projects' success as it helps to identify and mitigate potential risks, allocate resources more effectively and build trust among project stakeholders. By prioritizing risks according to their severity and their level of impact, project managers can increase the likelihood of project success and minimize potential losses (Ahmed and Mohammed, 2019).

The complex and full of uncertainties environment of the construction industry, characterized by advancing technologies, quickly changing business demands, and market competition has led to the necessity of implementing methods that differ from the traditional project management approach (Jalali Sohi et al., 2016; Marle, 2020; Ozorhon et al., 2022).

One of the developments of project management is the introduction of Agile Project Management (APM). APM can help construction projects stay on track, adapt to changing circumstances and tackle the uncertainties and risks that are involved (Oyegoke et al., 2008; Ahmed and Mohammed, 2019).

The application of agile practices in a project can offer several advantages, including enhanced motivation, better control of requirements, increased productivity, cost reduction, improved quality, and client satisfaction (Z. Wang et al., 2014). Despite the benefits that these practices can have, it should be acknowledged that the empirical exploration of the agile concept within the construction industry remains relatively uncharted territory, with a scant number of studies compared to the more extensive literature focused on IT and manufacturing industry (Ozorhon et al., 2022).

1.2. Problem definition

As previously mentioned, a construction project often involves many parties, extended time-frames and complicated relationships, all contributing to a high possibility of project risks that continue to increase (Oyegoke et al., 2008; Shayan et al., 2019). Therefore, one of the most crucial processes throughout a project is the risk management, as it can help the team identify the potential risks and their impact in order to determine the response plan accordingly (Marle, 20200). An effective risk management process in the changing competitive environment seems to require combinations of organizational processes that drive central control functions as well as more spontaneous and dispersed risk responses (Andersen, 2010).

Furthermore, an effective and efficient risk management approach necessitates a structured method and, crucially, expertise and familiarity (A. F. Serpella et al., 2014). However, they mention that risk management in construction projects is full of limitations that affect its effectiveness and the projects' overall outcome. Additionally, research indicates that within the construction sector, risk management tends to be reactive, sporadic, informal, and lacks structure, leading to an limited ability to handle risks effectively (A. Serpella et al., 2015). Tah & Carr (2001) explain that the primary obstacles recognized for in an effective risk management system include the system's informal nature and the absence of collaborative mechanisms for risk management among stakeholders of the project.

In addition, individuals engaged in a project frequently lack a unified perception of project hazards and their outcomes, obstructing the adoption of early warning measures and tactics to effectively address issues arising from decision-making at any stage. At the same time, risk identification often occurs solely during the planning and budgeting phase, with inadequate review during the actual execution and implementation of the project (Nielsen, 2006).

The inefficiencies that are noticed in the risk management process that is often followed have increased the need for the implementation of different techniques and methods. Agile techniques and methodology can offer solutions that counteract the barriers of traditional risk management processes. Literature mentions that a risk management plan should be updated, reviewed, and further developed in later stages of the project to have the up-to-date risk information, and this is among others a benefit of using agile methods (Shayan et al., 2019). However, even though the literature that exists surrounding risk management, this is the not the case for the use of agile methods in it (Yaraghi and Langhe, 2011; Odzaly et al.,

2014; B. G. Tavares et al., 2019).

Moreover, while the benefits of applying agile practices in projects, such as enhanced flexibility and adaptability to change, are widely recognized, challenges persist in their implementation within the construction industry, especially in risk management processes. Research indicates that although agile methodologies can facilitate the identification of potential risks, they may not always offer effective management solutions (Pilliang et al., 2022; Buganová and Šimíčková, 2019). This is particularly evident in the construction industry, where the application of agile methods in risk management is scarcely documented, revealing a significant gap between theoretical frameworks and practical application (A. Serpella et al., 2015). At the same time, most existing research has focused on the integration of agile methods within smaller organizations, often overlooking the challenges that larger organizations face that include the difficulty of selecting an appropriate agile method that can accommodate the complexities of large-scale projects (B. Tavares et al., 2022). The literature suggests a pressing need for more inclusive research to explore how different agile frameworks can address these challenges and enhance success factors across varied project environments (Kischelewski and Richter, 2020). Almeida (2021) reinforces this point, advocating for a comprehensive, systematic approach to risk management that is not confined to specific agile practices but is adaptable across diverse organizational contexts.

1.3. Research objective and research questions

The objective of this thesis project is to bridge the gap that exists regarding the risk management process and the use of agile methods in this process in the construction industry. The study aims to address these issues by proposing a framework that implements agile practices with the goal of supporting construction companies in approaching risk management in a way that incorporates agile methods. The main research question guiding this study is therefore as follows:

How can agile methodologies be implemented in the risk management process?

In order to assess this problem, there are certain sub-questions that need to be answered as well:

- SQ1: How is the risk management process described in literature?
- SQ2: What are the key principles and methodologies of APM?
- SQ3: What are the characteristics and pitfalls of risk management in waterfall projects and risk management in an agile context?
- SQ4: Could a framework help integrate agile principles into the risk management process?
- SQ5: To what extent can the current risk management process be improved by using a framework that incorporates agile methodologies?

By addressing these sub-questions alongside the main research question, this study can provide a comprehensive understanding of how agile practices are being used to support and

improve risk management in construction projects, as well as the challenges and best practices for effectively integrating them in a project.

This study aims to provide a comprehensive understanding of agile practices in risk management within construction projects by addressing sub-questions related to their application, the associated challenges, and the identification of best practices for integration, while complementing the main research question.

1.4. Research and practical relevance

This research project has both scientific and practical relevance. First of all, the risk management process including the different tools and techniques, the several steps that it is consisted of, as well as the inefficiencies and barriers in this process are studied. This study aims at examining the implementation of agile methods in the risk management process and their influence on the enhancement of this process. The implementation of agile methods in the risk management process in the construction industry is limited and there is often a gap between literature and real life application (A. Serpella et al., 2015). As mentioned in the problem definition, the concentration of research on smaller companies in existing literature has underscored the necessity for research that is applicable to a broader range of organizational contexts, including those encountering unique in implementing agile methods (Kischelewski and Richter, 2020). Therefore, the ambition of this research is to propose a risk management framework that is adaptable and suitable for application across diverse team sizes and organizational contexts and offers a comprehensive approach to risk management that leverages the benefits of agile methodologies.

A combination of literature review and the examination of the current way in which the risk management process is conducted in an engineering company is used in order to deal with the topics that were mentioned. The risk management process of the company and the way in which it is conducted was examined in order to identify possible inefficiencies. The findings of the literature and the study of the risk management process helped in the creation of a framework that aimed at implementing agile practices in the risk management process. This research can provide suggestions for improving the risk management process in the construction sector with the creation and validation of a conceptual framework aiming at creating a different risk culture and and an increased interaction with risks on an everyday basis.

1.5. Deliverables

There are two main research outcomes that are expected from this graduation project. First, the goal is to enhance the existing literature and research by bridging the gap that exists regarding the use of agile methodologies in the risk management process in the construction industry. Additionally, the research aims at creating a framework that could act as a guide that construction companies can use for the implementation of agile methods in the risk management process.

2

Research design

In this chapter the research approach is explained in the first section, followed by the different research steps that are followed alongside a research outline.

2.1. Research approach

According to Creswell (2018) “research is a process of steps to collect and analyze information to increase our understanding of a topic or issue.” According to Woody (2014), research involves identifying and constantly refining issues, developing potential solutions or hypotheses, gathering, structuring, and assessing information, drawing conclusions, and determining outcomes to confirm whether they correspond with the initial hypothesis. The research process is a series of interconnected scientific actions where each action seamlessly connects to the next. The process is initiated by identifying the research issue and subsequently progresses in an ordered manner through the next.

The three common approaches to conducting research are quantitative, qualitative, and mixed methods (C. Williams, 2007), with the qualitative approach being used in the analysis of the conducted exploratory interviews and questionnaire in this project. One of the purposes of qualitative research is to provide a deeper understanding of the context and it focuses on the “how” and “why” of the phenomenon, with a bigger focus on the process (how are things done0 in this research project. Qualitative research also does not fully depend on the literature review findings, as it aims to provide unique perceptions from people (Creswell, 2018). Exploratory interviews aim at encouraging further research and debate on the topic. This study does not use statistical hypothesis testing as it is qualitative and follows often an interpretive approach. The purpose of this kind of research is to understand the phenomena in depth, rather than to understand the relationship of variables (Henning et al., 2004). At the same time, a certain level of quantitative analysis was done from the qualitative data that were used as way of interpreting the views of people that were interviewed and identifying the frequency of certain answers. The overall goal of the research was to investigate the different constructs and meanings that people attach to their experience (Easterby-Smith et al., 1993).

Taking into consideration the objectives and goals of this research project, the Design Science Research (DSR) approach was deemed suitable. DSR offers a unique methodology

for investigating complex issues and has been applied to different industries, including construction management (Selvakumaran and Hall, 2022). DSR focuses on both the development and evaluation of artifacts in real-world settings, aiming to solve existing problems and making sure that there are not any unwanted consequences (Hevner et al., 2004; Selvakumaran and Hall, 2022). These artifacts can range from models, methods, constructs and frameworks, like this thesis project tries to do as well. A DSR project often employs a cyclic or iterative approach consisting of six activities: problem identification and motivation, solution objectives, design and development, demonstration, evaluation, and communication (Peffers et al., 2007; Azasoo and Boateng, 2015). DSR also often combines, revises and extends knowledge that already exists to create innovative solutions (vom Brocke et al., 2020).

In this study, the adoption of DSR is particularly beneficial given its alignment with the framework proposed. DSR's iterative nature allows for the proposed framework to be continuously refined and evaluated through real-world application. This provides a methodological fit since the project aims not only to understand but also to innovate in the domain, introducing new constructs (Vaishnavi and Kuechler, 2015). In this study, the proposed framework was refined in order to incorporate the feedback gathered from the different evaluation methods that were used.

2.2. Research outline

Based on the modified DSR model presented by Azasoo & Boateng (2015), the research steps in this thesis project are shown below in Figure 2.1.

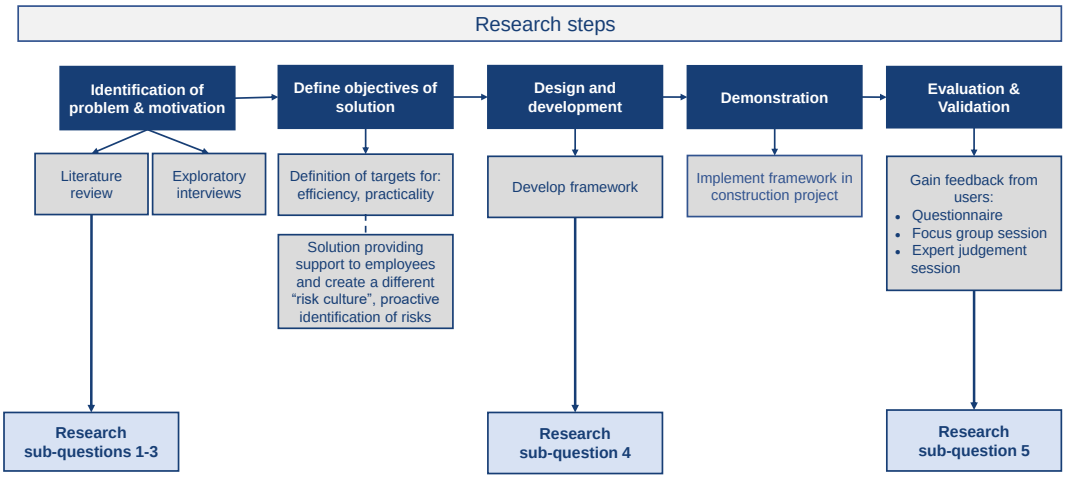


Figure 2.1: Research steps

The first step of this research project was to identify the problems, justify the need for a solution and try to give an answer to research sub-questions 1 to 3. In order to achieve that, a literature review was initially conducted. The literature review regarded APM and its application in the construction industry, as well as the differences between agile and waterfall project management. Additionally, the risk management process, the steps included and the barriers that this process could have, were researched. The literature review also included the characteristics of risk management in waterfall projects and with the use of agile

practices. *Science Direct* and *Google Scholar* were the main sources of information in combination with certain books. In order to find relevant papers, Connected Papers as also often used. This tool helped to find papers that are similar or have referenced another specific paper. An example of that is shown in Figure 2.2 below. The conducted literature review is presented in Chapter 3.



Figure 2.2: Results from Connected Papers when searching the paper by Fernandez & Fernandez (2008)

Alongside the literature review, resources and data were provided by an engineering company, with a complex project environment, facilitating an in-depth exploration of their risk management process. The involvement of the engineering company, which will often be referred to as ”the company” throughout this study, played a pivotal role in grounding theoretical propositions in the realities of industry practices, ensuring that the study’s findings are both relevant and applicable to real-life scenarios. An overview of the risk management process followed in the company is presented in Chapter 4. Additionally, exploratory interviews were conducted with employees of the company, aimed at identifying, among other things, the problems and challenges that professionals face in the risk management process that is currently used. According to Kvale (1994), a qualitative interview is defined as “an interview, whose purpose is to gather descriptions of the life-world of the interviewee with respect to interpretation of the meaning of the described phenomena.”

Additionally, Wünderlich (2009) mentions that a qualitative interview is heavily dependent on the sensitivity and the environment of the interviewee. Throughout these interviews, the researcher follows the rules of good interviewing, such as nods of understanding, maintaining eye contact while being an active listener (Carson et al., 2001). The exploratory interviews in this case could show in practice the inefficiencies and the needs that professionals have regarding the risk management process and the way in which they understand and view the whole process. The analysis of these interviews in combination with the literature review provided the baseline for the next step of the research. The analysis of the interviews is included in Chapter 5.

The next step of the research is to define the objectives of the solution, which can be identified from the problem definition and knowledge of what is possible and feasible. The objectives can also be either quantitative (e.g., terms in which the proposed solution would be better that the current ones) or qualitative (e.g., a description of how what is proposed can support solutions to problems) (vom Brocke et al., 2020). As mentioned earlier, the ultimate aim of DSR is to solve a problem by creating an artifact (Azasoo and Boateng, 2015). In this case, the goal of proposing a solution is to help create a different risk culture where people think actively about risks on an everyday basis and the identification of risks becomes more proactive. An

effort was also made to make the suggestions as easily applicable and as possible and not so complicated so that people would be willing to use it in their everyday work. A target that was set is to raise awareness regarding risks and increase the frequency in which the project team interacts them and actively tries to mitigate them.

After that, the design and development are the next steps, trying to give an answer to research sub-question 4. More specifically, a framework was developed in an attempt to solve the identified problems and optimize the risk management process. The elements that are included in the framework are a combination of literature review findings and the findings from the exploratory interviews. The proposed framework aimed at targeting the problems that were identified while trying to increase the adaptability where risks are identified and addressed in a more proactive way. The overall goal of the framework is to increase the efficiency of the risk management process, increase employees' level of engagement with risks and achieve a more proactive approach towards risk identification and mitigation. The proposed framework was created using the Scrum philosophy while trying to take advantage of the benefits that agile practice can offer. The design of the framework is shown in more detail in Chapter 6.

After the design of the framework, the next steps are the demonstration and evaluation of the proposed framework, which are presented in Chapters 7 and 8. The demonstration of the framework was done through its application in a project that was already in progress in the company. The framework was tested for three weeks by the employees involved in the project team. A questionnaire was sent to the project team after the implementation in order to identify their views and opinions regarding the implementation cycle and the different elements of the framework. A focus group session in which the participants provided feedback that complemented the questionnaire responses was conducted. Additionally, an expert judgment session was held to validate the framework and was pivotal in obtaining expert opinions on the framework's effectiveness and gathering suggestions for future enhancements and improvements. Using the suggestions gathered from these evaluation methods, an updated version of the framework was created along with an explanation of certain steps that need to be taken in order to ensure a successful implementation in the future.

In this thesis project, a pilot testing of the proposed framework was chosen while trying at the same time to give an answer to research sub-question 5. By conducting a pilot test, valuable insights can be gained about the way in which the proposed framework can operate in a real-world context, typically within a controlled environment (Lodhi et al., 2013). This testing phase allows the identification of potential issues and could validate the practicality of the approach while gathering feedback from the people involved (Turner, 2005). Additionally, it offers an opportunity to optimize the framework based on actual user experiences and needs, increasing its chances of success when implemented on a larger scale within a company. Through pilot testing, the framework's feasibility can be assessed, and its effectiveness can be measured.

3

Literature review

This chapter presents the findings on the literature review that was conducted. The following sections give an overview of the history and principles of APM, make a comparison on the characteristics of agile and waterfall project management and present the basic characteristics of Scrum, one of the most known agile frameworks. Additionally, the applications of APM in the construction industry are stated and are being followed by a brief explanation of a typical risk management process. The barriers of risk management along with the consequences that ineffective risk management can have been elaborated. Finally, the characteristics of agile risk management are presented, as well as the benefits and negative elements of it. The literature review chapter will also try to give answers to the following research sub-questions:

SQ1: How is the risk management process described in literature?

SQ2: What are the key principles and methodologies of APM?

SQ3: What are the characteristics and pitfalls of risk management in waterfall projects and risk management in an agile context?

3.1. Agile project management

APM can be traced back to the 1990s when a group of forward-thinking software developers began to question traditional project management approaches and their efficiency (L. Williams, 2010). It was recognized that the approaches that were used so far were rigid, sequential methodologies that often resulted in delayed projects and failed to meet customer expectations. Because of that, they started experimenting with more flexible and iterative approaches that could be used in the sector of software development. APM was created this way, and its aim was to bring a great focus on adaptability, collaboration, and customer satisfaction (Balaban and Đurašković, 2021).

APM consists of several core values and principles. Agile values individuals and interactions

over processes and tools, acknowledging that the success of a project depends on the people involved and their ability to collaborate effectively. Thorough documentation is not crucial, as delivering a tangible outcome to the customer has a higher value. Customer collaboration is another key value, recognizing the significance of involving the customer throughout the project in order to ensure that their needs and expectations are met (Slinger, 2008). Finally, agile values respond to change over strictly following a specific plan. Project requirements can change over time, and it is important for teams to be flexible and easily respond to these changes (Levitt, 2011).

In 2001, the guiding principles of agile project management were formulated by a group of seventeen software development experts. The result was the Agile Manifesto, a framework that outlines four core values, which are prioritizing people and communication above formal procedures and tools, valuing functional software above extensive documentation, favoring client collaboration over strict contract discussions, and emphasizing adaptability to alterations rather than adhering strictly to a plan. These values serve as guiding principles for APM, providing a framework for teams. However, the Agile Manifesto does not include any specific methodology, best practice solutions, or mitigation methods for managing and delivering successful projects. There is not a single solution that could identify and mitigate all project challenges. The existing issues need to be identified and analyzed, pinpoint the factors impacting project success, along with the corresponding mitigation methods, to achieve project success. The Agile Manifesto is consisted of 12 principles (Appendix A) that focus on delivering value to customers through iterative development, collaboration, and adaptability (Sithambaram et al., 2021). The four key principles as described in the "Manifesto for Agile Software" (Cervone, 2011) are:

- Individuals and interactions over processes and tools: Agile emphasizes taking advantage of the strengths and expertise of individuals into a team, facilitating effective collaboration for quick and easy project delivery. This approach moves away from rigid reliance on processes and tools typical of traditional methodologies.
- Working software over comprehensive documentation: Within the agile framework, the priority is on creating operational software, rather than producing elaborate documentation.
- Customer collaboration over contract negotiation: In the agile environment, establishing a partnership with the client is essential to ensuring the delivery of quality products that meets client satisfaction. This approach contrasts with merely adhering to contractual terms, where deliverables are strictly confined to contract clauses, leaving no room for adaptability.
- Responding to change over following a plan: The agile methodology offers significant flexibility, where plans are viewed as guidelines rather than directives that need to be followed strictly, allowing for adjustments whenever necessary.

Overall, agile project management offers a dynamic approach that inherently accommodates the complexities and uncertainties of managing projects. By prioritizing individuals, working outcomes, client collaboration, and responsiveness to change, agile methodologies increase project resilience and help to withstand risks and leverage them as opportunities.

3.2. Agile vs waterfall project management

APM and waterfall project management are two contrasting approaches of delivering value to customers and managing projects. APM acknowledges the unpredictability of projects and the ever-changing requirements of customers and relies on a flexible set of practices, tools, and techniques that allow for quick adjustments and adaptations throughout the project life-cycle. In contrast, waterfall project management is characterized by meticulous planning and control, with an emphasis on defining client requirements at the project's outset and minimizing changes thereafter (Thesing et al., 2021;Makhtar and Khayyat, 2022).

The time, scope, cost and client requirements are determined in the early phases of the project and feedback is given after the completion of each project phase (Lalmi et al., 2022; Alves et al., 2020). This approach depends on the predictability of the project's circumstances and clear understanding of requirements, even though projects often deviate from the initial requirements (Ciric et al., 2019). The project can be approached with a clear objective and structured road-map, envisioning the entire journey from initiation to finalization, using distinct work modules, assigned duties, and deadlines. The primary goal is to execute the initial plan as accurately as possible. This offers consistency and structure, predictable resource allocation, and well-documented planning (Thesing et al., 2021). Literature also refers to the waterfall model as the traditional one, mentioning that is a predictive approach, characterized by defining the scope, time, and cost variables prior to a project's undertaking (Negrete et al., 2023).

In stable environments where projects have clear requirements, constraints and goals, the traditional approach is beneficial and efficient. However, in dynamic and innovative projects, the traditional approach is faced with several limitations. Uncertainties, evolving customer requirements, and complex stakeholder relationships pose challenges that the rigid and plan-oriented traditional approach struggles to address effectively (Thesing et al., 2021; Salameh, 2014).

The emergence of APM was created from the need to manage projects in uncertain and complex environments. Agile methods offer a more adaptive and less rigid management approach, suitable for situations where uncertainty and complexity are significant. Agile methods embrace change, encourage collaboration and creativity and promote the delivery of project components or products in iterative cycles. They provide a valuable alternative to the traditional approach, particularly in innovative projects that demand continuous innovation and cost reduction (Shenhar, 2004). It should also be noted that there are certain success factors that influence the successful implementation of APM. More specifically, Kropp & Meier (2015) mention that there are three major success factors behind the APM implementation, which are culture, people, and communication. Chow & Cao (2008) add delivery methodologies and customer involvement in the key success factors as well.

At the same time, Misra, Kumar & Kumar (2009) highlight the importance of customer collaboration and satisfaction, as well as the employees' skills and training in successfully implementing agile methodologies. In APM, team participants should exhibit advanced technical abilities, proficiency, and knowledge, while being motivated and have knowledge about agile practices and management strategies (Aldahmash et al., 2017).

It should also be mentioned that both approaches have benefits and can coexist within a project or organization, depending on the project's characteristics, level of complexity and external factors, while there are circumstances when a hybrid approach might be considered

the best solution (Ciric et al., 2022). What is more, even though there is literature suggesting the use of hybrid models that combine both agile and traditional methodologies, there are no studies that address the impact of the adoption of these combined approaches in organizations in practice (Gustavsson, 2016). Additionally, Reiff and Schlegel (2022) mention that the attempts of merging both practices are extremely complex when it comes to the decision-makers inside of these companies searching for the correct solutions for their project development and finding the balance between these contrasting approaches poses a substantial challenge.

Certain key differences of waterfall and APM are presented in Table 3.1.

Table 3.1: Characteristics of waterfall and agile project management

	Waterfall project management	**Agile project management**
Approach	Sequential, linear approach, each phase completed in sequence before moving to the next	Iterative, where development cycles are divided into sprints. Teams work on smaller, manageable increments, allowing for continuous improvement and adaptability.
Flexibility	Rigid, with little room for changes or scope adjustments once the project has started	Changes are embraced throughout the project. Requirements can be adjusted, and new features can be added based on feedback and evolving needs.
Scope	Fixed and defined in the beginning of the project. Changes to scope are challenging and may require significant effort and impact the project timeline.	Adaptable and can evolve as the project progresses. Priorities can be adjusted, and new features can be incorporated as the project progresses.
Feedback	Limited and typically occurs at the end of each phase. Clients often see the final product only at the end, limiting their input.	Continuous feedback loops throughout the development process are encouraged. Regular feedback allows for early identification of issues and allows for correction of mistakes, enhancing higher client satisfaction.
Documentation	Extensive documentation at each stage.	Minimal documentation that is often generated when needed.
Team Size	Usually, larger teams with specialists from different domains.	Smaller to medium-sized teams with cross-functional expertise. This allows for effective collaboration, faster decision-making, and better communication.
Time Estimation	Upfront estimation based on requirements and plans, often leading to longer development timelines.	Iterative estimation techniques. Time estimates are refined and adjusted throughout the project, allowing for more accurate planning and responsiveness to changing needs.
Risk Management	Identification and address of risks during the initial planning phases, and any later adjustments require revisiting and possibly revising substantial parts of the project plan	Risk assessment is an ongoing activity, with the team constantly evaluating potential risks and their impact on project deliverables, allowing them to anticipate and address issues before they become critical problems.

The table was created by integrating insights from the literature and more specifically the papers by Thesing et al. (2021), Ciric et al. (2019), Lalmi et al. (2021) and the Project Management Institute (2013).

3.3. The Scrum framework

Even though there is a broad spectrum of agile methodologies, the objectives in all of them are the same. The goal is to replace upfront planning with incremental planning according to the information that is available, minimize the impact that changes could have, increase the client's involvement and the level of communication with them and deliver frequent and continuous value to the organization (Jalali Sohi et al., 2016). Some of the most used agile tools are Scrum, Kanban boards and eXtreme programming (XP) to name a few (Dingsøyr et al., 2012), with Scrum being the most used process (Jalali Sohi et al., 2016; Hidalgo, 2019).

Scrum is a framework that was created by Sutherland and Schwaber between 1993 and 1995 (Sutherland and Schwaber, 2017) and their work strongly influenced the Agile Manifesto. The framework consists of several components, including Scrum Teams, Scrum Events, and Scrum Artifacts and an overview of it is shown in Figure 3.1.

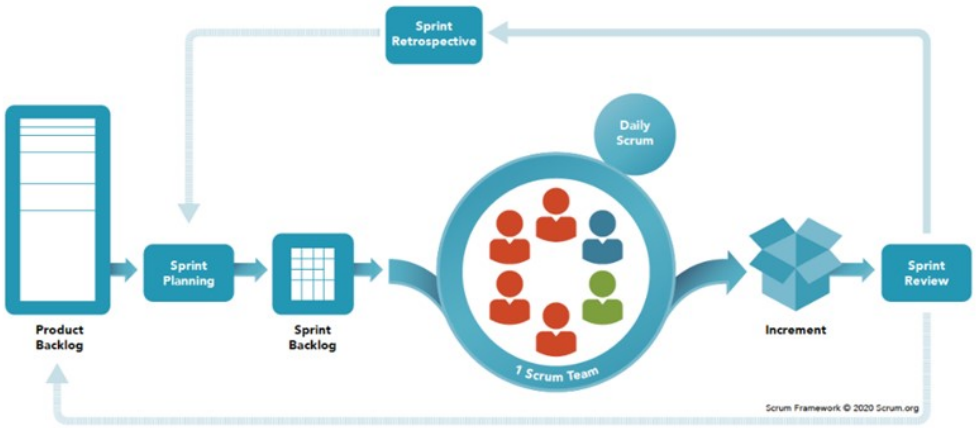


Figure 3.1: The Scrum framework (retrieved from Scrum.org, n.d.)

Scrum Teams are self-organizing, cross-functional groups responsible for delivering increments of work. They typically consist of a Product Owner, Scrum Master, and Development Team. The Product Owner is responsible for defining and prioritizing the product backlog, representing the customer or business interests. The Scrum Master acts as a facilitator and coach, ensuring that the team follows Scrum principles and removing any impediments. The Development Team is responsible for delivering the product increments during the iterations, known as Sprints (Ahmed and Mohammed, 2019).

Scrum Events provide opportunities for collaboration, synchronization, and feedback within the Scrum framework. The main events include Sprint Planning, Daily Scrum, Sprint Review, and Sprint Retrospective. During Sprint Planning, the team defines the work to be accomplished in the upcoming Sprint. The Daily Scrum is a brief daily meeting where team members share progress, discuss challenges, and plan their work for the day. The Sprint Review is held at the end of each Sprint and involves a demonstration of the completed work

to stakeholders. Finally, the Sprint Retrospective is a reflection and improvement session where the team discusses what went well, what could be improved, and makes adjustments for future Sprints (K. S. Rubin, 2013). Scrum was originally recommended for small and medium-sized teams and projects, but today it is also used in large projects and teams (Esteki et al., 2020).

3.4. Agile project management in the construction industry

Even though APM is generally applied in software development teams, its implementation in other businesses is also recommended by experts and project managers, including the construction industry (Ciric et al., 2019). Agile methods can lead to improved project performance by reducing project delays and increasing collaboration and communication among project stakeholders. A more efficient use of resources can also be achieved through agile management, as teams can quickly adapt to changing circumstances and prioritize tasks accordingly (Streule et al., 2016). APM can help construction projects stay on track and tackle the uncertainties and risks that are involved (Oyegoke et al., 2008; Ahmed and Mohammed, 2019). However, even though agile practices can be positively impactful in a project, its implementation is still scarce, and it continues to be explored.

According to Streule et al. (2016) that conducted a case study in which the implementation of Scrum was tested in the design phase of a project, the use of Scrum resulted in higher transparency, better communication and collaboration among the teams and faster project development. Demir & Theis (2016) also mention that APM could be suitable for managing work and tasks in the design phase, especially in the early stages, such as the creation of preliminary design.

As Kumar & McArthur mention (2015), the use of short iterations could result in a clearer communication between client and designer, and therefore reducing re-works and the need for multiple design changes. Additionally, it is mentioned that Scrum could also be successfully used in the construction phase, resulting in a reduction of wasted time. At the same time, it is also claimed that the implementation of APM in the execution phase of a project is more challenging, as there are more interdependent activities, and in general the construction sector is more resistant to change and adopting new techniques (Owen et al., 2006; Kasturiwale and Rathod, 2021).

At the same time, there are authors that have researched the limitations of APM. Agrawal et al., (2016) mention that the biggest limitation of the agile methods is lack of upfront planning followed by lack of sufficient documentation, as agile methods favor the change of requirements, even on a later stage. This can make tracking progress more difficult. What is more, according to Fahmi bin Ismail & Mansor (Ismail and Mansor, 2018), agile methods require more coordination between the various parties that are involved when they are applied in large projects.

According to Miller (2013), the implementation of APM requires an overall shift in the culture of the company, which is not always a reality, and therefore leading to an unsuccessful application. Furthermore, it requires a significant level of expertise in several disciplines, an element that managers often do not pay enough attention to.

3.5. Risk management process

The environment in which construction projects exist is complex and there are plenty of variables that can shape the outcome and the progress of activities. Within this dynamic environment, uncertainties exist, increasing the level of unpredictability of construction projects. In construction projects every activity has a certain level of uncertainty and in order to ensure success in these environments, an in-depth understanding of risk is necessary (Judson and Paul, 2019). Renika, Umarani & Kamal (2014) say that risk is the possibility of being exposed to the effects of uncertainty.

Risk management is considered critical for the projects' success. It helps to identify and mitigate potential risks, allocate resources more effectively and build trust among project stakeholders and overall manage the uncertainties that exist. Doval (2019) mentions that an established risk management process in organization can have positive results if it is integrated in the culture of the team. More specifically, an effective risk management process can ensure a successful identification and managing of risks, keeping track of the progress of the project and the objectives of the organization while maintaining effective communication with external stakeholders.

The project risk can be described as an "uncertainty that has an impact on project objectives" (Hillson and Simon, 2012). If there is a possibility of a positive outcome or benefit being presented from a risk, then opportunities arise (Buganová and Šimíčková, 2019). Schön, Radtle & Jordan (2020) also mention that the distinction between uncertainty and risk lies in the fact that uncertainty can be interpreted as having both advantageous and disadvantageous aspects, while risk is often associated with negative consequences (Moran, 2014).

The main types of project risks are the schedule overruns, financial loss, threat for the successful completion and even failure of the whole project. Risks can also be categorized into dynamic (risk with a gain/loss potential) and static risks (chances for loss without opportunity for gain). Static risks are pure risks, and unlike dynamic risks, have specific solutions. Another division of risks is their categorization into internal risks (within the control of the project team) and external risks (beyond the control of the external team) (Oyegoke et al., 2008). Clements, Drysdale & Francis (2012) mention that risks can also be known and unknown. Certain examples of known risks are safety related risks, exceptionally bad weather and changes in currency values.

At the same time, there are risks that are unforeseen or unknown. Taylor (2006) mentions that a lot of the unforeseen risks that are noticed are related to client relationship and more specifically client trust, client understanding of project requirements and client unwillingness to report "bad" news. It is more difficult to identify these problems from the beginning, as both sides are eager to reach a deal, and everyone is on their "best behavior." Overall, Jaafari (2001) mentions that there are several risk variables that are commonly present in large projects. These are promotion, market, political, technical, financing, environmental, cost estimate, schedule, operating, organizational, integration and force majeure risks.

The risk management process typically consists of several steps which aim at identifying, assessing and mitigating the risks that might have an impact on the organization and project (Salmon, 2020). These steps are:

1. Establishing the goals and objectives: It is significantly important that the objectives, goals and scope of the project alongside its deliverables from the project be established, as the potential risks are influenced by them. This step includes the identification of the key stakeholders, who play a crucial role in risk identification and mitigation. This initial step not only sets the direction for the entire risk management process but also ensures that it is aligned with the project goals, thereby enhancing the organization's ability to tackle uncertainties efficiently. In this step, there are certain tools that can be used, such as a WBS (Work Breakdown Structure) that can be used to get a better understanding of the project through the breakdown of the project in different levels. The basic elements that need to be considered in this step are (Moran, 2014):
    - Risk characterization: Project members must understand the nature of risks associated with the project from the outset and how risk and reward are balanced.
    - Risk communication: Effective risk communication, which may involve expressing risk expectations, is initiated during the planning stage.
    - Risk management capability: It's essential to convey information about the organization's risk management capability and how effectively risks can be managed, including project-related risks.
    - Risk culture: Clarity on the organization's risk culture, encompassing attitudes towards risk, compliance with policies, and responses to negative outcomes (e.g., blame culture), is crucial at this stage.
2. Risk identification: The goal is to create a comprehensive list of risks that could affect various aspects of the organization's operations. These may be external (less control is expected) or internal (more control can be expected) (Moran, 2014). The creation of a risk register, which will also be used in later stages, is recommended in this step. This step can be done through a thorough documentation review and study of similar projects in the past, as well as using information gathering techniques, such as brainstorming, checklist analysis, questionnaires, SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis, expert judgement and cause and effect diagram (Srinivas, 2019).
3. Risk assessment and analysis: Once threats have been identified, the next step is to assess their potential impact and likelihood. This involves analyzing the severity of each threat and the probability of it occurring. Risk assessment helps prioritize risks based on their potential consequences and enables organizations to allocate their resources effectively. Once risks have been evaluated, they are grouped in the risk register. Some of the methods that can be used for the risk assessment are:
    - Quantitative method: This risk assessment is done for those risks that are high/critical/unmanageable. The goal is to estimate the event driven contingency to be included in the estimate in order to limit the probability that the final costs may exceed the total budget to an acceptable level. Quantitative risk analysis is preferred when adequate field data, test data, and other evidence exist to estimate the probability (or frequency) and magnitude of the losses. However, the use of quantitative risk analysis has been restricted to large scope risk analyses, as it is complicated, time-consuming, and expensive (Modarres, 2006). There are techniques that can be used for this assessment, including a Monte Carlo analysis, a decision tree, a sensitivity analysis and a Z-matrix (Srinivas, 2019).

- Qualitative method: Threats undergo a qualitative assessment in which such aspects as probability of occurrence and impact are computed. The multiplication of likelihood and severity gives a value for risk (Munier, 2014). This type of risk analysis is perhaps the most widely used one, because it is simple and quick to perform (Modarres, 2006).
- Pestle analysis: This is a strategic planning tool used to evaluate the impact of political, economic, social, technological, environmental and legal factors that might have on a project. The process involves evaluating the external context prior to initiating a project by the organization. This approach ensures a comprehensive identification of all potential risks and concerns (Rastogi and Trivedi, 2016). This method requires a combination of in-depth qualitative and quantitative discussions.

4. Risk mitigation and contingency plans: Once risks have been evaluated, organizations develop and implement strategies to manage and mitigate them. There are several risk treatment options, including risk avoidance, risk reduction, risk transfer and risk acceptance. During risk avoidance, actions are taken to eliminate or avoid the risk altogether by changing processes, procedures, or business activities. This strategy is mostly used when the outcome of a potential threat is high risk. During risk reduction, measures are taken to minimize the likelihood or impact of the risk, such as implementing safety protocols or redundancies and is used mostly when the mitigation actions can control the potential risks. Risk transfer focuses on shifting the responsibility or financial burden of the risk to a third party, often through insurance or contractual agreements and is used when the likelihood of a risk occurring is low. Risk acceptance aims at acknowledging the risk and deciding to tolerate it without implementing specific risk mitigation measures. This approach is often taken for risks with low potential impact or likelihood, when any negative consequences of the risk are minor, or when the cost of mitigating the risk would be higher than the costs incurred if the risk happened (Munier, 2014).
5. Risk monitoring and review: Risk management is an ongoing process, and it's important to continuously monitor and review the effectiveness of the implemented risk treatment strategies. Regular monitoring helps identify any changes in risk profiles, new emerging risks, or the ineffectiveness of existing risk controls. It allows organizations to adapt and modify their risk management approach accordingly.

3.6. Barriers & pitfalls of risk management in waterfall projects

Research indicates that the construction sector is more prone to risks due to the unique attributes of its projects. The unique characteristics of every project, its complex nature, the involvement of various stakeholders, significant fund requirements, ever-changing conditions, extended timelines, and vulnerability to external elements like weather make it a high-risk industry. These factors significantly increase the levels of uncertainty and risk throughout all phases of construction projects and therefore, risk management should be seamlessly incorporated into project management to ensure the successful execution of construction projects, considering aspects like timeliness, budget, quality, safety, and ecological sustainability (Siraj and Fayek, 2019; Zou et al., 2007).

While risk management is widely recognized as a critical process for identifying and mitigating

risks, approaches that are often used have barriers that hinder their effectiveness (Moran, 2014). In waterfall projects, risk evaluations rely on causal links, event analysis, failure reports, risk assessments, and using historical data for probability computations. However, this method faces challenges when examining complex systems, as it perceives the system as an assembly of elements with linear interactions (Aven, 2016).

By understanding these limitations, organizations can gain insights into the areas that require improvement and develop strategies to overcome these barriers. The most common barriers that are linked with risk management approaches that are used in waterfall projects are resistance to change from employees, poor communication between management and the rest of the project team, lack of training for employees regarding risk identification and interpretation of information as well as lack of resources, such as funds and people (Dandage et al., 2017; Kotb and Ghattas, 2018):

- Resistance to change or employees' inertia is one of the frequently encountered barriers for effective project risk management and leadership.
- Poor communication between top management and the project team leads to risk avoidance, in combination with not enough support from top management.
- High cost of risk management.
- Cross-functional conflicts, as any project consists of a large number of functions, and hence, employees are divided into many functional departments.
- Insufficient resources that result in project failure, despite all the endeavor of the team. The lack of resources such as funds, people, and technology can be a barrier to successful implementation of risk management in any project.
- Failure to clearly define risks.

Another critical barrier in risk management for waterfall projects is the issue of siloing. Often, distinct departments or teams manage risks without collaborating, leading to an absence of a common perspective on project risks. This is detrimental to the organization's ability to cope with interconnected risks effectively (S. Q. Wang et al., 2004). Moreover, risk escalation poses a substantial challenge in waterfall projects. Project managers are sometimes reluctant to bring more attention to emerging risks, generally due to fear of negative consequences or due to a culture that discourages open problem-solving. This often leads to delays in responding to risks, further putting project success in jeopardy (Zwikael and Ahn, 2010).

Additionally, standard risk practices in waterfall models often lack continuous risk assessment. Unlike agile methodologies that encourage ongoing risk evaluations, risk assessment in waterfall projects is generally a one-time activity at the beginning. This limited scope for reassessment hampers the team's ability to adapt to newly emerging risks throughout the project (Raz et al., 2002). Furthermore, they often fail to address the interconnected nature of risks, limiting its ability to mitigate the effects across an organization or system (A. F. Serpella et al., 2014).

Lastly, standard risk practices tend to focus predominantly on negative risks, often ignoring opportunities that could be beneficial to the project. While agile approaches advocate for a balanced perspective on threats and opportunities, risk management in waterfall projects is usually more concerned with risk avoidance than opportunity seeking (Hillson, 2002).

When risks are not handled properly, there could be significant consequences regarding time, budget, quality, and safety. Serpella at al. (2014) highlight that the lack of an effective project risk management mechanism can lead to negative outcomes for project stakeholders, primarily because of the absence of proactive measures to counteract the inherent risks and uncertainties present in any project. The lack of prevention against the risks regarding environmental hazards, communication and scope changes can lead to contractual disputes and increases in costs. At the same time, Ferede, Mashwama & Thwala (2020) mention that ineffective risk management where certain risks have not been taken into consideration can lead to financial loss, loss of trust from the client, reduced quality of the delivered service and even a complete project failure.

The ineffectiveness in risk management can also lead to poor stakeholder relations. Stakeholders include not only the clients but also investors, suppliers, and the community where the project is located. When risks are not managed properly, especially those related to community and environmental impacts, it can lead to public protests or even legal action, affecting the project's social license to operate. Leung, Chan & Olomolaiye (2008) suggest that poor risk management may lead to stakeholder dissatisfaction, affecting future collaboration and potentially leading to a reputational decline for the construction company involved.

Furthermore, lack of effective risk management can also expose the company to various legal liabilities. If, for instance, a construction project fails to adhere to regulatory requirements or fails to fulfill contractual obligations due to poor risk assessment and management, it can result in costly litigation. Winch (Winch, 2010) emphasizes that the lack of effective risk management exposes companies to legal complications that not only have financial implications but also could stall ongoing and future projects.

Last but not least, the financial stability of the entire company could be at risk. Failed projects can result in severe financial stress for a company, limiting its ability to secure new projects and even threatening its existence. According to a report by Mbachu & Nkado (2006), companies that have suffered from poor risk management in one or more projects often find it difficult to recover, especially if they are small to medium-sized enterprises with limited financial resources.

3.7. Characteristics & pitfalls of agile risk management

Moran (2014) mentions that agile methodologies and the feedback mechanisms that they have can reduce (negative) risk by making information available in a timely manner, and therefore the project members can avoid negative outcomes. At the same time, while these can be effective measures to reduce uncertainty, increase transparency and improve communication, none of the agile methods suggests specific activities to manage risks and it often more difficult to scale them up to large projects (2021).

Despite the benefits that the application of agile practices can have in a project, including enhanced flexibility and adaptability to changes, there are still challenges regarding their implementation in the construction industry and more specifically in the risk management process. Even though the Scrum framework utilizes an iteration or incremental approach to optimize the foreseeability of the risks, it does not include sufficient formal procedures for risk management (B. G. Tavares et al., 2019). According to research, while agile methodologies

can help identify potential risks, they do not always provide an effective way to manage them (Pilliang et al., 2022). At the same time, it should also be noted that the existing research regarding the combination of Scrum and agile methods in risk management is limited (B. G. Tavares et al., 2019; Taherdoost and Keshavarzsaleh, 2015).

In agile frameworks, an incremental approach to risk management often replaces the comprehensive risk assessment that is typically created in the beginning of traditional projects. These small assessments occur during each sprint, or short development cycle, allowing the team to rapidly respond to new risks as they emerge. This flexibility can also create problems sometimes, as frequent adjustments may lead to "risk churn," where the focus on immediate concerns may overshadow longer-term strategic risks (Dingsøyr et al., 2012).

Another feature of agile risk management is the spread of risk management responsibilities evenly across team members, ensuring collective participation in addressing risks. In traditional setups, risk management is usually centralized and the responsibility falls in specialized roles. In contrast, agile methodologies spread risk management responsibilities across the team, ensuring collective accountability. While this approach fosters a culture of shared responsibility, as it could potentially lead to a lack of clear responsibility in situations where risks materialize, complicating the process of identifying who is accountable (Neves et al., 2014).

Agile methodologies are also known for their emphasis on human interactions over processes and tools, which can create a strong internal communication structure. However, the focus on internal issues often leaves gaps in external risk monitoring. Relationships with stakeholders, such as subcontractors are often less emphasized, potentially leading to overlooked external risks (Hoda et al., 2010).

It should also be noted that agile methodologies, initially designed for software development, may not perfectly translate to the construction industry, with its unique blend of tangible and environmental risks (Shubh and Gandhi, 2012). In construction projects, certain types of risks like environmental impacts, site accidents, and supply chain disruptions need specific and often pre-planned interventions that may not align well with agile's flexible and evolving nature.

By considering these challenges, project managers can better understand how to adapt agile risk management practices to suit the specific needs and constraints of their construction projects. A one-size-fits-all approach is rarely effective, making it important for teams to adapt agile methodologies according to the issues that are faced (Aziz and Hafez, 2013).

3.8. Literature summary

The literature demonstrates that the construction industry is often more prone to risks and uncertainties due to its unique characteristics such as complexity, varied stakeholder involvement, and vulnerability to external factors like weather. Standard risk management methods, especially those in waterfall projects, although comprehensive, often suffer from various limitations. These range from resistance to change, poor communication, and high costs to the inability to address the interconnected nature of risks. Waterfall methodologies often focus predominantly on risk avoidance rather than seeking opportunities and lack

continuous reassessment of emerging risks.

On the other hand, agile methodologies offer a more flexible approach, allowing for micro-assessments of risk in incremental cycles. These agile practices aim to reduce uncertainty and improve transparency through implicit and explicit risk management strategies. However, agile methods present their own set of challenges when applied to the construction industry. Their implementation in the construction phase could be challenging due to the inter-dependency of the activities. Additionally, agile's strong focus on internal communication can sometimes overlook important external risks involving stakeholders.

The literature also indicates a gap in the comprehensive integration of risk management within agile frameworks like Scrum, which do not possess formal procedures for risk management. What is more, existing research on the between Scrum and agile methods in risk management is limited. Both methodologies have advantages and disadvantages that make them more or less suitable depending on the specific context of a construction project. Agile methodologies, originally designed for software development, may need to be adapted to address the tangible and unique risks of construction projects. In both cases, it appears that a one-size-fits-all approach to risk management is ineffective.

Therefore, while risk management is essential in ensuring the successful execution of construction projects, both agile and waterfall approaches have distinct advantages and limitations. The key lies in understanding these approaches and customizing or even hybridizing them to fit the specific requirements and challenges of each construction project.

Table 3.2 presents the challenges or standard risk management practices based on literature and the ways in which agile methods can help tackle those problems.

Table 3.2: Challenges of waterfall risk management and agile solutions

Challenges in waterfall risk management	How agile methodologies can help
Resistance to change	Agile promotes a culture of adaptability and quick response to change.
Poor communication between top management and project teams	Agile emphasizes transparent and frequent communication among all team members.
High cost of risk management	Agile iterative approach allows for more targeted and thus cost-effective risk assessment.
Lack of formal training	Agile often incorporates risk management training as part of its iterative learning process.
Cross-functional conflicts	Agile promotes collective accountability, which can reduce cross-functional conflicts.
Lack of resources	Agile allows for flexible resource allocation, adapting to the most pressing needs.
Failure to clearly define risks	Agile incremental assessments allow clearer, real-time definition and understanding of emerging risks.
Siloing of risk management	Agile fosters collaboration and breaks down silos through collective risk responsibility.
Risk escalation	Agile encourages timely escalation of risks.
Lack of continuous risk assessment	Agile involves continuous risk evaluation through its iterative cycles.
Focus on negative risks only	Agile incorporates a balanced perspective, considering both threats and opportunities.
Gaps in external risk monitoring	Agile could be adapted to include specific practices for external stakeholder engagement.

4

Risk management process of the company

This chapter will present the different steps that are included in the risk management process that is followed in an engineering company. The description of these steps will help in the analysis of the answers that were given by the interviewees, which are presented in the next chapter. The information presented in this chapter was taken from a document explaining the risk management process and a training course regarding the same topic.

4.1. Description of the risk management process at the company

The company's approach to risk assessment and management is a process that has been developed through a long history of successful project execution and the management of project risks. The approach is based upon a facilitated and structured process. Risk management starts during the proposal stage, continues through project kick-off and throughout the life of a project or program. The company's disciplined, methodical and comprehensive approach to risk management aids a project team in the identification of risks and appropriate preventive measures to mitigate or minimize risks inherent with project execution, including application of lessons learned from past and ongoing projects. Proactively managing project risks contributes to achieving project goals, to the benefit of the project. The process is segmented into five phases that are presented in Figure 4.1 below.

The company manages risk through a process, which is utilized to identify, analyze, and respond to risks and opportunities throughout the project's life cycle. The company has taken its substantial industry experience and proven techniques to establish a standardized process that promotes disciplined reviews for identifying risks, defining mitigation strategies, responding to changes and managing risks appropriately.

The process that is followed consists of a uniform work process, common risk language, analysis, and periodic management reviews. As needed, the project team enlists the assistance of various special-skill individuals and Subject-Matter Experts from supply chain, construction, risk, cost and scheduling, engineering, tax, treasury, insurance, etc. to provide specialist input. In addition, each business unit within the company has assigned at least one

dedicated risk officer to ensure risk awareness, compliance and to participate in the continuous risk management process.



Figure 4.1: Risk management phases (retrieved from company document)

Throughout the process the team is encouraged to not only consider risks that may negatively impact the project's objectives but also to identify opportunities that may enhance the project's performance.

The company's Risk Management Process is illustrated in Figure 4.2 below.

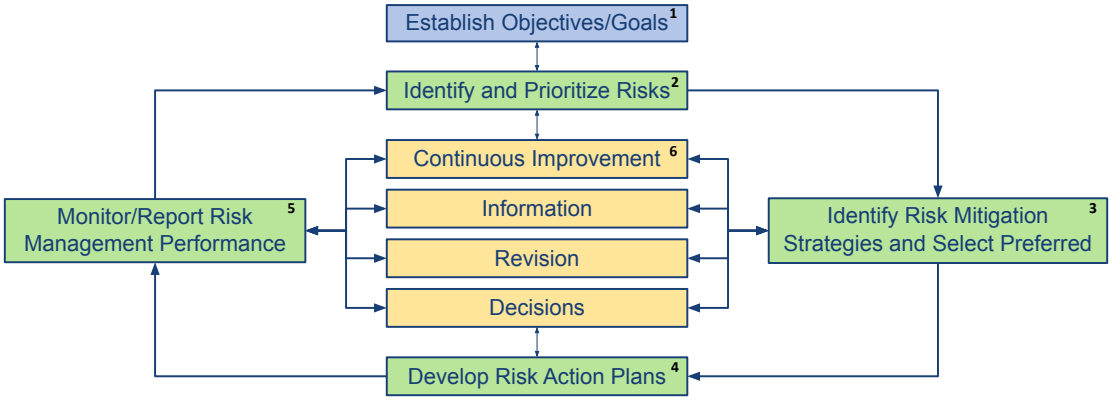


Figure 4.2: Steps of the risk management process at the company

Goals and Objectives Key to any risk management process is to establish the scope, goals and objectives of the exercise. The organization's risk appetite must be identified by defining its project objectives as well as its thresholds and tolerance for deviation from those objectives.

During this stage the role of management in the process should be determined (review and approval process), as well as the need for integration with estimating, scheduling, construction planning, and financial reporting processes should be considered.

Identification The identification stage begins with a brainstorming session to identify risks, their causes and the effects on the project's objectives, including lessons learned from past and ongoing projects. The brainstorming session participants must include all facets of the project team, Project Management, Project Controls, Engineering, Procurement, Construction,

etc. Each participant is encouraged to identify as many risks as they can that could impact a successful project completion.

Risk assessments should include a team discussion regarding potential opportunities to improve upon project objectives.

Assessment After identifying potential risks, the focus then shifts to the assessment of the identified risks. The risks are prioritized – considering severity of the consequences and the likelihood of occurrence - to determine where to focus mitigation efforts. These two factors are combined in a heat map allowing identification of a prioritized risk rating.

Impact Rating (or Prioritized Risk Rating) Table 4.1 below presents a matrix which is utilized to evaluate and prioritize risks based on two axes: Likelihood and Consequence/Severity. The Likelihood is represented on the horizontal axis, ranging from 1 to 5, indicating the probability of a risk event occurring from least likely to most likely. The vertical axis represents the Consequence/Severity of the risk, also ranked from 1 to 5, indicating the level of impact from lowest to highest.

The matrix is color-coded, providing a visual indication of the risk levels:

- The green cells represent a combination of factors corresponding to a lower priority level, suggesting these risks may be acceptable or may require standard mitigation strategies.
- The yellow cells indicate a moderate priority level, suggesting these risks should be managed with deliberate consideration and may need specific action plans for mitigation.
- The red cells denote a high priority level, implying these risks warrant significant attention and robust mitigation efforts due to their high impact and likelihood.

Quantitative measurement for prioritizing risk

Consequence/Severity					
5	3	4	4	5	5
4	2	3	4	4	5
3	2	2	3	3	4
2	2	2	2	3	3
1	1	1	2	2	3
	1	2	3	4	5
	Likelihood				

Table 4.1: Impact rating (retrieved from company document)

Mitigation/Action Plans The company's approach to risk mitigation identifies actions to be taken, identifies any potential mitigation costs and establishes a timeframe for implementation.

Responsibility for leading the implementation of mitigation plans for a risk is assigned to the person or organization that is most capable in managing and mitigating that risk. The risk mitigations proposed are reviewed and agreed upon by all members of the project leadership team, project management, engineering, procurement, construction. It is through this process that the project team develops execution plans and identifies what specific actions are to be taken to avoid the risk or in the event the risk occurs, to minimize the impact to the project.

Monitoring The project manager will monitor the risk assessment to make sure risk mitigation is being implemented on the project and analyze the reported information for gaps or areas of improvement. Risk responsible parties will also make sure risk mitigation is implemented and will report any difficulties to project management. This also includes the identification of any additional risks that were not identified during the initial brainstorming efforts.

As a part of the monitoring process a team review/update of the risks is scheduled periodically or when a risk trigger event occurs. During this review each risk is presented and reviewed as necessary dependent on the progress or phase of the project. The risks and mitigations to be implemented must be reviewed/modified during the course of the project. Some of the risks will be eliminated if the particular risk situation is no longer present. Periodic updates are critical in maintaining a project team's risk mitigation focus and team continuity. This activity provides a methodology to identify any additional risks/mitigation strategies, and also opportunities that may be identified as the project progresses.

Monitoring and identification of new or changing risk is critical to the project success:

- All potential risks will not be identified during initial sessions. Diligence is required.
- Not all mitigations will be effective. Teams must adjust execution plans to drive to the desired result.
- New opportunities for reaching the project objectives may be identified as the project progresses. Teams that identify and exploit new opportunities have successful projects.

4.2. Company's risk management approach & comparison with agile practices

The analysis of the risk management process in the company shows that the approach that is followed is comprehensive and appears to be suitable for complex projects while following the steps that appear in literature. At the same time, comparing this process with the principles of agile methodologies could illuminate potential areas for enhancement, ensuring that the process is used at its optimal capacity.

Rigidity vs Flexibility Company's process is notably structured, offering a methodical framework for risk identification and mitigation. While this approach has advantages and aligns with the PMBOK (Project Management Institute, 2013) and ISO 31000 standards (ISO, 2018), it seems to contrast with agile methodologies that emphasize flexibility. Highsmith (2010) and Conforto et al. (2014) argue that an agile approach allows organizations to adapt to unforeseen challenges rapidly and make changes when required. Given that construction

projects often operate in environments where requirements can change quickly, a more flexible approach could offer advantages.

Timing and Analysis Paralysis The early initiation of risk management in projects facilitates detailed planning but may lead to a seize of action. Sommer et al. (2015) discuss the concept of "analysis paralysis," where excessive upfront analysis inhibits prompt action, a key aspect of agility. The approach that is followed by the company may therefore discourage agile responsiveness and adaptation, potentially slowing down the project and escalating costs. This highlights the importance of an existing balance between thorough preparation and agile execution, especially when unexpected issues arise during project implementation.

Decision-making The company engages a wide array of stakeholders and experts in its risk management process, aligning with standard risk practices like the ones mentioned by Hillson (2002). While comprehensive, this approach could conflict with agile principles that advocate for leaner decision-making structures. Augustine (Augustine, 2008) warns that too many decision-makers can bog down the agile process, reducing the project's ability to adapt to changing conditions.

Monitoring and Adaptation The company employs periodic reviews for risk assessment, a practice somewhat aligned with agile principles of ongoing evaluation and adaptation. However, the academic literature on agile practices suggests a more dynamic approach to risk monitoring. Continuous risk reassessment and real-time adaptation, allow not only the identification of new risks but also the facilitation of significant changes in strategy when warranted (Nerur et al., 2005). Therefore, the quarterly reviews may not fully take advantage of the benefits of continuous, agile monitoring that a more frequent risk review could have.

The risk management strategy that is followed presents a detailed and systematic approach that could be enhanced by incorporating elements of agile methodologies such as aspects of adaptability, real-time response, and streamlined decision-making processes. While both traditional and agile practices have their respective strengths and limitations, enriching the company's current model with agile elements could result in a more dynamic and responsive risk management system. The current approach would blend strategic planning with the agility to swiftly adapt to changing project landscapes, thereby offering a more comprehensive and effective solution for managing risks in various project environments.

In addition to reviewing company documents, exploratory interviews will be conducted to delve into employees' perceptions of the risk management process. These discussions are designed to uncover both the positive aspects and areas needing improvement, as seen through the eyes of those directly involved. The findings from these interviews will be elaborated upon in the following chapter.

5

Exploratory interviews

This chapter will present the results of seven exploratory interviews that were conducted among different employees of the company. The goal of these interviews was getting a better understanding of the risk management of the company, what is the point of view of different employees in order to determine the areas that need to be improved and the ways that agile methodologies can help achieve that.

5.1. Purpose of the interviews

In order to reach one of the end goals of this research and eventually try to give recommendations on how the risk management process can become more agile, several exploratory interviews were conducted among the employees of the company. The purpose of these interviews was to provide a better understanding on the risk management process that is followed in the company in order to identify certain strengths and weaknesses of the process. In order to fulfill this purpose, seven employees were interviewed and shared their opinion and understanding of different aspects of the current risk management process. The ultimate goal of these interviews was to analyze the responses of the interviewees and observe a pattern in them. The selection process is elaborated on in the next section.

5.2. Analysis of the responses

The interviews were all conducted through MS Teams and were comprised of a few introductory questions, several yes/no questions and finally several open questions. To minimize the risk of incomplete data and receiving vague responses from the open-ended questions, phrasing the questions clearly is crucial (Reja et al., 2003). An effort to achieve that was also made in these interview questions. It was decided to interview seven employees that are working in different projects and departments, as it was considered that interviewing people with different roles would give a better understanding of the employees' opinion on the risk management process that is followed in the company. Patton (2015) comments that there are no specific rules regarding the sample size. It depends on what you want to know, what is the purpose and what can be done with the available time and resources. The selection of seven employees

for interviews was therefore determined based on the scope and objectives at this stage of the study. Given that the aim was to gain a nuanced understanding of the company's risk management process from a variety of perspectives, this number was considered sufficient to achieve a comprehensive yet manageable range of insights.

The selection of the interviewees was done from a list that was provided which included the ongoing projects of the company and the people that are working in certain key roles. Each interview was recorded with the consent of the interviewee in order to use the transcript for the analysis. The analysis of the results was done using the *Atlas.ti 23* software in an anonymous way. For the analysis of the yes/no questions, the results were exported from Atlas.ti into an *.xlsx* file in order to create certain graphs. For the analysis of the open questions, Atlas.ti was used to create the tables that are presented in the following sections.

Table 5.1: Description of interviewees

	Interviewees						
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7
Role	Project Manager	Project Manager	Project Control Specialist	Manager of Engineering	Project Controls Lead	Project Director	Lead Piping Engineer
Years of experience	25	22	25	16	30	35	34
Years of working in company	8	16	4	16	22	27	34
Currently assigned to project	YES	YES	YES	NO	YES	YES	YES
Familiar with risk management process	YES	YES	YES	YES	YES	YES	YES
Involved in risk management process	YES	YES	NO	NO	YES	YES	YES
Participation in risk register review meetings	YES	YES	YES	NO	YES	YES	NO
Familiar with frequency of risk register review meetings	YES	YES	YES	YES	YES	YES	YES
Familiar with 'agile' and tools like scrum	YES	YES	YES	YES	YES	YES	YES
Takes risk register into consideration	YES	NO	NO	NO	NO	NO	NO
Responsible for specific risks	NO	NO	NO	NO	NO	NO	YES
Understands impact of risks	YES	YES	YES	NO	YES	YES	YES
Pitfalls prevent interviewee from fulfilling role	NO	YES	YES	YES	NO	NO	NO

The profile of each interviewee is presented in Table 5.1. The table includes the answers to the introductory questions that were asked, alongside the yes/no questions. For each interview transcript and each answer, several codes were created that were later put into groups in order to quantify the results and discover the repeatability of specific words and concepts. The list of the codes that were created from all the transcripts is included in Appendix B.

The table begins with four introductory questions aimed at identifying the roles of the interviewees within the company, their industry experience, and the years that they have been working in the firm. Responses indicate that two of the participants serve as project managers on various projects, while the others occupy distinct roles. Each interviewee brings a substantial amount of experience to the table, and all but one is currently engaged in a project. Furthermore, responses to the subsequent nine yes/no questions indicate a general familiarity with the risk management process among all interviewees, though it appears interviewees 3 and 4 are not actively engaged in this area. This suggests a potential variation in the distribution of risk management tasks or a divergence in the focus areas of these roles.

Additionally, the majority of interviewees are involved in risk register review meetings, and all demonstrate awareness of agile terminology and methodologies such as Scrum, mirroring the organization's move towards agile practices. It is also notable that only interviewee 7 bears responsibility for specific risks, in contrast to their colleagues. The responses to the final question suggest that interviewees 2, 3, 4, and 5 encounter distinct challenges that could hinder their role fulfillment, indicating that certain impediments may be unique to their respective positions or circumstances, with possible implications for their performance in project management or associated activities.

Besides the yes/no questions, there were also several open questions asked. As the Figures 5.1-5.5 below show, most of the interviewees gave the same answer regarding the current frequency of the risk review meetings while most of them responded that these meetings should be held on a monthly basis instead.



Figure 5.1: Frequency of the risk register review meetings

Additionally, all of the interviewees had the same answer regarding the owner of the risk management process. In the question *"How often does the team review the risk register"* the interviewees gave two answers, both indicating that mostly the team leads are reviewing the risk register.



Figure 5.2: What should be the frequency of the risk register review meetings



Figure 5.3: Owner of the risk management process

Figure 5.5 presents the answers that were given regarding the drawbacks that a long risk register can have on the employees and the way that they are dealing with it. The three responses that were given indicate that the longer the list of risks in the risk register, the more likely is that the employees will not be motivated to actually review it. When talking about these drawbacks, interviewee 1 said *"I think that if you have a risk register of 200 risks and you just leave it out there, 200 risks, the only incentive you give people is to avoid the list. And I think you need to help people to, to prioritize. And if you dump 200 actions on somebody's desk, is it all important?"*. At the same time, interviewee 5 said *"And what are you going to do with so many risks? 100 risks? It almost becomes unmanageable, the volume of it on a small project, because you also need to focus the attention of people's mindset on the risks. People get lost in it."*

In the rest of the questions that were asked the interviewees gave more lengthy answers from which different codes were created in the Atlas.ti in an effort to identify patterns and answers that were given multiple times from the interviewees. Table 5.2 shows the responses that were given regarding the steps of the risk management process and more specifically shows how many times specific topics were mentioned across the interviews and the table related frequency of each code. According to the responses, there are certain topics that are



Figure 5.4: Frequency of the team's review of the risk register

mentioned in most of the interviewees, such as the name of the risk process that the company uses and the determination of mitigation actions. Even though there are certain answers that were given by most of the interviewees, the overall answers that were given were different, as none of the interviewees explained the steps of the risk management process in the same way. This is also shown by the 12 different answers that were given.

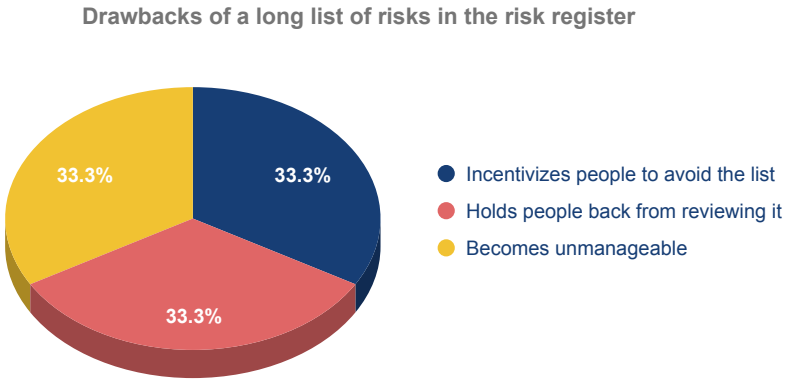


Figure 5.5: Drawbacks of having a long risk register

Table 5.3 below represents the answers that were given regarding the pitfalls of the current risk management process that the interviewees have noticed. As the table shows, seven answers were given with three of them being mentioned in two interviewees. One of the answers that was given twice was the limited involvement of people except for the team leads, which is something that Figure 11 indicated. A quote from interviewee 1 was *"The system that the company uses is way too rigid and requires way too many things to be filled, so, I think the tool itself is anything but agile. And how I deal with that is just not deal with everything that I think is not really helping me."* In the same question, interviewee 3 said *''So, the attention on risk management is not enough. And there's a lot of firefighting going on. The company has tried to introduce this agile Scrum lean into the company since 2018. But nobody actually has a clear idea."* Additionally, an interesting issue that interviewee 4 raised was that sometimes people do not understand the problem that lies underneath. The

Table 5.2: Steps of the risk management process

	1: interviewe... 30	2: interviewe... 24	3: interviewe... 22	4: interviewe... 27	5: interviewe... 27	6: interviewe... 25	7: interviewe... 22	Totals
allocate cost 1				1 3.45%				1 3.45%
assign owners to risks 1					1 3.45%			1 3.45%
categorization of risks 1							1 3.45%	1 3.45%
contract risk 1	1 3.45%							1 3.45%
mitigation actions 6	1 3.45%		1 3.45%	1 3.45%	1 3.45%	1 3.45%	1 3.45%	6 20.69%
Monte Carlo 1			1 3.45%					1 3.45%
PMAR 1					1 3.45%			1 3.45%
prioritization of risks 1	1 3.45%							1 3.45%
proposal phase 4	1 3.45%	1 3.45%		1 3.45%		1 3.45%		4 13.79%
quarterly based risk management followed in company 6	1 3.45%	1 3.45%	1 3.45%	1 3.45%	1 3.45%	1 3.45%		6 20.69%
risk register 4	1 3.45%		1 3.45%		1 3.45%	1 3.45%		4 13.79%
trigger event 2	1 3.45%					1 3.45%		2 6.90%
Totals	7 24.14%	2 6.90%	4 13.79%	4 13.79%	5 17.24%	5 17.24%	2 6.90%	29 100.00%

Table 5.3: Pitfalls of the risk management process

	1: interviewe... 30	2: interviewe... 24	3: interviewe... 22	4: interviewe... 27	5: interviewe... 27	6: interviewe... 25	7: interviewe... 22	Totals
firefighting action 1		1 5.00%						1 5.00%
I cannot identify them 1							1 5.00%	1 5.00%
lack of training and understanding of the risk identification discussions 1		1 5.00%						1 5.00%
limited involvement of people besides team leads 1				1 5.00%				1 5.00%
mitigation actions 6	1 5.00%		1 5.00%	1 5.00%	1 5.00%	1 5.00%	1 5.00%	6 30.00%
numerous pre-determined risks 1				1 5.00%				1 5.00%
people are not accountable, leading to micromanaging 1	1 5.00%							1 5.00%
risk descriptions are often not accurate enough 1						1 5.00%		1 5.00%
risk register is too long and detailed 2					1 5.00%	1 5.00%		2 10.00%
risks are added multiple times in the risks register 1		1 5.00%						1 5.00%
the cuurent system is bureaucratic and time consuming 2	1 5.00%					1 5.00%		2 10.00%
the review of the risks is not frequent enough 1	1 5.00%							1 5.00%
the risk level categorization is often not accurate, too soft 1						1 5.00%		1 5.00%
Totals	4 20.00%	3 15.00%	1 5.00%	3 15.00%	2 10.00%	5 25.00%	2 10.00%	20 100.00%

interviewee most specifically said *"A lot of times people are blaming the tool that the company uses. But regardless the tool, we know tools will always be in the way and it's always cumbersome. It's more, the mindset and I think we are not looking ahead. And people say oh I don't have time for that. But the problem I think lies underneath. People do not understand the importance of risk management."*

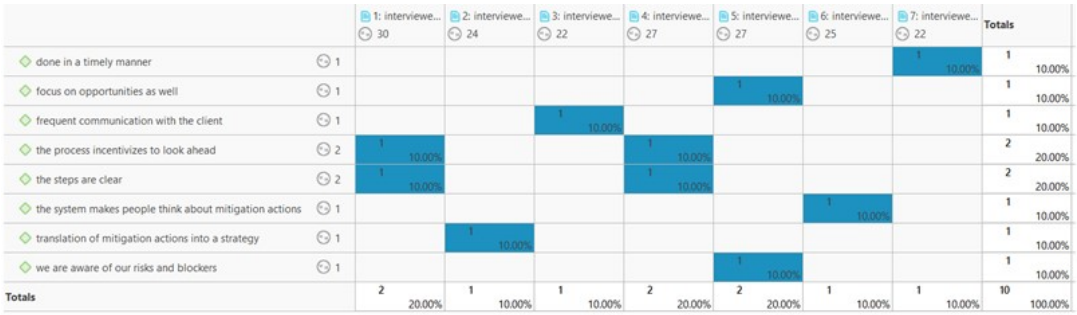
Table 5.4 shows the results regarding the positive aspects of the risk management process. There were mainly eight answers given, while two of them were mentioned by two interviewees. In this case, the answers were different like the previous question regarding the pitfalls.

One of the questions that was then asked was *"What is your understanding of working in an agile way?"* where the interviewees gave the characteristics that think agile working has. As Table 5.5 shows, only one answer was given twice.

Based on the answers that were given on the questions regarding the frequency in which the team reviews the risk register and the pitfalls of the risk management process, a follow up question was asked to try to determine the reasons of the limited involvement of people besides the team leads in the risk management process.

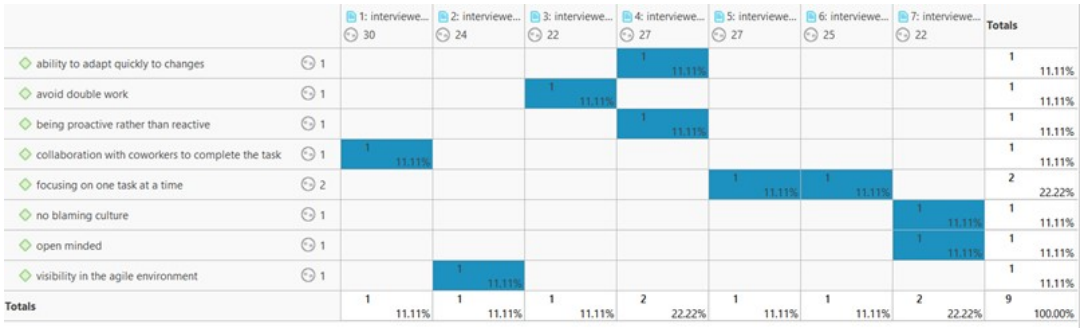
Table 5.6 shows the responses that were given, with one answer being given by two interviewees. When responding to this question, interviewee 1 said *"I expect you as first within the team to step forward and help elevate what is important. Instead of me sitting in*

Table 5.4: Positive aspects of the risk management process



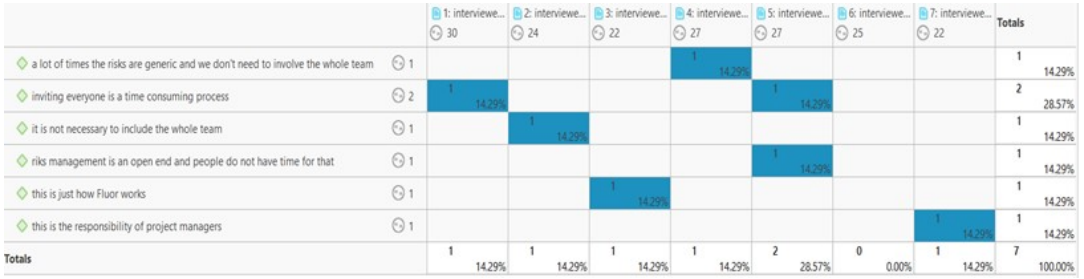
		1: interviewe... 30	2: interviewe... 24	3: interviewe... 22	4: interviewe... 27	5: interviewe... 27	6: interviewe... 25	7: interviewe... 22	Totals
done in a timely manner	1							1 10.00%	1 10.00%
focus on opportunities as well	1					1 10.00%			1 10.00%
frequent communication with the client	1			1 10.00%					1 10.00%
the process incentivizes to look ahead	2	1 10.00%			1 10.00%				2 20.00%
the steps are clear	2	1 10.00%			1 10.00%				2 20.00%
the system makes people think about mitigation actions	1						1 10.00%		1 10.00%
translation of mitigation actions into a strategy	1		1 10.00%						1 10.00%
we are aware of our risks and blockers	1					1 10.00%			1 10.00%
Totals		2 20.00%	1 10.00%	1 10.00%	2 20.00%	2 20.00%	1 10.00%	1 10.00%	10 100.00%

Table 5.5: Characteristics of working in an agile way



		1: interviewe... 30	2: interviewe... 24	3: interviewe... 22	4: interviewe... 27	5: interviewe... 27	6: interviewe... 25	7: interviewe... 22	Totals
ability to adapt quickly to changes	1				1 11.11%				1 11.11%
avoid double work	1			1 11.11%					1 11.11%
being proactive rather than reactive	1				1 11.11%				1 11.11%
collaboration with coworkers to complete the task	1	1 11.11%							1 11.11%
focusing on one task at a time	2					1 11.11%	1 11.11%		2 22.22%
no blaming culture	1							1 11.11%	1 11.11%
open minded	1							1 11.11%	1 11.11%
visibility in the agile environment	1		1 11.11%						1 11.11%
Totals		1 11.11%	1 11.11%	1 11.11%	2 22.22%	1 11.11%	1 11.11%	2 22.22%	9 100.00%

Table 5.6: Reasons only team leads are mostly involved in the risk management process



		1: interviewe... 30	2: interviewe... 24	3: interviewe... 22	4: interviewe... 27	5: interviewe... 27	6: interviewe... 25	7: interviewe... 22	Totals
a lot of times the risks are generic and we don't need to involve the whole team	1				1 14.29%				1 14.29%
inviting everyone is a time consuming process	2	1 14.29%				1 14.29%			2 28.57%
it is not necessary to include the whole team	1		1 14.29%						1 14.29%
riks management is an open end and people do not have time for that	1					1 14.29%			1 14.29%
this is just how Fluor works	1			1 14.29%					1 14.29%
this is the responsibility of project managers	1							1 14.29%	1 14.29%
Totals		1 14.29%	1 14.29%	1 14.29%	1 14.29%	2 28.57%	0 0.00%	1 14.29%	7 100.00%

each and every meeting with each and every team and being part of it." Interviewee 3 in this question also said *"People are working for multiple things and are quite busy already. People are working on their own stuff and the risk is kind of forgotten."* In this topic, interviewee 5 also said *"So, it's about, workload. It's about focus. I think there is focus on risk management for sure by a small group and it's also can be a little bit overwhelming. You open the list and there are like 250-line items. And people do not want to work on that. I think it's about focus and about workload, in my view."*

5.3. Assumptions and conclusions

Based on the answers that were given there are certain conclusions and assumptions that could be made. As the answers from the open questions indicate, there were various different responses given in the open questions. There has been an effort to identify a pattern in the responses, but this is not possible in most of the cases, as there were only one or two answers that were given by all the interviewees. Therefore, an assumption that can be made is that the limited number of people that were interviewed influences the ability to create a response-based pattern.

At the same time, six out of seven interviewees had a different role in the company and different level of experience. Because of these parameters, the interviewees could have a different level of knowledge, involvement and understanding of the risk management process, and therefore the responses might differ. More specifically, the interviewees that had a lead role could describe the risk management process and identify the pitfalls more easily. If the sample of the interviewees was larger, then the responses could also have more coherence and more common elements could be found. Additionally, the different answers of interviewee 4 in the yes/no questions who was the only one that was not assigned to a project, could potentially indicate that the risk management process in the company is project-based.

Overall, the responses of the employees show that they have identified certain inefficiencies in the company's risk management process alongside the positive aspects. Some of the topics that were mentioned were the lack of act upon mitigation actions, the bureaucratic nature of the risk management process that is used in the company and the fact that often risk registers are long and the several risks are included multiple times, which decreases people's motivation to actually review the risks on an everyday basis. Furthermore, it was highlighted that people often do not understand the importance of risk management and the impact the risks can have. Feedback received also highlighted the lack of training and understanding surrounding risks along with the not so frequent review of risks which fuel the lack of motivation and risk prioritization. By addressing these issues, the company can cultivate a risk-aware culture that recognizes the value of active participation and effective risk mitigation in driving project success and fosters a deeper understanding of risk management's critical role.

6

Framework design

This chapter will introduce the proposed framework and its different elements, while also elaborating on the rationale behind its creation and its goals. At the same time, this chapter will try to give an answer to the following research sub-question:

SQ4: Could a framework help integrate agile principles in the risk management process?

6.1. Imperatives for change & framework rationale

The construction domain is dynamic, characterized by constant challenges and opportunities. Agile project management, with its focus on frequent communication and engagement throughout the project, short iterations, and adaptability, can often offer solutions for these challenges. These agile principles were taken into account for the creation of a framework, recognizing their value in promoting flexibility and responsiveness. There are different definitions for what a framework is, and they often vary according to the discipline and field. Partelow (2023) mentions that a framework provides a structured lens through which ideas, rules, and beliefs are organized to plan, decide, or solve problems within a particular field. A framework is not only a collection of tools or practices, but it also embodies a coherent set of assumptions, concepts, and values that inform and shape the approach to a specific issue or domain.

Taking into consideration the APM theories and key principles, alongside the invaluable insights gained from the conducted exploratory interviews, this framework offers a comprehensive and practical solution rooted in empirical insights aiming at addressing the problems that are faced throughout the risk management process and aid both project managers and employees in their effort to navigate the imminent project risks with adaptability and efficiency. Through this chapter, the aim is to demonstrate how these agile principles can be combined with the risk management process and provide a practical path forward. The goal is to help both project managers and employees in their effort to tackle imminent project risks with adaptability and efficiency. This goal aligns with the conceptualization of a framework as a structured approach designed to solve problems within a specific domain, while incorporating tools and practices that will be presented in more detail

later on in this chapter.

Furthermore, the proposed framework is not solely a theoretical construct, but a practical solution based in empirical insights. The invaluable experiences and perspectives of risk experts, team leads, and project managers have been collected through the exploratory interviews. Their feedback has been crucial in creating a framework that not only aligns with the principles of APM but recognizes the real-world challenges and opportunities that construction projects present as well. The following sections will elaborate further on the proposed framework, including its development and structure.

The results from the exploratory interviews have unveiled the key drivers necessitating a shift in how risk management is approached within the company. These results, in combination with the fact that even though risk management exists in most companies as a concept, there is often not a concrete plan and procedure that is followed and is characterized by several restrictions (Adeleke et al., 2019), inspired the creation of a framework that could act a guidance to construction companies (Iqbal et al., 2015).

To begin with, the exploratory interviews have brought to light an understanding among employees of the existence of a risk management process within the organization. However, upon closer examination, it becomes obvious that while there is a general awareness of this process, individuals often struggle to name each step, in detail. This could highlight a gap between knowledge and practical application.

One recurring theme that emerges is the recognition that individuals may not always be aware of the specific risks they are responsible for, let alone actively monitoring them in their day-to-day work. Moreover, employees often express a sense of being overwhelmed when it comes to navigating the risk register, which frequently leaves them unsure of where to initiate their risk-related efforts. Furthermore, the significance and potential impact of these risks are not always well understood. This lack of clarity often translates into a lack of motivation to engage proactively with risk management.

Additionally, it is understood that although there is a standard risk management process within the company, the level of engaging with the risks is not the same among the different projects. In certain projects, employees follow the basic process while in others there is an effort to *“keep the conversation open”* regarding risk management.

However, this situation sheds light to a common issue encountered in many organizations as the existence of risk management is often known as a concept, but its integration into everyday work processes is often incomplete. This scenario is not unique to the company following a quarterly based risk review and is something that is taken into consideration when creating the framework. The intention is to create a guideline that can serve as a practical resource for employees, not only within the company but for companies within the construction industry. This framework can facilitate the integration of risk management into daily operations, fostering a more proactive and informed approach to dealing with risks. The development of a practical framework aims to contribute to an open conversation about improving risk management practices in the construction industry and will serve as a flexible and adaptable tool that can be modified and applied in various organizational settings to meet specific needs and promote a culture of proactive risk management.

Another significant insight from the interviews is the opinion among employees that they are navigating risk management in a manner that is not uniformed. They understand that

they have a role to play in addressing risks, but there is often a lack of clarity regarding their specific responsibilities. This unsureness can lead to sub-optimal risk management practices and a sense of disconnection between individual contributions and project outcomes. What is more, the analysis of the interviews showed that a many employees think that there is often firefighting action and not a more proactive approach and as mentioned in literature, a reactive response to the occurrence of risks can potentially result in increased project costs and delays (T. Williams et al., 2012).

The proposal of a comprehensive framework emerges as a logical step forward in addressing these challenges. By providing a framework that offers a clear and user-friendly road-map for risk management, employees will have a reliable guide to navigate the intricacies of risk identification, assessment, and mitigation. Such a framework will not only streamline the risk management process but also bridge the gap between awareness and practical application.

The development of a comprehensive risk management framework has also been significantly enriched by discussions with the project manager of the project in which the framework would be implemented and evaluated. These conversations have played a pivotal role in validating the challenges and efficiencies identified previously, while also providing valuable clarity regarding the objectives that guide the creation of the framework.

The ultimate goals guiding the framework development are part of a bigger effort of achieving a more proactive and effective risk management culture and align with agile principles including accommodating changes and issues that may arise, collaboration between project team members, short iterations and regular reviews and reflections (Rosser, 2015). Therefore, the creation of the framework has certain objectives that could help reach its ultimate goal. These objectives are:

- Better prioritization of risks: The first objective is to enhance the prioritization of risks, ensuring that the most critical ones receive the attention they deserve. This includes recognizing that not all risks are equal and that resources should be allocated according to their potential impact. Assigning clear ownership of risks is also considered a priority, as it promotes accountability and ensures that risks are actively managed.
- Motivating involvement and highlighting importance: Another key objective is to motivate individuals to actively participate in the risk management process and recognize the vital role they play in ensuring project success. This goal seeks to make employees aware of the significance of their contributions to risk identification, assessment, and mitigation.
- Improved communication and monitoring: Effective communication between team leads and team members regarding risks, blockers, and difficulties associated with mitigation actions is crucial. Continuous monitoring is considered fundamental as well. Regular reviews and updates of risk information are therefore recommended, alongside providing support from risk experts to ensure a dynamic risk management process. Furthermore, the importance of feedback loops is emphasized, encouraging team members to provide insights on risk assessment and mitigation actions. This encourages a culture of continuous improvement, where lessons learned contribute to ongoing enhancement.
- More frequent reviews: To enhance adaptability and responsiveness, the fourth objective is a shift towards more frequent risk assessments and reviews, ensuring that

risks are continuously monitored and addressed as the project progresses.

- Visual management tools: Transparency and engagement could be enhanced by the implementation of visual risk management tools, such as risk boards or Kanban boards, to enhance communication and visibility of risk-related activities. Familiar tools like those used in platforms such as Teams can be a valuable reference. Improving the version of an existing risk management tool often proves to be more beneficial than creating a new system with a completely new approach. Therefore, the creation of a framework focused more on daily engagement as frequent interactions and immediate interventions can show progress. The incorporation of metrics and reporting for real-time insights into progress is considered beneficial as well. Metrics such as risk velocity, measuring the time between risk occurrence and its impact, provide valuable insights into risk management effectiveness.
- User-friendly guide: One of the framework's key objectives is to offer a straightforward and practical guide that can be easily applicable without overwhelming users.
- Creating a new risk culture: The ultimate goal is to create a distinct risk culture within the organization. This cultural shift aims to instill a proactive approach to risk management, where employees actively think about risks, prioritize them, and engage in proactive decision-making.

A summarized overview of the most important issues that were identified, the inputs and goals of the suggested framework are shown in Figure 6.1.

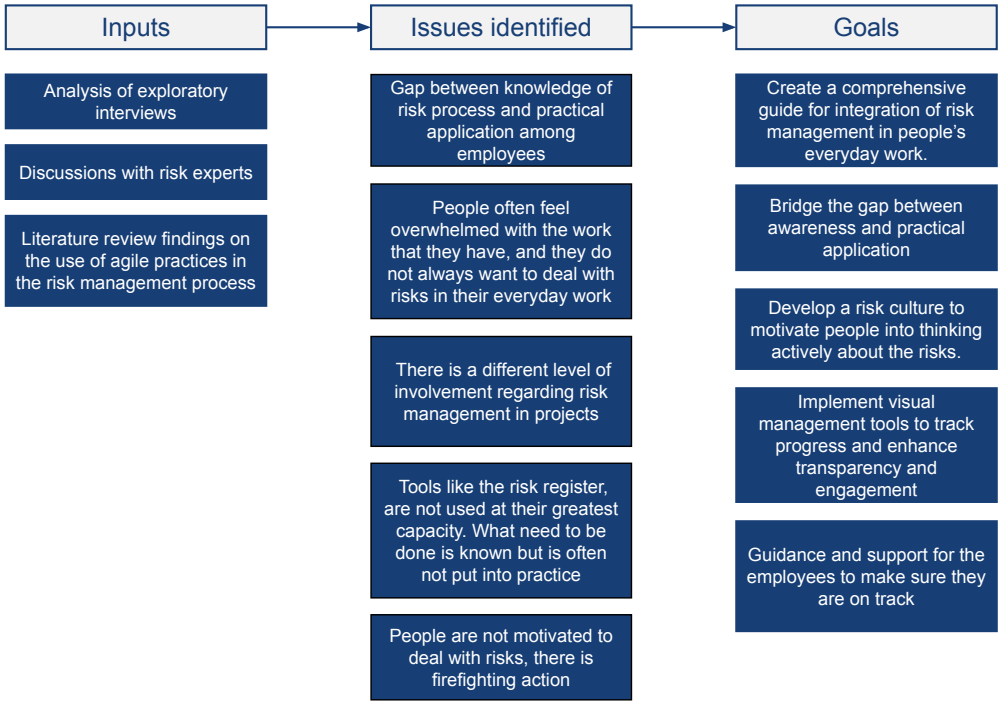


Figure 6.1: Overview of input, issues, and goals of suggested framework

6.2. Framework development

Taking into consideration what was described in the previous section, the specific elements of the framework and a visual representation of it are presented in Figure 6.2.

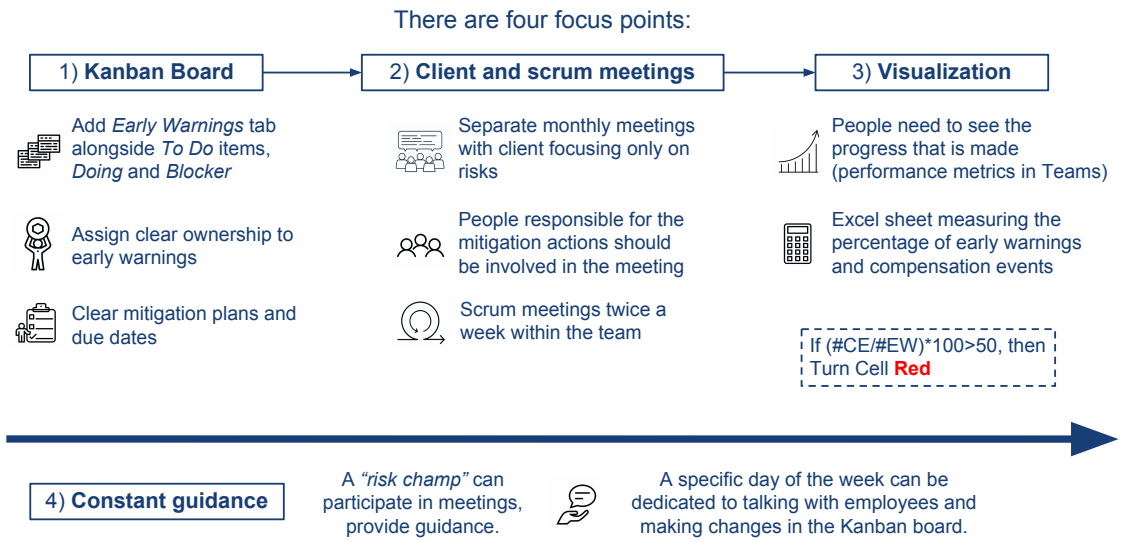


Figure 6.2: Suggested framework

As Figure 6.2 shows, there are four focus points in the suggested framework. First of all, Kanban boards are a fundamental tool in Agile methodologies, offering real-time visualization for managing tasks (Anderson, 2010). Dividing tasks into tabs like *Backlog, To Do items, Doing, Blockers,* and *Early Warnings* ensures systematic tracking. Digital tools like Microsoft Teams can support Kanban boards with collaborative features and accessibility, as they can be used anytime by employees. What is more, transparency in risk descriptions is essential, as well-defined risks can increase the level of understanding and facilitates effective management strategies (ISO, 2018).

According to Nikander (2002) an Early Warning (EW) is an observation that is or can be seen as an expression, an indication, a proof, or a sign of the existence of some future or incipient positive or negative issue, making their connection to risk management obvious. EWs provide an indication of evident risks and thereby an assessment of a project's exposure to future problems and failure (Kappelman et al., 2007). They are also crucial for decision-making as they provide sufficient time before an actual problem materializes, offering a valuable opportunity to assess and choose appropriate responses and this can critically determine whether a project will meet its objectives in the given circumstances (Nikander, 2002).

Dai & Ke (2022) mention that the utilization of EW is integral to the fortification of risk management strategies as they can help detect and manage potential cost-related risks and they are crucial for mitigating risks (de Elía et al., 2023) ensuring that project trajectories align with predefined financial and losses are minimized. In this case, EW are used the same way that they are described in the NEC4 contracts.

It is described as a notification given when a party becomes aware of any matter that could

potentially change the project's outcome, such as affecting the total cost, delaying completion, or impairing the performance of the works when in use, even if the change is not certain to happen (Klein, 2017). The increased number of EW could show that people are more aware of the risks that exist and that they will be more prepared for them.

The second focus point is client and scum meetings. Regular interactions with stakeholders are essential to achieving effective risk management. Therefore, client meetings dedicated solely to risks should be conducted monthly, where open discussions about potential concerns could take place. At the same time, internal Scrum meetings promote team collaboration, ensuring that everyone is aligned with the project's goals (Sutherland and Schwaber, 2017). Having these meetings twice a week ensures continuity in operations and allows for quick adjustments when necessary. The frequency of these meetings could be adapted in case there are specific risks that need constant attention from the team until they are under control.

The third focus point is the importance of visualization. In today's fast-paced construction environment, real-time visualization tools are a necessity. Tools like the performance metrics tab in Teams can keep the team informed and motivated. An additional measure, like an Excel sheet tracking the percentage of EW against compensation events, provides quantitative feedback. Ensuring this ratio remains below 50% can be a potential key performance indicator, promoting proactive risk handling and minimizing project costs (Kerzner, 2017). If the team ensures that the compensation events are kept to a minimum and the ratio remains under 50%, this could be presented to the client and could convince them to give incentives. Every time an EW is mitigated without needing a compensation event, the client saves money and time.

The fourth focus point is the need for constant guidance and support. To make risk management part of daily operations, ongoing guidance is essential. Assigning a "risk champ" ensures that there is an expert on hand to provide advice, support, and most importantly, accountability (Raz et al., 2002). Regular check-ins, possibly on a dedicated day, can ensure that risk mitigation measures are being followed, and adjustments to the Kanban board can be made in real-time. A close collaboration between the project manager and "risk champ" is crucial as employees are more inclined to engage with and adhere to the process when encouraged by individuals they interact with regularly and trust.

While the proposed framework focuses on daily risk management activities, the significance of the quarterly risk register remains great. The steps that need to be followed to create a risk register that is easily readable and understandable by employees are already known to employees. However, these steps are not always followed, and the document is not used to its fullest. The proposed framework therefore tries to focus on areas of frequent interaction, to incorporate risk management in daily operations and promote proactive measures over reactive responses in ways that incentivize people to deal with risks more frequently.

Figure 6.3 shows an example of a MS Teams environment with some of the suggestions implemented. It is important for each item to have clear ownership and action plans so that the people responsible can have a clear path to follow.

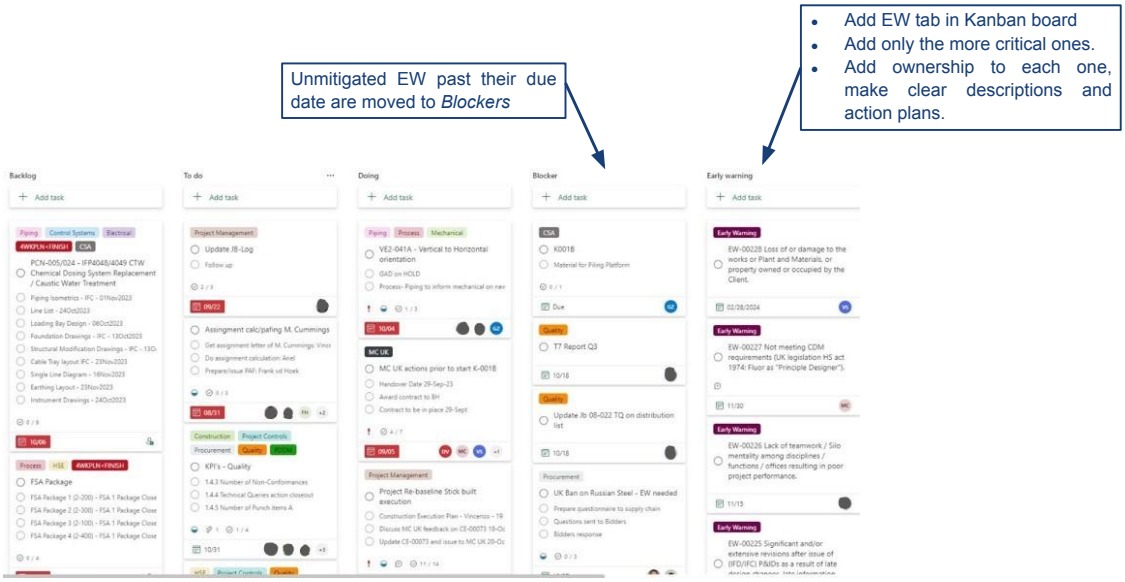


Figure 6.3: Example of a Kanban board in the MS Teams environment

7

Framework evaluation

This chapter presents the implementation of the proposed framework in a company project. The characteristics of the project and the reasons for its selection are also elaborated on, alongside the implementation process. Additionally, the questionnaire that was distributed amongst the participants of the implementation process and its analysis will be presented. Finally, the focus group session that was conducted will be explained. The chapter concludes with key findings and conclusions drawn from both the questionnaire results and the focus group discussion, offering insights into the framework's effectiveness and areas for improvement. This chapter aims to give answer to the following research sub-question:

SQ5: To what extent can the current risk management process be improved by using a framework that incorporates agile methodologies?

7.1. Project selection

The selection of a project for the application of theoretical frameworks is important as it can provide both a methodological foundation and a practical illustration of the research's applicability. In the context of the current thesis, an engineering project has been selected for the implementation of the proposed framework.

Before selecting the project for the framework's implementation, various other projects were evaluated for their suitability. However, these alternatives were ultimately not chosen due to specific constraints that did not align with the objectives of this research. For instance, the project manager for one of the potential projects was abroad, making coordination challenging, while another project's start date was too late to fit within the research timeline.

Conversely, the selection of this project as the ideal candidate for the study was influenced by a variety of factors. First of all, the project stands out as the largest Engineering, Procurement, and Construction (EPC) project within the company's portfolio which suggests a complex risk landscape. The project had also already experienced a series of modifications, indicating a dynamic operational environment that is ideal for the assessment of the framework's adaptability and resilience in the face of change.

Further, the temporal phase of the chosen project was such that the introduction of new changes remained feasible, thereby allowing for a real-time evaluation of the framework's implementation impact. This aspect of timing is critical, as it aligns with the academic endeavor to not only propose theoretical constructs but also to observe their integration and efficacy within a live project cycle.

Additionally, the client's emphasis on active risk management aligned with the research's purpose to refine and apply agile risk management practices in a setting where their value is acknowledged and encouraged.

Lastly, the project manager of the project, with his expert knowledge in risk management, provided an invaluable partnership in this academic endeavor. His openness to incorporating new strategies and his expertise in risk management enhanced the potential for a successful relationship between the academic framework and practical application. His presence ensured that the theoretical constructs posited in this thesis would be met with a constructive perspective, creating the ideal environment for the application of the proposed suggestions. What is more, the team has already been trying to incorporate certain agile practices, such as Scrum meetings, and achieving a more proactive approach to risk identification, which is not always the case in other projects. This therefore indicates that the implementation of the framework may be perceived in a more positive way.

Overall, the selected project presented itself as a suitable candidate for the implementation of the agile risk management framework. It offered a unique combination of size, stage, change predisposition, client interest, and managerial openness, which collectively promised fertile ground for academic investigation and practical application.

The project had a start date in 2022, and a finish date set for 2025. However, due to delays, the projected completion was extended to February 2026 due to various factors, such as client-requested changes and strategic adjustments, reflecting the project's dynamic and evolving nature.

7.2. Implementation process

Trials, also known as trial implementations or proofs of concept, play a crucial role in project management. They involve testing ideas, processes, or tools on a small scale to determine their feasibility and effectiveness before a comprehensive roll-out. This method provides an opportunity to assess the practicality and potential obstacles of a project, allowing for the collection of valuable insights and identification of any issues. Furthermore, trials are instrumental in verifying assumptions, improving procedures, and achieving efficient resource allocation, therefore helping in making decisions about larger-scale implementations (Institute of Project Management, 2023). The implementation of the suggested framework in this project exemplifies a trial, as it was implemented for a certain period of time on a smaller scale in order to test a new idea.

This trial period aimed to assess the viability and effectiveness of the suggested agile framework over a period of three weeks. This duration was chosen as it was deemed sufficient to observe potential results and changes in the project's risk management approach. In order to inform the employees about the implementation cycle, an email was sent before the initiation to the people participating in the project team explaining the process

what is expected from them. The actions taken during the implementation cycle aimed at making sure that every element of the framework would be realized, which is explained below.

7.2.1. Kanban board

An EW tab was added in the Kanban board, where new risks identified during the last client risk meeting have been included. The due date for the mitigation of these risks was determined as the date of the next risk client meeting (23rd of November). These risks alongside other EW that were considered the most critical and imminent, were placed in the EW tab of the Kanban board. The aim was to have a centralized log for EW and display it in the net risk client meeting, in order to show that the team actively tries to mitigate the risks that were identified.

Each EW would have dedicated owners and mitigation actions attached to it. During the implementation period, “risk owners were encouraged to proactively identify and implement the mitigation actions for the risk that they are responsible for. Another element that was noted was the fact that active risk mitigation should result in EW not materializing in actual risk events which can cause disruption in project execution. Attention was also given to the positive impact that successful risk mitigation could have on the project team. Fewer issued compensation events could result in increased income for the project team.

In case an EW approached its due date without a mitigation plan in place, it was instructed to be moved to the “Blockers category of the Kanban Board so that it could be brought up for discussion in the Scrum meeting. The goal of this proactive approach was to mitigate risks in a timely manner, thereby enhancing the overall efficiency of the project management process. During the implementation cycle team members were encouraged to proactively add EW to the Kanban board. This approach is aimed at fostering a proactive risk management culture within the team.

7.2.2. Client and Scrum meetings

The project’s Scrum meetings would be conducted twice a week, every Monday and Thursday, each lasting 30 minutes. These meetings would be attended by representatives from two offices in different locations and client representatives, totaling 40 invitees. In the Scrum meetings, only the items included in the Blockers tab of the Kanban board would be discussed. As mentioned earlier, the risks that have been identified in the previous risk client meeting would be discussed, along with the mitigation plans and status (closed, not started yet, in progress) of each one.

7.2.3. Visualization

During the Scrum meetings the charts that are incorporated in the Teams channel would be shown, such as the number of completed tasks. What is more, in the beginning of the implementation cycle the percentage of the number of Compensation Events corresponding to the number of EW was shared with the project team to test whether this would be motivating.

7.2.4. Constant guidance

The EW identified and presented in the corresponding Kanban Board tab would be discussed on a weekly basis, each Wednesday. This meeting served as a platform to discuss mitigation actions for each EW, allowing to track necessary actions in an effective way. For this meeting, the owners of the risks would be identified by the project manager and the “risk champ” and they would be called in this meeting to help identify mitigation actions. Therefore, it was asked from employees to leave the time slot of the meeting open in their calendars. The mitigation actions of the EW were discussed with the assigned owners and the “risk champ” in a weekly meeting dedicated to EW. If there was a chance that a risk can be mitigated, then it was added as an EW. At the same time, if the EW was close to its due date and it was not mitigated, it was moved to the Blockers tab.

During the implementation cycle, my role would be to observe and take notes of the process while I would also be available in case of questions regarding the different elements of the framework. By participating in meetings, including bi-weekly, EW, and client risk ones, I engaged in the project environment strictly as an observer. This approach allowed me to maintain a neutral stance and preserve objectivity, enabling a clear focus on the framework’s application and team interactions without direct involvement in decision-making processes and influence on the content.

This trial was not just a test of the framework’s functionality but also an opportunity to validate assumptions about its efficacy, refine its processes, and ensure effective resource allocation. The findings and outcomes of this trial were expected to provide valuable insights into the framework’s applicability and effectiveness.

7.3. Questionnaire

After the end of the framework implementation period a questionnaire was distributed among the project team. The questionnaire was created using *SurveyMonkey* and was sent via email to approximately 30 people one day after the end of the implementation period, with the client and select people that did not participate in the implementation period being excluded from the email recipient list.

The questionnaire was comprised of the questionnaire consisted of 41 questions with 12 of them containing conditional logic, meaning that not all the questions needed to be answered by each participant. The first page included a brief introduction explaining the different sections, the completion time, and the deadline for its completion. Additionally, the importance of honesty in the answers given was highlighted along with the reassurance of anonymity. The questionnaire was divided in six sections: Demographic questions, Implementation of framework, Scrum meetings, Client risk meeting, Early Warnings and Outcomes & Feedback.

The completion time was approximately 8 minutes, and the questionnaire was initially open for one week. However, only 7 complete responses were received by this deadline. Therefore, the questionnaire was left open for an additional three days. After personal outreach to several team members, the response rate improved, resulting in 13 completed questionnaires from a diverse range of roles including project managers, project engineers, and other key personnel from crucial disciplines.

The primary objective of creating the questionnaire was to gather in-depth feedback on the team's experience during the implementation phase and their perceptions of the framework's effectiveness. The questions aimed at gathering insights into various elements of the framework and its potential influence on different aspects such as identification and mitigation of EWs. This feedback is crucial in understanding the practical implications and potential enhancements of the framework, aiming to improve its overall efficacy.

The next chapters will dive into an analysis of the results derived from the questionnaire, offering interpretations and insights. The figures presenting more detailed quantitative data, including the number and percentages of responses are included in Appendix C.

7.3.1. Demographic questions

Firstly, the questionnaire began by collecting demographic information from the respondents, which included their role in the company, years of experience at the company, and overall industry experience. The responses varied widely, reflecting a diverse range of perspectives. Amongst the participants were six project managers, three team leads, one senior position and two positions in other disciplines.

Table 7.1: Demographic characteristics

Role in the company	Years of working in company	Years of industry experience	Years of experience in current role
Project Controls Specialist (Planning)	4	30	20
Project Controls Lead	22	30	20
Contract Administrator	6	16	16
Lead Process Engineer	18	18	4
Construction Manager	12	20	10
Quality Manager	7	7	2
Senior Design Engineer	12	18	2
Engineering Manager (1)	5	25	5
Project Engineer	18	18	10
Mechanical Engineering Lead	1	13	1
Project Manager	16	26	14
Engineering Manager (2)	24	35	13
Process Engineer	23	23	23

A big range can also be seen in the questions regarding the years of experience in the company and the overall industry experience. For the former, the answers ranged between 1 to 23 years while for the latter the range was between 7 to 35 years. This diversity in the

respondents' professional backgrounds and experience levels helps to understand the different insights and feedback on the framework implementation. A representation of the answers given on the demographic questions is shown in Table 7.1.

7.3.2. Implementation of framework

The second section of the questionnaire was the Implementation of the framework, with questions aiming at gaining insight on the clarity of the purpose and the different elements of the framework. The responses given in this section indicate that the majority of the participants agree that the the purpose of the study and the different elements included in the framework were adequately explained. The feedback gathered highlights a potential area for improvement in how the framework and its objectives are communicated to the participants, suggesting a need for clearer explanations or more detailed presentations in future implementations. The answers given can be seen in Figure C.1 and Figure C.2.

7.3.3. Scrum meetings

In the third section of the questionnaire the questions aimed at gathering insights regarding the Scrum meetings and determining whether certain framework elements were implemented during the three-week period. In the beginning of the implementation period it was suggested to keep the number of participants in the Scrum meetings to ten, but it was explained that this would not be possible. Nevertheless, the responses showed that most participants were satisfied with the high number of participants in the Scrum meetings (>25) and the level of collaboration achieved. The reasons given for these answers are:

- Comprehensive Representation: The meetings included attendees from all necessary functions and disciplines, both from the company and the client side. This representation ensured that all relevant perspectives and expertise were available for discussion.
- Presence of Decision-Makers: Key decision-makers, including stakeholders and the client's decision-maker, were present in the meetings. Their attendance was essential for making informed decisions and addressing issues effectively.
- Immediate Access to Necessary Inputs: Having all the relevant parties present allowed for the immediate gathering of necessary inputs directly from the right people, facilitating efficient discussions.
- Participation of Leads and Key Players: All leads, and key players were typically invited and would participate, ensuring that the meetings were attended by those with the most knowledge about the project.

At the same time, certain responses indicated that the number of participants should be lower was the fact that the duration of the meeting is limited, and that five to ten people would the ideal number of participants in order to have an effective interaction. These answers can be seen in Figure C.3.

In the analysis of the questionnaire, the section concerning whether the Teams Performance Metrics tab (e.g., the number of completed tasks) was shared during the Scrum meetings revealed insightful trends. A significant portion of participants indicated that this

element of the framework had not been implemented within the assessed three-week period. This observation aligns with personal observations and discussions with a focus group, underscoring the gap in implementation. The rationale behind the absence of this framework component will be explored in detail in subsequent chapters. However, there were also responses where participants reported the sharing of Teams Performance Metrics, which might reflect misunderstandings of the question, variations in meeting attendance and engagement, or confusion regarding the elements that were shared during the Scrum meetings. These answers can be seen in Figure C.4.

Following this was a follow-up question designed to assess the motivational impact that sharing performance metrics did or could have on completing tasks within their due date. The feedback suggests that the concept of sharing performance metrics carries varying degrees of motivational influence, with opinions ranging from slight to moderate encouragement, while a portion of respondents remained uncertain about its motivational effect. The different responses highlight the complexity of motivation in team settings and can be seen in Figure C.5 that presents the viewpoints of participants who previously indicated that performance metrics were shared and Figure C.6 that captures the perspectives of those who did not make such observation and speculated on its potential influence.

7.3.4. Client risk meeting

In this section, the feedback given regarding the clarity on the agenda of the client risk meeting can be seen in Figure C.7 and reflects on the two answers given. While most of the respondents believe that the agenda of the meeting was clear, there is also a significant percentage that does not share this opinion. This result shows that there is room for improvement in how the agenda is communicated or structured.

The answers given regarding the presentation of the EW tab of the Kanban Board in the client risk meeting are presented in Figure C.8. While most respondents were either not present at the meeting or unsure about the EW tab presented, those who did attend provided conflicting answers. The different answers suggest that there may have been a lack of clarity in the question's phrasing or that the participants' engagement levels during the meeting varied. It should also be noted that the meeting did not include the entire project team, which may contribute to the varied responses. Moreover, my personal observations confirm that the EW tab was indeed not shown during the meeting. These findings could indicate a need for clearer communication and a meeting agenda that could help to ensure that all participants are actively engaged in the proceedings of such meetings.

Additionally, the participants that indicated that the EW tab was shared in the meeting, thought that it had a positive impact on showcasing a proactive risk management approach, as depicted in Figure C.9. However, it is important to note the discrepancy highlighted earlier.The EW tab was not showcased in the client risk meeting, raising questions about the clarity of the question or the participants' interpretation of meeting discussions. This discrepancy underscores the potential for confusion among respondents regarding the questionnaire's intent or their own engagement levels. Conversely, Figure C.10 reveals divergent viewpoints from those who did not witness the EW tab presentation, with some recognizing its potential advantages and others expressing uncertainty. This split in perception highlights the potential need for more explicit demonstrations of the framework's

functions or a deeper clarification of proactive risk management strategies to the team.

7.3.5. Early Warnings

The answers given on this section regarding EWs demonstrate a high level of clarity among the project team regarding the person to which they could refer to in case of any EW related questions (Figure C.11).

Moreover, based on the answers given it can derived that the implementation cycle did not have a significant impact on the level of the participants' engagement with the EWs, as most of the team interacted with the system either weekly or as specific needs arose. One of the goals of creating the framework was to increase the numbers of times that people reviewed the EWs. However, most of the respondents maintained their usual frequency of interaction with the EW tab, indicating that the implementation cycle may not have significantly influenced their engagement. The responses given can be seen in Figure C.12 and Figure C.13. The high percentage of answers given indicating that there was not a difference on the level of engagement with the EW tab, gives an opportunity to further examine the factors contributing to these results and will be discussed in the next chapters.

Additionally, the insight that was gathered reveals that most of the EWs did not have mitigation actions attached to them by the end of the week. At the same time, the due dates of EWs were often not being adhered to and changed in various degrees. These results, that are confirmed by personal observations made throughout the implementation period, show that these framework elements were not fully put into action and could indicate that the absence of clear, actionable steps for risk mitigation may lead to difficulties in meeting specific deadlines. Figure C.14 and Figure C.15 present these results. Responses also show that The unmitigated EWs were not consistently moved to the Blockers tab (Figure C.16). The importance of moving unmitigated EWs to the Blockers tab was highlighted in the beginning of the implementation cycle, as this was the way that they could be discussed during the Scrum meetings.

Feedback from the questionnaire reveals an increased level of engagement in the identification of EWs, as most of the participants actively contributed to the identification of EWs (Figure C.17). This proactive involvement showcases that the team is alert and thinks about potential risks. The importance of identifying EWs was also communicated before the start of the implementation period.

The feedback regarding the impact of sharing the ratio of Compensation events and EWs on team motivation towards identifying EWs reveals varied reactions (Figure C.18). While a significant portion of participants remained neutral, suggesting that the information did not significantly alter their motivation levels, others reported feeling more motivated. This variation indicates that while sharing such metrics can inspire some team members, it might not universally boost motivation. Additionally, the presence of participants who were either unaware of this ratio or found it irrelevant underscores the potential necessity for clearer communication. This metric was initially introduced during the first Scrum meeting of the implementation phase.

Additionally, the responses given highlight varying levels of team engagement in the weekly EW meetings. The data reveals a notable segment of the team rarely participated, with only a few attending regularly. These meetings, scheduled every Wednesday, were designed for

team members, especially those identified as EW owners, to collaborate on mitigation strategies with the Project Manager and ”Risk Champ”. Despite the expectation for employees to reserve these times in their calendars, adherence was inconsistent, and often employees were called in the meeting but did not respond on the call or they were not prepared for it. This discrepancy between expected and actual participation, in combination with the significant number of respondents identified as EW owners, underscores a gap in engagement and highlights areas for improving communication and commitment to these discussions. These results could also be connected to the fact that most respondents helped identify mitigation actions only for a few EWs that they were owners of. These answers can be seen in Figure C.19, Figure C.20 and Figure C.21.

Furthermore, responses given in this section of the questionnaire illustrate the partial implementation of the framework element regarding the attachment of ownership to each EW and mitigation action. This can be derived from the fact that only a fraction of EW owners were fully aware of the mitigation actions that they were responsible for and indicates that there is room for improvement ensuring that each mitigation action has a specific owner. These responses can be seen in Figure C.22 .

Feedback gathered regarding the balance between the due dates and the mitigation actions highlight a potential area for improvement in ensuring that each EW has detailed mitigation actions that have realistic time-frames. This can be supported by the fact that most of the participants were not able to mitigate the EWs that they were responsible for within their due date. The observations that have been made during this period support the results of these questions, as the due dates were frequently adjusted and pushed back. Figure C.23 and Figure C.24 present these results. Some of the reasons that were mentioned regarding the inability to mitigate EWs within their due date concerned the interface with other disciplines and dependence on other parties, such as vendors and client, showing that employees often feel like certain things are out of their control. What is more, it was mentioned that often the mitigation actions identified are too optimistic and the projected time is not sufficient to mitigate complicated EWs. Finally, one of the reasons that was given is the fact that people are often occupied with other work responsibilities, and they feel that they do not have sufficient time to implement the mitigation actions.

7.3.6. Outcomes & feedback

The last section of the questionnaire focused on gathering an overall feedback and future use of the framework. The feedback gathered indicated a generally positive perception of the framework’s fit with the project objectives. However, the presence of a few neutral and strongly negative perceptions suggests areas for improvement in ensuring that the framework is more uniformly understood and integrated into the project’s goals.

The responses given also indicate that the application of the framework did not cause a change in the time needed to complete their work following the framework’s application. This may be related to the fact that certain elements of the framework were not implemented to their full effect, as described in previous questions. However, the experiences were not uniform, as a minority reported it saved and cost them time. Additionally, a significant number of participants demonstrated full commitment to implementing the framework, while the partial commitment or a focus on individual work tasks by others suggests that the framework

may not have been perceived as integral to their roles or that competing priorities limited their ability to fully engage with the framework. The varying answers show that there is room for improvement in communicating more effectively the benefits that implementing a framework could have and its added value. Figure C.25 and Figure C.26 present these results.

In the last part of the questionnaire, participants were asked to pinpoint the strengths and weaknesses of the framework and to suggest any modifications that they think are necessary. One of the strengths mentioned was the systematic identification of EWs as it could contribute to the timely development of mitigation actions, ensuring that potential issues were addressed proactively. Participants also valued the framework's role in achieving team alignment regarding the recognition and prioritization of EWs and Blockers, which enhanced the team's collective focus and encouraged more results-oriented actions. Additionally, it was mentioned that the framework encouraged the immediate highlighting of issues, and as a result risks were identified and acted upon without delay. The integration of EWs tab in the Kanban board was also highlighted as a strength, as it created visibility of risks for all team members and raised awareness among the team. This visibility, along with the focus on EWs and the dedicated client risk meetings, was credited for amplifying the team's commitment to mitigating identified risks and Early Warnings. In summary, the strengths gathered from the answers highlight the focus on client communication, increased risk visibility and awareness and a proactive planning of mitigation actions, attributes that could increase the effectiveness of the risk management process.

Regarding the weaknesses of the framework, the responses raised concerns about the consistency and clarity of the process. The irregular review of EWs, uneven distribution of information among team members, and the absence of clear accountability for managing risks were some of the problems that were mentioned. What is more, it was mentioned that not all team members were sufficiently informed about the EWs, indicating a communication gap within the team. A significant issue highlighted was the lack of a dedicated person to oversee the whole process and make sure that is followed. Respondents pointed out the necessity of having a designated person whose responsibility would be to ensure that the process is executed daily and that each risk and action item is assigned an owner and a due date. However, these elements were all part of the suggested framework, but were not implemented to their full extent. Furthermore, another issue raised was that proactive risk management is not considered a priority by all team members.

These reported weaknesses are in line with the issues previously identified in previous responses of the questionnaire. The necessity for distinct ownership, specific mitigation actions, due dates and a designated person that could assist in the process was emphasized but appeared to be inadequately addressed in practice during the implementation period.

Respondents suggested certain modifications as well based on their experience. Participants proposed that department managers should play a more active role in communicating the framework's processes and expectations to their teams to ensure clarity and alignment. The importance of more effective communication among the different disciplined involved in the mitigation actions of EWs was also highlighted to ensure that they can collaborate seamlessly together.

Additionally, it was suggested to ensure that the implementation in the future should be stricter, indicating that the process and the different steps should be followed more. This could be achieved possibly through more in-depth explanations or training sessions, to

ensure everyone is fully informed and engaged. Another suggestion was to add a dedicated risk manager to the project team and to introduce dedicated meetings focused solely on EWs, elements which were already included in the framework.

To increase transparency and motivation, the suggestion of reporting EWs progress in a one-pager monthly progress report to the entire team was also mentioned. Another suggestion that was made was to implement the framework in another project in the future for a longer period that the three weeks of the current study.

Despite the issues that were identified by the participants, there is a generally favorable attitude towards the framework, with most participants open to the possibility of its continued use. However, the responses given indicate a need for additional training and resources to ensure that all team members are equipped with the knowledge and skills necessary to use the framework, as many participants mentioned that they would need guidance to implement the framework in the future. These responses could be related to the weaknesses that were mentioned in the previous question and the elements of the framework that were not fully implemented. Figure C.27 and Figure C.28 present these results.

The strengths, weaknesses and modifications suggested are summarized in Figure 7.1.

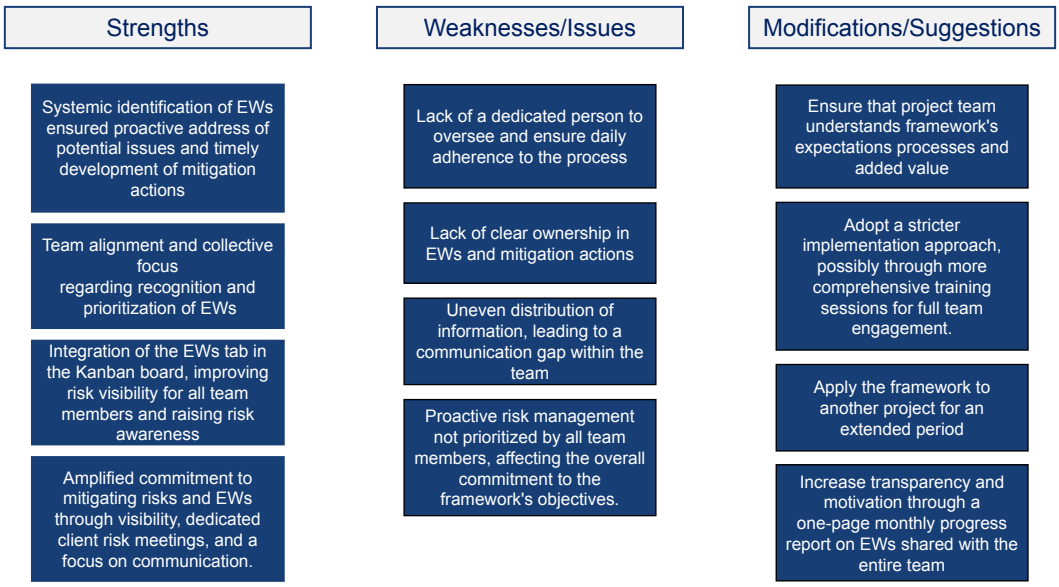


Figure 7.1: Summary of questionnaire's outcomes and feedback

7.4. Focus group session

After the closure of the questionnaire and the collection of responses, a focus group session was conducted to gather additional feedback regarding the framework and its future improvement, as well as gain insight on the reasons for which certain elements of the framework were not fully implemented during the three week-period.

The focus group session was conducted with four key members of the project team in which the framework was implemented. The participants held important roles within the project, encompassing positions such as *Project Manager*, *Engineer Manager*, *Project*

Controls Lead, and *Project Quality Manager*. During the Scrum meetings the Scrum master role was often assumed by the *Project Quality Manager* or *Project Manager*. Due to scheduling conflicts, the input from the Project Controls Lead was collected independently and integrated into the session's findings to ensure that their perspective was also included in the analysis. In the beginning of the focus group session, the questions were distributed to the participants in a written form which contained a visual representation of the framework along with three demographic questions and eight framework and questionnaire related questions.

The analysis of the focus group session will be approached by presenting each question, followed by the responses given. This will help achieve a clear understanding of the participant perspectives and insights on each topic discussed. The questions asked and the answers given are presented below:

1. What modifications, if any, would be necessary to make this framework more adaptable to your specific work environment?

In this question, the respondents of the focus group session discussed that while the framework fits in the current way of working, there were certain issues in the implementation phase, as it was not implemented properly. Further explanation on why this happened will be given in the next questions. Additionally, it was mentioned that the visualization aspect of the framework could be more explicit and clearer. For example, this part could contain the specific performance metrics that would be beneficial to show (e.g., number of unfinished tasks). Moreover, the need for explicit communication of expectations was emphasized, indicating that a successful implementation depends on the team's clear understanding of their roles and responsibilities.

2. Do you think that the process was fully followed, partially followed, or not followed at all and what are the reasons for that?

During the focus group, all participants acknowledged that adherence to the risk management process was only partial. This response is confirmed by some of the questionnaire responses that were presented in the previous chapter. Different reasons were given for the partial adherence to the process. An issue mentioned was that people were preoccupied with immediate, high-priority 'firefighting' activities, were dealing with urgent issues that required immediate attention, and therefore they often did not pay attention to future-oriented risk planning.

Furthermore, it was mentioned that for some team members it was not entirely clear what was expected from them and what their responsibilities were. At the same time, the designated 'risk champ' was heavily engaged with other critical tasks, potentially preventing them from being fully engaged with that specific role.

What is more, the tendency to prioritize immediate, reactive problem-solving over proactive risk management was a recurrent theme. Participants indicated that the time pressure of completing urgent tasks overshadowed the importance of managing future risks, leading to only partial implementation of the process.

3. Do you think that this process helps to increase collaboration?

The focus group participants recognized the potential of the process to increase collaboration across the team. However, they highlighted that in order for that to happen, it is imperative to assign clear ownership to actions and follow the steps each week. Consistency in following the steps on a weekly basis was deemed essential to ensure that the process is followed.

Despite these challenges, the participants expressed that the process facilitates the communication between the different disciplines. They noted that the process heightens awareness of project risks and encourages people to be more involved. The process, therefore, despite certain areas that could be improved, is acknowledged as a tool that could increase collaboration and proactive involvement.

4. Why do you think that most people responded that they would need an instructor to guide them through this process in the future?

This is one of the questions asked in the questionnaire and was asked in the focus group as well, in order to gather additional insight on the responses given. The participants identified that there is a need for targeted training to enhance understanding and management of EWs. This is supported by Streule et al. (2016) who mention that lack of appropriate knowledge on a topic can create challenges on the project team. Adequate training on the identification, documentation, and timely issue of EWs is considered essential to the successful implementation of the framework in the future.

Additionally, it was acknowledged that cultural factors within the organization may affect the adoption of new practices and make people more skeptical about integrating them in their everyday work. Another point that was mentioned was that people believe that the framework contains too many steps. This further illustrates the need for explicit and detailed explanations to ensure that all team members can navigate the process effectively. The feedback given overall underscores the aim of enhancing the framework's usability and the team's engagement with it.

5. What are the potential barriers you foresee in the adoption of this framework by project teams?

The focus group participants discussed that in order for the framework to be adopted from the project team and be integrated in their work, there needs to be a committed individual that would not only oversee the process but also communicate effectively the framework's value to the team. It was emphasized that for successful adoption, team members must be convinced of the tangible benefits the framework could bring to their work. If people believe that what is proposing is going to add on the responsibilities and the work that they need to do, then they will often not be willing to engage with it.

The effective use of visualization tools within the framework was also seen as an important factor, even though this aspect was not realized in the implementation phase. Additionally, a common challenge highlighted was that often people feel that the time that they have is insufficient and therefore they give their ultimate attention to more pressing matters and immediate tasks. This feedback suggests that for broader acceptance and integration of the framework, project teams require both clear demonstrations of its value and reassurance that it can be integrated into their current workload without distracting them from their primary

responsibilities.

6. Are there any critical items that you believe are missing or underrepresented in the framework?

One of the primary suggestions given in this question was to improve the utilization of the framework's tools, such as the board, by developing methods that encourage more efficient usage among team members. It was suggested certain steps could be added in the figure that was created to depict the framework.

One of these steps could be the addition of the objectives and goals of the framework before the rest of the steps. The person that will have the responsibility to oversee the process will have the responsibility clearly communicate the objectives and responsibilities to the rest of the team. Moreover, a suggestion was made to integrate the framework more closely with existing company-wide risk management processes, that are followed on a quarterly basis.

By linking the framework to these established reviews, which occur on a quarterly basis, there is potential to create a more cohesive and comprehensive approach to risk management within the company an ensure that the framework is not an isolated tool.

7. How would you adjust the process in order to enhance the framework's effectiveness?

The responses to this question centered on the strategy of implementing the framework in the future in small steps. Participants highlighted the importance of a gradual approach when introducing the framework, particularly for new projects. They suggested starting with fundamental components, such as familiarizing the team with the Kanban board, and allowing sufficient time for people to familiarize with this element before progressing further.

This step-by-step approach is recommended to prevent the team from becoming overwhelmed by the introduction of several new elements and therefore this gradual introduction of different aspects of the framework helps to maintain the team's interest and engagement.

8. Can you rank the following suggestions aiming at enhancing the framework's efficiency based on importance?

- Introduce risk specific training programs to employees.
- Convince people of the importance of implementing the changes. People should not feel that they are doing extra work.
- Add financial impact on every EW (what is the financial impact if not mitigated).
- Regular check-ins and guidance from project manager and/or risk champ.
- Prioritize EWs based on criticality for the next 4 weeks. Update the list regularly.

In this question it was asked from the participants to rank these aforementioned suggestions according to what they think is the most at least important in order to enhance the framework's efficiency. According to the responses, the most important for most of the participants is convincing people of the importance of implementing the changes and the fact that people should not feel like they are doing extra work.

People should understand the added value of what is proposed in order to integrate it more

easily in their work. Additionally, the second most important seemed to be the specific training in order to educate the employees about the EWs and the way in which they can raise it. The addition of financial impact on every EW and the regular check-ins and guidance interchanged between third and fourth place in the responses. These actions are both important to make sure that people understand the impact that unmitigated EWs can have and that the process is followed correctly. Lastly, the fifth place was given on the prioritization of EWs based on the criticality of the next three weeks. This is an important task as well but it crucial to make sure that the people are willing to follow the process and that they understand the different steps.

Based on the feedback gathered from the focus group session, the strengths and issues that were identified along with the modifications that were suggested are summarized in Figure 7.2.

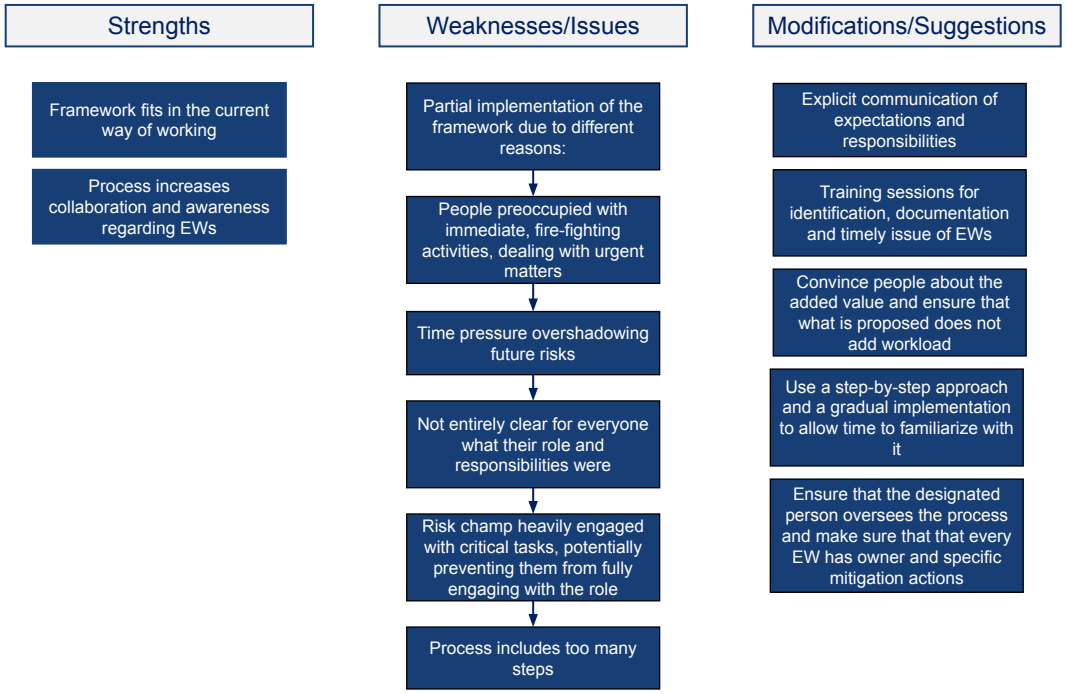


Figure 7.2: Summary of focus group session's outcomes and feedback

7.5. Conclusions

This section aims to summarize the core insights and results that have been drawn from the analysis of the questionnaire and the focus group session regarding the application of the framework, the issues that were faced and suggestions for future improvement.

To begin with, the analysis of the questionnaire shed light to certain issues that were observed during the implementation cycle as well. Based on personal observations made, certain elements of the framework were not implemented in the way that they were intended to. This was also confirmed by the analysis of the questionnaire which showed that the EWs tab that was added on the Kanban board was not reviewed and updated each week. At the same time, the EWs that were added on the Kanban board often did not have specific mitigation actions, owners and due dates attached to them. At the same time, EWs that were not mitigated within their due dates were not consistently moved to the Blockers tab. Alongside these issues, the participants mentioned that there was not a designated person

that would make sure that the process is being followed every week guide them through the EWs. This was an element that was included in the suggested framework but ended up not implemented successfully. Furthermore, the analysis of the questionnaire revealed certain inconsistencies in the participant's answers.

Specifically, in the question regarding whether the EWs tab was shown in the client risk meeting, the answer was not unanimous. According to personal observations, the EW tab was not presented in that meeting. However, there were answers given indicating that the tab was presented, revealing certain issues regarding communication and perhaps active participation. Moreover, participants mentioned that guidance will be necessary in possible future implementation of the framework in order to be able to follow the steps of the framework. This indicates a need for a possible modification regarding the framework's structure as well as a thorough step by step implementation process, as mentioned in the focus group session.

The focus group session that followed the questionnaire gave more insight on the reasons that influenced the results of the questionnaire and provided important feedback that can help improve the implementation of the framework in the future. During the discussion with the participants the fact that not all the elements of the framework were implemented was often mentioned. One of the reasons that led to this was the engagement of employees and 'risk champ' with critical activities. It was mentioned that often people felt that the time was sufficient and therefore did not prioritize proactive risk management and integrating new elements to their everyday work. What is more, the discussion in combination with the questionnaire results shed light to other factors that undermined the complete and successful implementation of the framework.

One of the factors that was discussed is the fact that often employees are not fully aware of when they should raise an EW and what an effective description would be. This highlights the importance of training sessions that could explain in detail these steps. Moreover, attention was given to the cruciality of effective communication of the framework's objectives and goals in order to convince people about the added value of what is proposed. According to the responses given in the questionnaire, this aspect could possibly have been enhanced to better meet people's needs and expectations. Future implementations of the framework require the presence of a person that could oversee the process more closely and motivate people into following the steps. One of the goals of the implementation of the agile framework wad to increase the frequency in which employees engage with EWs. Based on the analysis of the correspondent question of the questionnaire, mot participants did not notice a difference regarding this frequency, which can be attributed partially to the fact that certain elements were not implemented as intended.

Despite the issues that arose and the aspects of the framework that were not completely successful, positive elements were also noted. The analysis of the questionnaire and the focus group session indicate that the framework raises awareness regarding EWs and enhances visibility and collaboration between disciplines. Furthermore, it was highlighted that it is a step to the right direction and could help employees pay attention to not only items of the present but also to future issues. Additionally, most participants have a positive attitude towards using the framework in future projects and agree that the objective and the thought behind its creation is aligned with the effort to enhance the risk management process and its everyday application.

Overall, the feedback that was given indicates that the practical application of the

framework requires adjustments, particularly in terms of clarity in role assignments and process adherence, to realize its full potential. As previously discussed, certain elements of the framework have not been implemented to their full extent. The partial implementation and the short, according to the participants, implementation period of the framework are some of the limitations of this study. Therefore, the outcome and impact of this implementation cannot be completely judged, and it is challenging to draw definite conclusions. For these reasons, an expert judgement session was conducted with experts outside of the project in order to gather further feedback and insights on the framework and the ways that could be improved. The analysis of the expert judgement session is presented in the next chapter.

8

Framework validation

Following the questionnaire and focus group session, it was decided to conduct an expert judgement session that could help with the validation of the framework, as the identification of concrete results was challenging due to the incomplete implementation of framework's key elements. This chapter will elaborate on the expert judgement session and its analysis, followed by the conclusions including an updated version of the framework that takes into consideration the feedback gathered.

8.1. Expert judgement session

The expert judgement aimed at gathering insights from professionals whose experience and knowledge could provide a more comprehensive understanding of the framework's practicality and areas for improvement and therefore contributing to its validation and improvement. This session was conducted with five individuals in total. The input of one of the participants was given at a later stage as they were unable to attend the initial meeting. All the participants have a great experience in the industry and more specifically in risk management, ranging from 22 to 35 years of experience. The participants held the role of Project Director, Project Manager, Risk Representative & Project Manager, Risk Executive and Engineering Manager & Risk Coordinator.

Before gathering the data from the experts a few slides were presented to explain them in order to explain the aim and agenda of the meeting, the topic of the thesis project, the steps that had been taken so far, followed by an explanation of the framework and its elements. Subsequently, the questions were handed out in paper format to those attending the meeting physically and via email to those attending through Teams. It was then explained that 20 minutes will be given to fill out the questions individually and return the document before a discussion would take place for the rest of the meeting. The follow up questions in the discussion section aimed at gathering more in-depth feedback (H. J. Rubin and Rubin, 2016). Before the participants commenced answering the questions, I emphasized the importance of objective and candid feedback, reassuring participants that all perspectives were valuable. The analysis of the questions is presented in the next section.

The analysis of the expert judgement session will be approached by presenting each question

and its answer, the same way as the focus group session was analyzed. Most of the questions that were asked in this section were elaborated on the discussion part of the meeting as well and thus, the responses include the overall feedback. Some of them are also present in the questionnaire and the focus group session. The questions that were asked are:

1. Can you envision this framework being implemented in your current projects and what modifications, if any, would be necessary to make this framework more adaptable to your specific work environment?

To the first part of the question all participants responded positively, as they mentioned that it would help the team to better manage and execute the project. At the same time, it was mentioned that the implementation of the framework would be beneficial only if it was incorporated from the beginning of the project and people got familiar with it.

Certain modifications that could make the framework more suitable to the participants' work environment were also commented. Firstly, it was emphasized that there should be a clear distinction between internal issues specific to the company and project-related issues that affect both the client and the company. Secondly, participants suggested that the framework should focus on risks associated with current, ongoing work. This approach would help in prioritizing risks that are most imminent and adequate attention is given to issues in the near future. The integration of the framework with the existing process that is used in the company was also mentioned as an important step and could help with the perception that employees have of it, as it would be part of the established process. Finally, there was a recommendation to incorporate the financial impact of not mitigating risks into the framework. By quantifying the potential financial consequences, the framework could provide a tangible demonstration of the impact that unmitigated risks can have and therefore, motivate team members to engage more actively with the EWs.

2. Do you think these steps could increase people's attention regarding risks?

The responses to this question were overall positive, acknowledging this process could increase awareness and focus on risks, especially with the assignment of specific owners and responsibilities. However, the importance of not overwhelming employees with a lot of new information and finding a balance regarding the volume of workload were highlighted. Additionally, it was noted that the focus should be on risks that realistically can be mitigated, which could help turning the focus in risks that are actionable. At the same time, one response indicated skepticism regarding the impact that this process could have, as it was mentioned that team members often may not fully understand the impact of their actions, or the risks involved, which highlights the importance of training and effective communication.

3. Do you think that people could follow the framework in the future without support from an instructor (e.g., Project Manager)?

The responses emphasized that a successful adoption of the framework depends on whether project teams understand the added value of the proposal, and therefore it is crucial to persuade them about the benefits that it can have. In order to do that, support from project managers and risk coordinators is necessary, especially in initial stages. As one participant wrote, "when something is new, it often needs to be sold to teams" for its application to be successful. Additionally, it was suggested that with adequate time and practice, people could

indeed adapt to the framework and integrate it into their regular work processes without any further support. Furthermore, it was expressed that even though the process is not complicated, there needs to be a designated person that could help the employees prioritize the risks and be the decision maker regarding the financial impact. As mentioned, this person could be the Project Manager that ultimately decides if a risk needs to be accepted or whether certain actions need to be taken and how many effort hours are needed. The culture of the company and employees was also highlighted as a reason for people being more skeptical about adopting new tools (Ciric et al., 2019) and not being able to follow the framework without an instructor as sometimes a lack of sense of responsibility and ownership can be noticed.

4. What are the potential barriers you foresee in the adoption of the framework by project teams?

Several potential barriers were identified by the participants. One of them is the resistance to change that can be present in project teams. Adapting to a new framework often requires modifying work habits that have been followed for years. Lack of risk understanding, and their impact was another significant barrier that can related to level of expertise and experience. The respondents pointed out the schedule and day-to-day pressure as well as the time that employees need to get acquainted with new practices often prevent them from adopting new systems. An argument was that people are bombarded with new information all the time, so it is important to explain to them why it can be beneficial. Additionally, the lack of discipline regarding the application of the framework and urgency was also mentioned as a potential barrier, as it can lead to inconsistent implementation and reduced effectiveness. Lastly, the lack of focus on specific areas and risks by the team could potentially be a barrier, as attention needs to be given on items that are important.

5. Could this process help in the identification of risks in a proactive way and their mitigation?

The responses to this question were positive. Participants agreed that the framework facilitates a proactive approach to risk management, as it provides a platform for team members to openly raise and discuss their concerns and motivates people into actively thinking about risks. The Scrum meetings were highlighted as valuable components of the framework as they create an environment where concerns can be shared and addressed in a timely manner. Moreover, it was mentioned that the current process in the company is not ideal and there is a lot of reaction instead of being proactive, whereas the suggested approach helps people look more into the future and not only at current issues.

6. How does this framework compare to existing risk management methods you have used?

The feedback given by the participants showcases certain features of the framework. It was mentioned that the current method used is time consuming, whereas the specific framework emphasizes proactivity and can help to turn the focus to risks when they actively need to be managed. Another element of the framework that was mentioned is its alignment with agile principles, as it is combined well with the daily and weekly execution routines of agile project management, it is forward-looking and adaptable. Moreover, the framework's real-time and

visual benefits were highlighted as advantages. The framework was seen as an important addition to the current risk management process, particularly for its everyday focus on risk management. This feature is especially useful in comparison to the less frequent approach of the risk management process that is currently used.

7. Are there any critical elements that you believe are missing or underrepresented in the framework?

In response to this question participants highlighted a few elements that they believe are missing from the framework. Participants indicated that the framework does not address or quantify the financial consequences, especially for risks that are already known but cannot be mitigated. This is considered essential, as it affects the effective resource allocation. Additionally, the way of handling of unmitigated risks was particularly mentioned, in terms of budget allocation. Participants expressed the need for a clear outline of how much money should be allocated for the mitigation of risks, how it should be used, monitored, and eventually released once the risk is no longer a concern.

Furthermore, participants suggested that the framework could benefit from an additional feature that describes its primary objective in a clear way and could be communicated before the rest of the steps. Another suggestion that was made for the improvement of the framework was to add a physical EWs board, in the room where the Scrum meetings are conducted, in which the most critical risks for the next month will be added and reviewed each week. The challenge in this would be to make it feasible in the hybrid working environment.

8.2. Conclusions & future improvement

This chapter elaborated on the the expert judgement session that was conducted and its analysis. Based on the insights that were gathered, an updated version of the framework is presented along with suggestions for the steps that need to be followed to ensure a successful implementation.

8.2.1. Insights from professionals

This chapter presented the expert judgement session that was conducted following the questionnaire and focus group session to gather further feedback regarding the framework. The session's purpose was to gather insights from professionals with experience in risk management regarding the different elements of the framework and areas of improvement. There are multiple points that were derived from the analysis of the expert judgement session. Participants acknowledged both the positive aspects of it and the areas that need to be improved or modified in order to maximize its efficiency.

Firstly, participants highlighted potential of implementing this framework in a project and the benefits that it could offer. It was discussed that this approach raises awareness regarding risks and could help the project team to manage them. At the same time, participants agreed that the framework facilitates a proactive approach to risk management motivates employees to actively think about risks. According to the participants' responses, the current process in the company is time consuming and there is firefighting action, in contrast to the suggested

approach which urges employees to not focus solely on issues of today and engage frequently with risks. Additionally, it was mentioned that guidance will be needed at least for the beginning stage of the framework's implementation in order to help employees adapt to the new process. As is mentioned in the paper by Errida and Lotfi (2021), a successful implementation of a new process requires the "creation of a guiding coalition", meaning that certain people need to lead the team during this change. This element was included in the framework but was not fully implemented. The feedback that was given aligns with the responses given in the focus group session where participants highlighted the increased awareness that the implementation of the framework can result to along with the enhancement of collaboration among different disciplines.

The participants of the expert judgment session also shed light on the framework's aspect that need to be improved. Attention was given to the fact that successful implementation requires convincing of the project team about the benefits and added value of the framework. Therefore, an addition of a section explaining the objective, goal and vision of the framework was suggested. Cummings and Worley (2009) mention that a change and an introduction of a new process needs to be motivating to people and the vision needs to be clearly communicated. Moreover, participants pointed out that the framework currently lacks an element showcasing the financial impact of risks. It is important for employees to understand the impact that risks can have, especially if they are not mitigated. Another suggestion that was also mentioned during the focus group session was to integrate the framework with the risk management process that the company currently uses, which could enhance people's acceptance as the framework would become part of an established process.

These insights from experienced professionals underscore the need for the framework to evolve, incorporating clearer financial metrics and enhanced visibility to ensure its efficacy and applicability in different project environments. As discussed in both the focus group session and the expert judgement session there are certain steps that need to be taken before the implementation of the framework to ensure its successful integration.

Training sessions that could educate employees on risks and the way that could raise an EW are crucial along with support from both the project manager and the risk coordinator, especially in the initial stages. Yeh, Lai and Ho (2006), mention that training guarantees learning, while Fashami and Babaei (2017) highlight the importance of both managers and project teams. Additionally, an important step would be to convince employees on the added value of the suggestions made. People's resistance is referred in literature as the biggest barrier that can make the adoption any change difficult and therefore, overcoming this resistance is essential (Errida and Lotfi, 2021).

Adopting a step-by-step approach is also essential, as the gradual implementation of different elements allows team members to adapt and become familiar with each aspect. As supported in the paper by Bengat, Odenyo and Rotich (2015), incremental change allows a gradual implementation and a smoother transition and adaptation to the new suggestions.

A summary of the strengths that have been identified and the modifications suggested by the experts is presented in Figure 8.1.

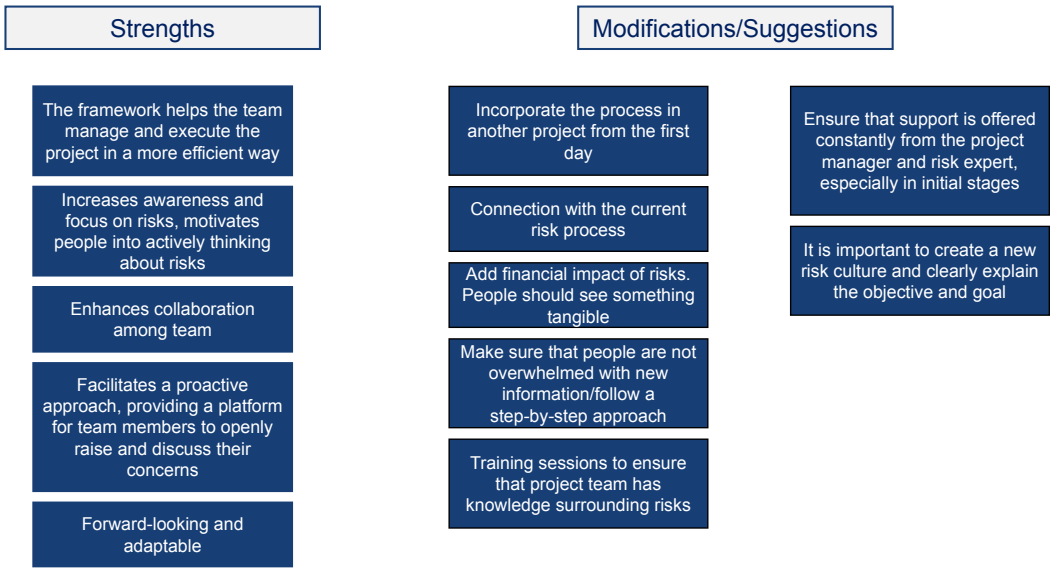


Figure 8.1: Summary of expert judgement session's outcomes and feedback

8.2.2. Updated framework

Based on the suggestions and the comments that were made in the questionnaire and both the focus group and the expert judgement session, the suggested framework was updated incorporating these suggestions. The updated framework is presented in Figure 8.2.

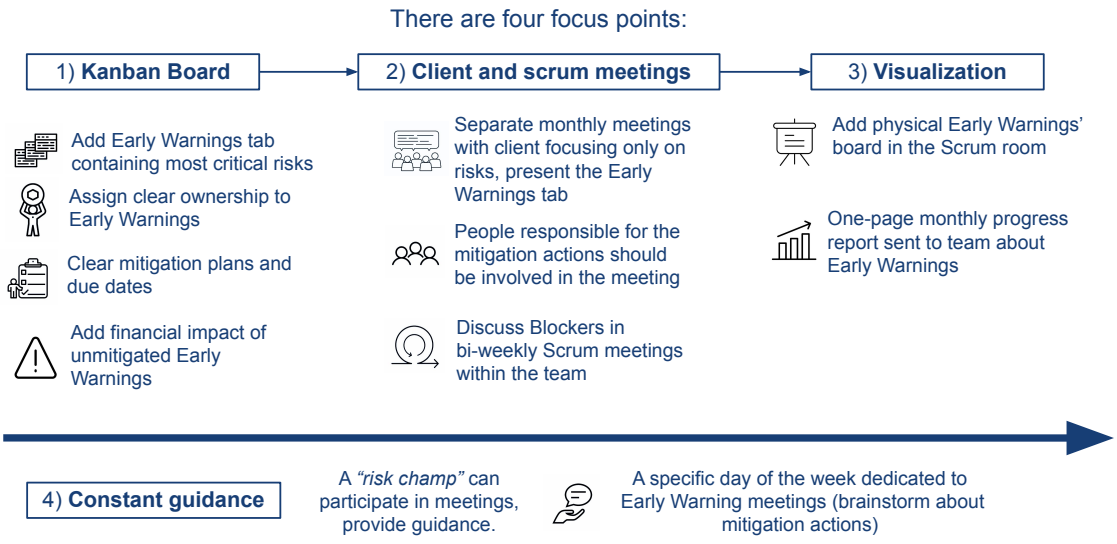


Figure 8.2: Updated framework

The revised framework introduced here reflects a series of enhancements aimed at optimizing the risk management process by incorporating feedback from various evaluative methods that were conducted, including a questionnaire, a focus group session, and an expert judgment session.

Starting with the Kanban Board, a modification was to mention that only the most pressing

EWs are suggested to be included in the corresponding tab, particularly those imminent in the upcoming four weeks. This approach ensures that the team's focus is directed towards risks that require immediate attention, facilitating regular updates and reviews for relevance and urgency. Furthermore, the financial impact of unmitigated EWs was integrated into the framework. This addition addresses the feedback that tangible, quantifiable metrics could increase the team's engagement with risks by illustrating the potential cost implications. This encourages a more proactive approach to risk mitigation, as the team can visualize and prioritize based on financial consequences.

Additionally, an element included in the client and Scrum meetings focus point has been refined and made more specific. The integration of EWs in the bi-weekly Scrum meetings is suggested to be made through the discussion of Blockers, as in these meetings other items and tasks are discussed as well. A more detailed discussion surrounding EWs is made in the dedicated EW weekly meetings.

Regarding the visualization focus point, an addition that was made was the introduction of a physical EWs board within the Scrum room. This physical presentation complements the digital Kanban Board and enhances the visibility of risks. The tangible presence of a dedicated EWs board acts as a constant visual reminder, reinforcing the importance of these items to the team's daily activities. Accompanying the physical board is the suggestion of distributing a concise, one-page monthly progress report focused on EWs to the team. This report aims at communicating the progress made, highlighting the number of EWs that have been successfully mitigated, those that are in the process of being addressed, and any new issues that have arisen. This targeted communication tool integrates the performance metrics element that was previously included in the framework and aims to keep the team aligned and informed, encouraging continuous engagement and collective effort in mitigating risks.

At the same time, the element involving the Excel calculation of the ratio of compensation events to EWs has been removed. The decision to remove this component was influenced by the insights gathered from the questionnaire responses, which indicated that tracking this ratio did not substantially impact the team's motivation levels. By integrating these changes, the framework becomes more aligned with the suggestions that were made through evaluation and validation processes. These revisions take into consideration the agile characteristics of iterative development and continuous learning, ensuring that the framework remains both relevant and impactful.

8.2.3. Framework implementation strategy

To ensure the successful adoption and implementation of the framework, it is crucial to follow a structured process that emphasizes clarity, training, and continuous support.

Before initiating the implementation, it is essential to communicate the vision and objectives of the framework with the project team. By explaining the rationale for adopting new practices, the project manager, in collaboration with the risk coordinator, can effectively convey the added value that the framework brings, reducing the resistance that can be observed when changes are introduced. In combination with the communication of the vision and objective, establishing training courses tailored to the project team is vital. These courses, designed to educate the team about EWs, will help the team to successfully identify potential risks, understand the

process of raising an EW, and develop a proactive mindset. The depth and frequency of these educational sessions should be adjusted based on the team's experience and existing knowledge, ensuring that each member is adequately prepared to engage with the framework.

During the implementation, the weekly meetings dedicated to EWs will serve as the key sessions for determining risk ownership and developing mitigation strategies. These meetings will be essential for team members to align on responsibilities and brainstorm solutions for emerging risks. During these sessions, the project manager and risk champ, together with potential risk owners, will discuss about imminent risks, particularly those forecasted for the upcoming four weeks. These meetings will not only serve as a platform for reviewing and updating the list of risks but will also ensure that any items past their due date are moved to the Blockers tab. Additionally, the Scrum meetings facilitated by the Scrum master, will then give attention to these Blockers, ensuring that risks are integrated into the project's day-to-day discussion about tasks. The presentation of the EWs tab in the dedicated client risk meeting will demonstrate a proactive approach to managing risks.

To support this process, a monthly progress report will be shared with the team, highlighting the EWs that have been handled, those that are overdue, and those that are still being worked on. Moreover, the addition of a physical EW board placed in the Scrum room will act as a reminder and will help increase awareness surrounding risks.

The framework is recommended to be introduced at the start of a project and rolled out using a step-by-step approach. Allowing time between each step gives the team a chance to familiarize with it and adapt to changes. Providing constant support from the project manager and risk champion is also considered crucial, as they can guide the team through the new process, making sure everyone understands and integrates each step into the daily workflow of the project.

An overview of these steps is presented in Figure 8.3.

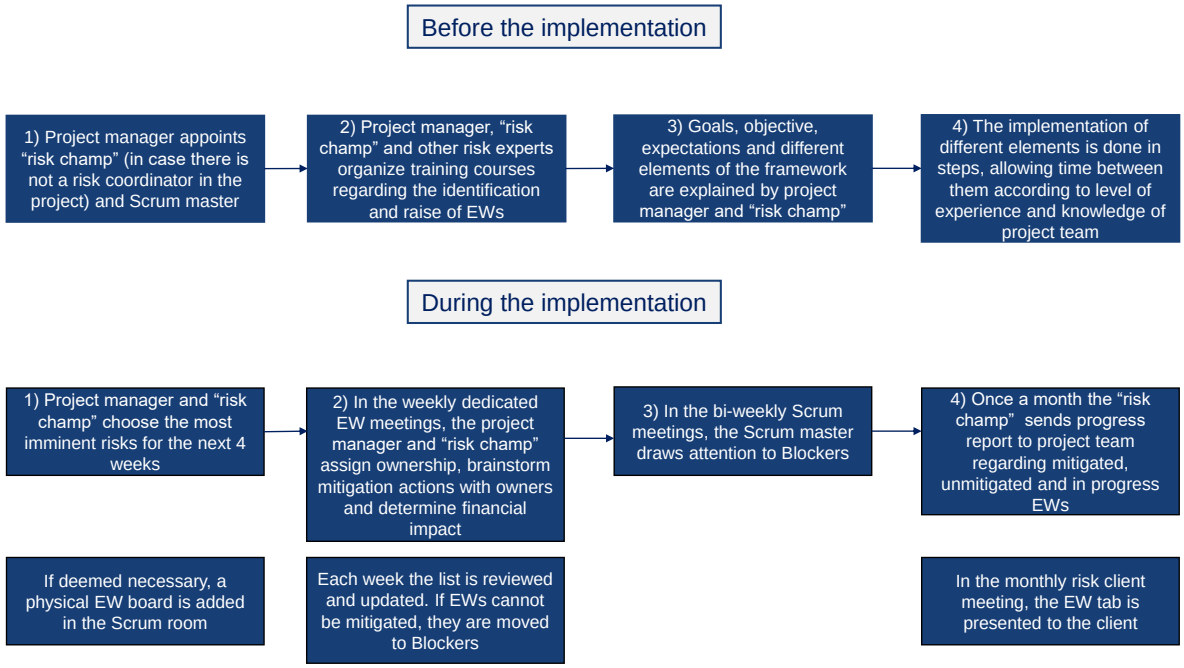


Figure 8.3: Steps ensuring successful implementation

9

Conclusions

This chapter presents the responses to the main research question and the sub-questions, followed by the limitations of the research and the recommendations for further research. The last section of the chapter presents the reflection on the process and the outcome of the thesis project.

9.1. Responses to the research question and sub-questions

In the introduction of this report five research sub-questions were created to help address the main research question, regarding the way in which agile methodologies can be implemented in the risk management process. The answers in these sub-questions and the main research question are presented below.

SQ1: How is the risk management process described in literature?

This research sub-question aimed at identifying what the risk management process is according to literature and what are the steps that are included. The risk management process, as described in literature, is a systematic approach that aims to identify, assess, and mitigate risks within a project or organizational setting. Several critical steps are included in this process, each contributing to the effective management of risks.

Firstly, the literature emphasizes the importance of establishing clear goals and objectives in the beginning of the risk management process. This step involves identifying key stakeholders and understanding the nature of risks associated with the project. Risk identification is a crucial next step, where a comprehensive list of potential risks is developed. The creation of a risk register is a common recommendation helping keep track of the identified risks. The next step is risk assessment and analysis, where the potential impact and likelihood of the identified risks is measured. The literature discusses both qualitative and quantitative methods for this assessment. Qualitative analysis is widely used due to its simplicity, while quantitative methods, like Monte Carlo analysis, are preferred for critical risks requiring detailed analysis. In the mitigation and contingency planning phase strategies aiming at managing identified risks are developed and implemented. Literature suggests

various risk treatment options, including avoidance, reduction, transfer, and acceptance, depending on the risk's nature and potential impact. Finally, continuous monitoring and review are highlighted as essential components of the risk management process. This ongoing step ensures that new risks are identified, and the effectiveness of the process is evaluated.

SQ2: What are the key principles and methodologies of APM?

APM is a dynamic and flexible approach that was initially developed as an alternative to more rigid, traditional project management methods. The complexities and rapidly changing of project environments led to the evolution of APM. The key principles of APM prioritize the individuals and their interactions, recognizing that the success of a project largely depends on the people involved and their collaboration. Another fundamental element of APM is the focus on producing tangible outcomes rather than extensive documentation, showcasing a shift towards more practical and immediate results. Additionally, APM values customer collaboration, giving attention to continuous engagement with the client throughout the project to ensure that the outcome align closely with their needs and expectations, an approach that is contrasting traditional methods. APM is also characterized by its adaptability to change, highlighting flexible planning, allowing in this way teams to adjust to changing requirements throughout the project cycle.

Various methodologies fall under the umbrella of APM, including Scrum, and eXtreme Programming. Scrum has gained recognition for its effectiveness in enhancing transparency, communication, and collaboration within project teams. Despite its advantages, the implementation of APM has certain challenges. Limitations such as the potential lack of upfront planning and adequate documentation can pose difficulties in tracking project progress. The implementation of Agile methods, especially in larger projects, requires coordination and a shift in organizational culture, combined with a high level of expertise in various disciplines.

SQ3: What are the characteristics and pitfalls of risk management in waterfall projects and risk management in an agile context?

Risk management in waterfall projects is characterized by a structured, sequential approach. This method typically involves comprehensive risk assessment at the beginning of the project, relying on causal links, event analysis, and historical data. However, it is also linked with several pitfalls, such as resistance to change, communication gaps between management and teams, difficulties in defining and dealing with risks in complex projects. Risk management in waterfall projects also tends to focus only on risks, often neglecting potential opportunities. Furthermore, its ability to adapt to new risks is limited.

In contrast, risk management in an agile context is characterized by its flexibility and iterative nature. Agile methodologies, such as Scrum, adopt an incremental approach, allowing for continuous risk assessment and rapid response to emerging risks. This approach enhances visibility regarding risk responsibility and accountability. However, agile risk management has limitations too. The strong emphasis on internal communication can sometimes result in gaps regarding external risk monitoring. The agile methodologies, originally designed for software development, may not fully align with the unique risks present in the construction industry, such

as environmental impacts or supply chain disruptions.

SQ4: Could a framework help integrate agile principles into the risk management process?

This thesis project introduced a framework designed to enhance the effectiveness of risk management processes by integrating agile methodologies. This framework was created based on the insights gathered from academic research, exploratory interviews and the problems identified from their analysis. The framework's development is based on the need to address the disconnect between theoretical processes and their practical application. The goal of its creation is to make risk management more accessible, understandable, and actively engaged by all project team members. This is achieved by incorporating agile principles such as flexibility, continuous improvement, and a focus on collaboration and communication. Key elements of the framework include the use of Kanban board and the addition of a risk focused EW tab for visual management of tasks and risks, regular client and Scrum meetings for enhanced communication and stakeholder involvement. The framework also highlights the importance of constant guidance with the role of a "risk champ," a dedicated individual responsible for supporting, guiding, and ensuring accountability and mitigation of EWs.

By integrating agile methodologies, the framework addresses several challenges commonly associated with traditional risk management in construction projects. It allows for more responsive handling of risks and encourages a shift towards a proactive culture that prioritizes early identification and mitigation of risks. Furthermore, the framework's design promotes iterative development, customer collaboration and flexibility which are agile characteristics.

The implementation of this framework within a large-scale project and company marks a significant contribution to the existing body of research on the integration of agile methodologies within risk management for large-scale construction projects. This practical application underscores the framework's adaptability, versatility and its potential to foster a more proactive, agile risk management culture across various project sizes and organizational structures. By demonstrating its utility in a large project, this study expands the dialogue on agile's applicability beyond smaller teams to encompass large, mature organizations, thus filling a gap in current research. This, in turn, enhances the understanding of agile methodologies' strategic implementation in risk management, contributing to the ongoing evolution of project management practices in the construction industry.

SQ5: To what extent can the current risk management process be improved by using a framework that incorporates agile methodologies?

The integration of agile methodologies within a structured risk management framework can offer certain benefits but also faces challenges. According to feedback gathered from the questionnaire analysis, the focus group and expert judgement sessions the agile-based framework that was suggested enhances awareness and visibility regarding EWs, increases collaboration between different disciplines, and promotes a proactive approach towards identification and mitigation of risks. However, there are several prerequisites for the

successful implementation of the framework. Providing training session to employees on risks and the impact that they could have is crucial. Additionally, aligning the framework with existing organizational processes in combination with creating a cultural shift towards agile practices are essential for successful integration. Effective communication about the added value of the framework and constant guidance especially in the initial steps are essential for realizing the full potential of the framework and improving the risk management process.

How can agile methodologies be implemented in the risk management process?

The framework that was suggested aligns with agile principles of adaptability, transparency, and team collaboration by introducing iterative processes through Scrum meetings and risk specific client meetings. At the same time, the framework suggested the use of tools such as Kanban board with a focus on risks, emphasizing continuous risk assessment and a proactive approach towards identification and mitigation of risks.

The integration of agile principles within the risk management framework, as shown by the feedback gathered from the questionnaire, focus group and expert judgment sessions, has positive outcomes. Firstly, there is an increase in the awareness of risks among team members, an element that is crucial for achieving a proactive approach towards risk identification and mitigation. Additionally, the framework encourages collaboration, as mitigation of EWs requires the collaboration of different disciplines. Despite the positive aspects and benefits that the framework can have, certain steps are necessary in order to ensure its successful implementation. Integrating the framework with existing processes and trying to shift the culture surrounding risks. Feedback suggests the necessity of training sessions and the collaboration of the project manager and risk coordinator to lead and guide the adoption of the framework as well as convince team members of its benefits. Incorporating these steps in combination with better communication of the framework's objectives and vision and a step-by-step process can increase the framework's effectiveness and its integration into the risk management process.

9.2. Recommendations

In an industry characterized by intense competition and rapid technological advancements, such as the construction industry, it is imperative for companies to remain agile and innovative. Embracing new methodologies and experimenting with different approaches is beneficial for the growth of the company. This commitment to innovation extends to employee training, especially regarding risk management. Developing comprehensive training programs that educate employees about the identification of risks, their potential impacts, and effective management strategies is crucial.

Moreover, the role of management in creating a culture open to new methodologies, such as the proposed framework, is crucial. It is essential for leadership to actively work towards creating a sense of interest among employees. This involves not only addressing and trying to cope with resistance to change but also effectively communicating the vision, objectives, and the necessity of the change. Clear communication of the reasons behind the adoption of new approaches and their potential benefits can play a significant role in making the transition smoother and ensuring successful implementation. At the same time, a collaboration between

the project manager and the risk coordinator is necessary at least in the initial stages of a new process' introduction in order to guide employees through the different steps.

Integrating new processes in risk management not only benefits internal operations but also positively influences the company's external view, especially among clients and stakeholders. Demonstrating a proactive approach on risk management showcases the company's commitment to minimizing risk impacts, which can enhance its reputation and trustworthiness in the eyes of clients, as proactive measures are often seen as a sign of a forward-thinking organization.

9.3. Limitations

In this section the limitations of the study are presented. Acknowledging these constraints and recognizing the boundaries is essential to better understand the implications of this thesis project. These limitations can be summarized in four key areas. The first limitation could be the duration of the framework's implementation cycle. According to the feedback gathered, the three-week period was considered insufficient for the full implementation of the framework and its evaluation.

In addition, a significant limitation was the partial implementation of certain framework elements. This incomplete implementation meant that the framework could not be evaluated effectively, making it more challenging to draw concrete conclusions about its overall efficacy.

Furthermore, another limitation of this study arises from its focus on a select number of agile tools and methods, primarily Scrum and Kanban. While the framework developed in this research takes inspiration from Scrum, it does not adopt the steps included in the Scrum methodology in their entirety. This study does not integrate a broader spectrum of agile methodologies resulting to possible overlook of the potential benefits that could emerge from a combination of diverse agile practices. What is more, the study's exploration of their impact is constrained to a single project environment, restricting the ability to generalize findings across different project types, sizes, and complexities.

Finally, the number of respondents to the questionnaire represented another limitation. Despite the involvement of participants with important roles in the project, the response rate was less than half of the total number of people that were contacted. This limited the number of different perspectives given and insights gathered, which could have influenced the subsequent analysis. Although inherent to quantitative research, the answers given in several questions of the evaluation and validation phases of the interviews could be subjective and have not been tested with another method.

9.4. Future research

The study agile methodologies and practices and their integration in risk management has revealed several possibilities for future research. As this area progresses and adapts to new technological developments, various research paths emerge, offering significant prospects for impactful discoveries and advancements.

Extending the application of the proposed framework across a wider range of construction projects could be an area for future research, as it will offer a way of evaluating its

adaptability and effectiveness in diverse project environments. At the same time, the framework's implementation in industries other than the construction one, could also provide interesting results. Moreover, a longer implementation duration is suggested to comprehensively assess the framework's impact over various project stages. Implementing the framework from the beginning of a project would also be interesting to explore. Additionally, applying the framework in different sized project teams could offer valuable insight regarding its adaptability and applicability. Integrating the framework in diverse environments could further refine it, allowing adjustments based on new insights and the unique demands and circumstances of each project and team.

Furthermore, exploring the addition of other agile methodologies or tools in the framework could enhance understanding and optimization of risk management and achieve a more comprehensive integration approach.

Future research could also delve into the behavioral aspects influencing the adoption of new frameworks and tools. This could involve investigating the reasons behind employees' resistance to change within the construction industry, whether due to cultural factors, lack of understanding, or fear of the unknown. Such research could examine the ways in which individual attitudes and organizational culture influence the successful integration of new processes. Understanding these behavioral attributes could provide important insights into using more effective strategies for framework adoption and change management in the construction sector.

9.5. Reflection

This section will provide a reflection on the overall process of my thesis project. After the months that I have spent working on this project, it would be beneficial to self-reflect on specific sections, and more specifically the literature review, the research methodology and the research results. The personal lessons learned will also be presented.

Literature review This research project started with a literature review which served as an indispensable foundation for the continuation of my thesis. The thorough examination of existing literature not only provided valuable insights into the context of risk management practices within the construction industry but also illuminated the evolution of agile methodologies and their application in the industry. Through an extensive analysis of existing studies, the literature review has laid the groundwork for a deeper understanding of the challenges and opportunities that arise when agile methods are combined with risk management in construction projects. The conducted review highlighted the gap that exists in the available literature and therefore the need for more research and development of an approach that addresses the combination of agile practices and the risk management process.

Research methodology Creating a well-defined research methodology is crucial. In retrospect, I believe that it is not uncommon for researchers to encounter challenges in narrowing down the focus of their work. This was also the case in my thesis project, as in the beginning I encountered difficulties in making the scope of my project more specific. I knew that I was fascinated by risk management and APM, but I was uncertain about the ways that

these two concepts could be combined.

In the first steps of the research, the literature review helped not only with the problem identification but also with the design of the framework at a later stage. The methodology that was adopted in this research project also included exploratory interviews that helped understand in a deeper level the point of view of several employees with different role and position, the analysis of which was used in the creation of framework.

However, it is important to acknowledge that due to time constraints, the framework could only be implemented in one project team. Conducting full-scale testing across multiple construction projects could undoubtedly have offered a more robust validation. Despite this limitation, the implementation aimed to provide valuable observations regarding the feasibility and effectiveness of the framework. This approach allowed for a practical evaluation of the framework's applicability in a real-life situation and project. It is also essential to recognize that this implementation serves as a foundation upon which future research can build and highlights the need for further investigation into agile risk management within the construction industry.

Research results The results at the end are the conclusions of this research. It is interesting to see the difference between what the initial expectations were and what are the actual results. In this case, I believe that for certain elements what was expected came true, while for others their progress was different than what was expected. The framework developed throughout this thesis provides both a new perspective on the risk management process and demonstrates its immediate practicality and applicability as it can be implemented in real-life construction projects, offering in this way a bridge between research and industry practice.

Lessons learned The journey of completing my thesis project has been transformative, marked by both intellectual growth and personal challenges. It is important to acknowledge that this endeavor was not always smooth as there were several difficult and stressful moments along the way. There were instances where the path ahead seemed uncertain. But these are the moments that made me push forward and not lose sight from the end goal.

Along this journey I learned some profound lessons. This experience has taught me the value of patience even more, the importance of being adaptive and seeking guidance and advice when needed. I also understood the significance of setting achievable milestones and breaking down complex tasks into manageable steps. Looking back now, I cannot help but appreciate the journey in its entirety. This journey has allowed me to reflect on the years spent at TU Delft and the invaluable experiences gained, not only in terms of academic knowledge but also in terms of personal growth, resilience, and the ability to overcome obstacles. This journey has not only concluded in the fulfillment of an academic milestone but has also shaped me into a more capable and resilient individual, ready to embrace future challenges with confidence.

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A

The agile manifesto

1. Customer satisfaction through early and continuous software delivery: Agile teams prioritize delivering working software to customers frequently, enabling them to provide feedback early in the development process.
2. Welcome changing requirements, even late in development: Agile teams embrace change and understand that requirements can evolve throughout the project. They adapt their plans and processes to accommodate changes effectively.
3. Deliver working software frequently, with a preference for shorter timescales: Agile teams aim to deliver usable software in short iterations, typically weeks rather than months, to gather feedback and make necessary adjustments promptly.
4. Collaboration between business stakeholders and developers throughout the project: Agile promotes close collaboration and active involvement of business stakeholders and developers to ensure the software meets the desired objectives and remains aligned with business needs.
5. Build projects around motivated individuals, giving them the environment and support they need: Agile recognizes the value of motivated individuals and promotes an environment that empowers them to take ownership, make decisions, and contribute to the project's success.
6. Face-to-face communication is the most effective way of conveying information within a development team: Agile encourages direct communication and face-to-face interactions as they are typically more efficient and enable quick feedback and resolution of issues.
7. Working software is the primary measure of progress: Agile teams focus on delivering working software as a tangible measure of progress rather than solely relying on documentation or intermediate milestones.
8. Agile processes promote sustainable development: Agile teams strive for a sustainable pace of work, avoiding burnout and maintaining a healthy work-life balance for team members.
9. Continuous attention to technical excellence and good design enhances agility: Agile teams prioritize technical excellence and maintain a focus on quality, ensuring that the software is built on a solid foundation and can adapt to changing requirements.
10. Simplicity: The art of maximizing the amount of work not done is essential. Agile

emphasizes simplicity in software development, avoiding unnecessary complexity and delivering the most valuable features with the least amount of effort.

11. Self-organizing teams make the best decisions: Agile teams are self-organizing and have the authority to make decisions at the appropriate level. This empowers them to adapt to changing circumstances and make informed choices.
12. Regular reflection and adaptation to become more effective: Agile teams regularly reflect on their processes, identify areas for improvement, and adapt their practices to increase their effectiveness over time.

B

Codes created in Atlas.ti

- a lot of times the risks are generic and we don't need to involve the whole team
- ability to adapt quickly to changes
- allocate cost
- assign owners to risks
- avoid double work
- becomes unmanageable
- being proactive rather than reactive
- BRMF
- categorization of risks
- collaboration with coworkers to complete the task
- contract risk
- done in a timely manner
- engineering manager
- every month
- firefighting action
- focus on opportunities as well
- focusing on one task at a time
- frequent communication with the client
- holds people back from reviewing it
- I cannot identify them
- in a monthly basis
- in a quarterly basis
- incentivizes people to avoid the list
- incorporating new initiatives
- inviting everyone is a time consuming process
- it is not necessary to include the whole team

- lack of training and understanding of the risk identification discussions
- limited involvement of people besides team leads
- mitigation actions
- mitigation actions are not followed up efficiently
- Monte Carlo
- no blaming culture
- no, I am not aware of the risks that I am responsible for
- no, I am not familiar with the term agile and different tools
- no, I do not know the frequency of the risk register review meetings
- no, I do not participate in the risk register review meetings
- no, I do not take the risk register into consideration in my everyday work
- no, I do not understand the impact that the risks that I'm responsible for can have
- no, I myself am not responsible for specific risks
- no, not familiar with the risk management process
- no, not involved in the risk management process
- no, they do not prevent me from fulfilling my role
- numerous pre-determined risks
- only the leads are involved and review the risk register
- open minded
- people are not accountable, leading to micromanaging
- piping lead
- PMAR
- prioritization of risks
- project control specialist
- project controls lead
- project director
- project manager
- project manager and different people
- proposal phase
- risk management is an open end and people do not have time for that
- risk descriptions are often not accurate enough
- risk register
- risk register is too long and detailed
- risks are added multiple times in the risks register
- the BRMF system is bureaucratic and time consuming
- the meetings about the mitigation actions should be more frequent
- the process incentivizes to look ahead
- the review of the risks is not frequent enough
- the risk level categorization is often not accurate, too soft

- the steps are clear
- the system makes people think about mitigation actions
- the team does not review the risk register at all
- this is just how Fluor works
- this is the responsibility of project managers
- translation of mitigation actions into a strategy
- trigger event
- visibility in the agile environment
- we are aware of our risks and blockers
- yes, familiar with the risk management process
- yes, I am aware of the risks that I am responsible for
- yes, I am familiar with the term agile and different tools
- yes, I know the frequency of the risk register review meetings
- yes, I myself am responsible for specific risks
- yes, I participate in the risk register review meetings
- yes, I take the risk register into consideration in my everyday work
- yes, I understand the impact the risks I’m responsible for can have
- yes, involved in the risk management process
- yes, they prevent me from fulfilling my role

C

Questionnaire results

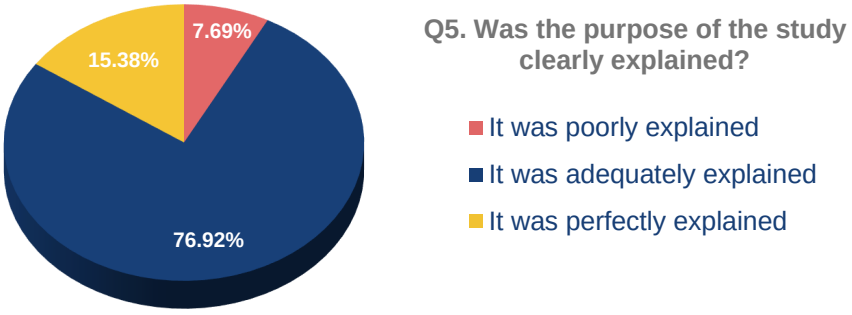


Figure C.1: Responses to Question 5

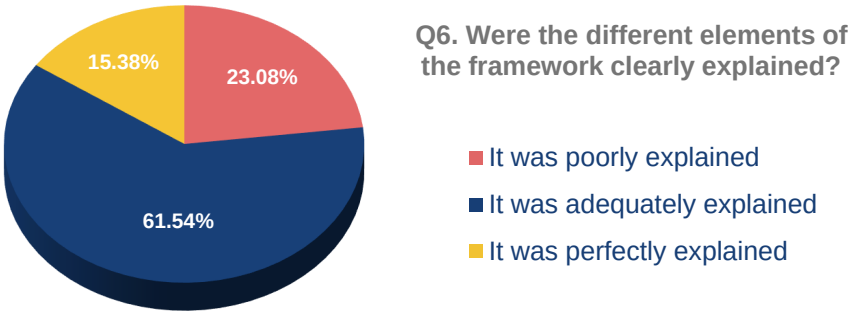


Figure C.2: Responses to Question 6

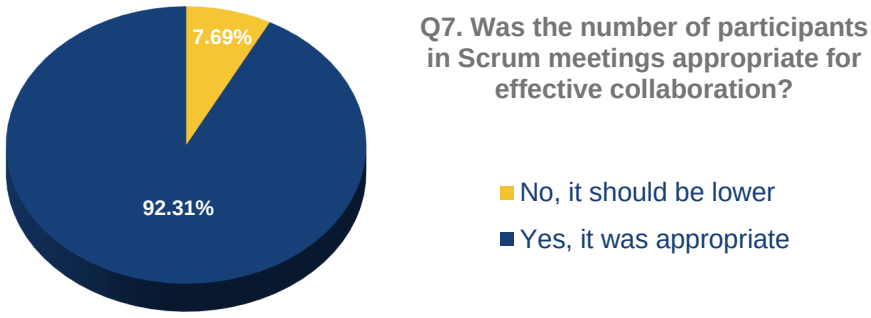


Figure C.3: Responses to Question 7

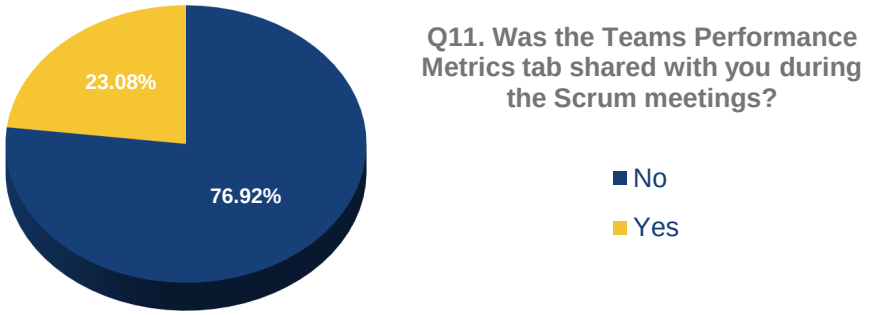


Figure C.4: Responses to Question 11

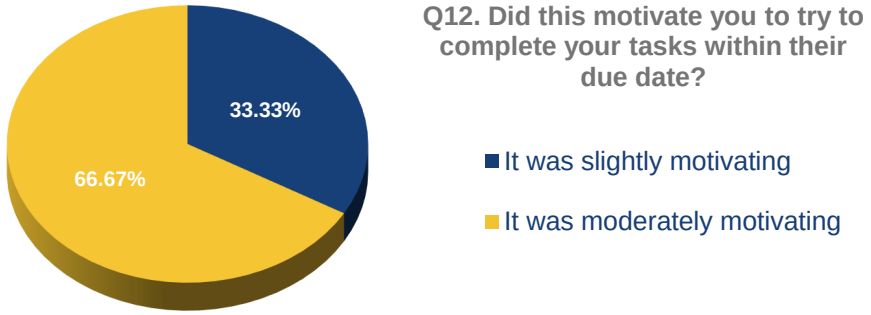


Figure C.5: Responses to Question 12

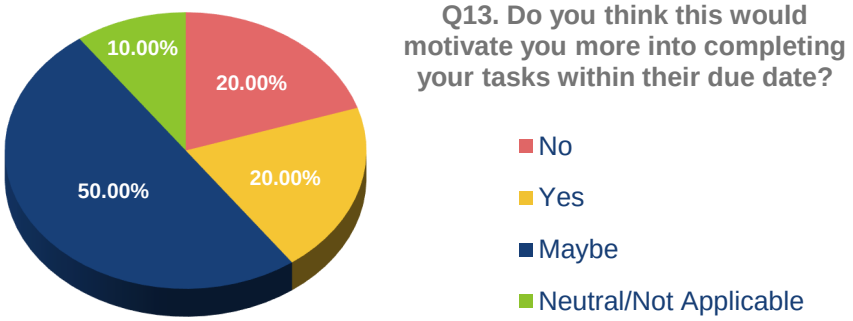


Figure C.6: Responses to Question 13

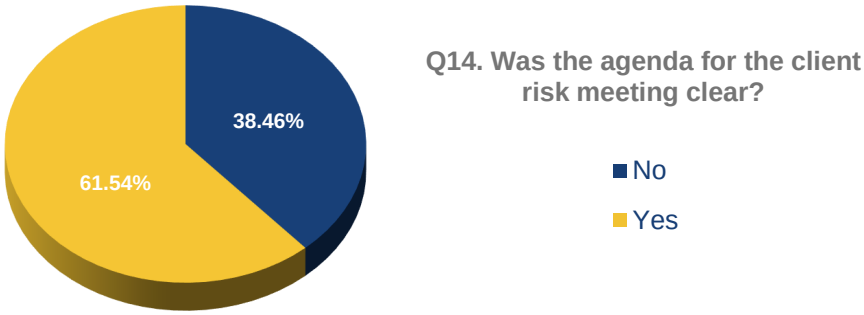


Figure C.7: Responses to Question 14

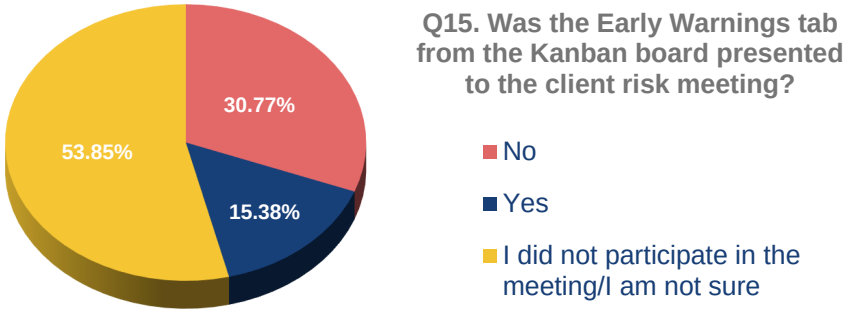


Figure C.8: Responses to Question 15

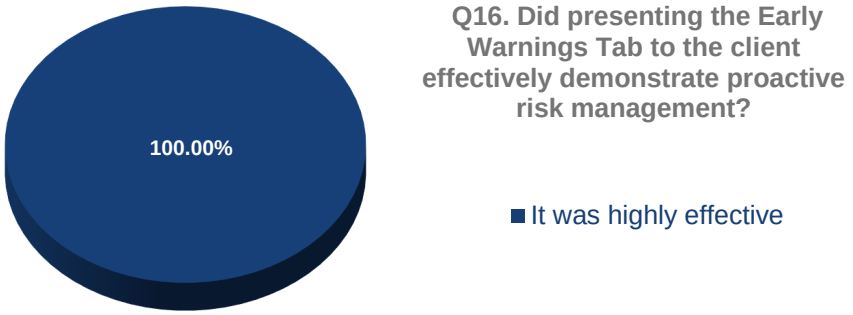


Figure C.9: Responses to Question 16

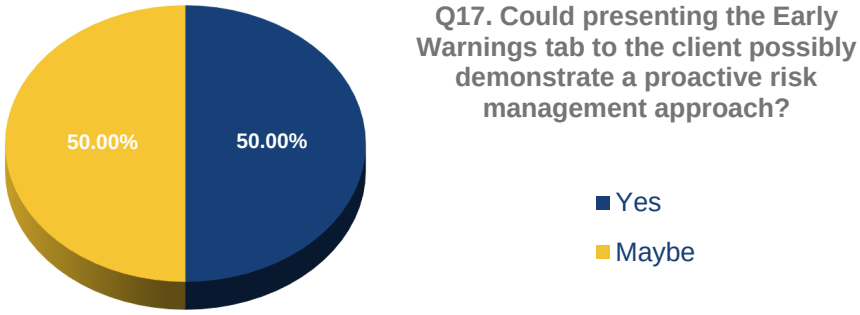


Figure C.10: Responses to Question 17

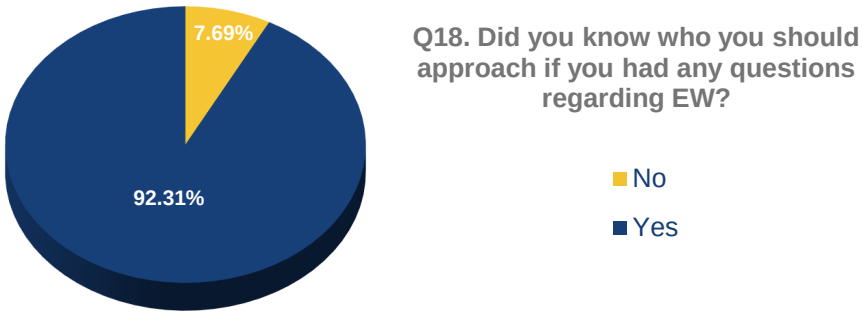


Figure C.11: Responses to Question 18

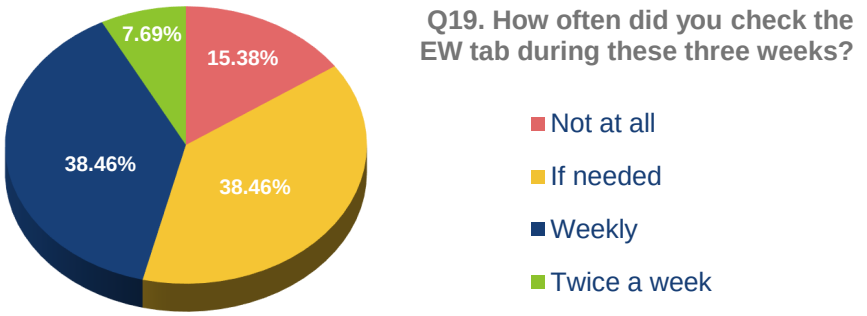


Figure C.12: Responses to Question 19

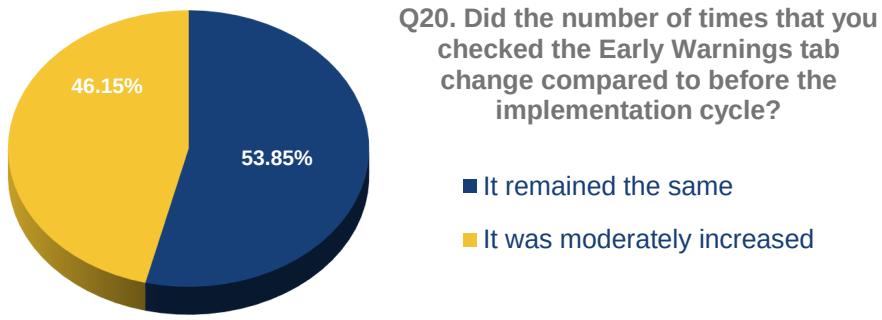


Figure C.13: Responses to Question 20

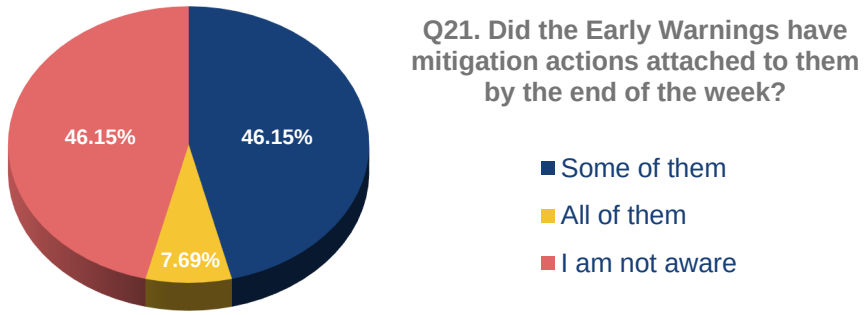


Figure C.14: Responses to Question 21

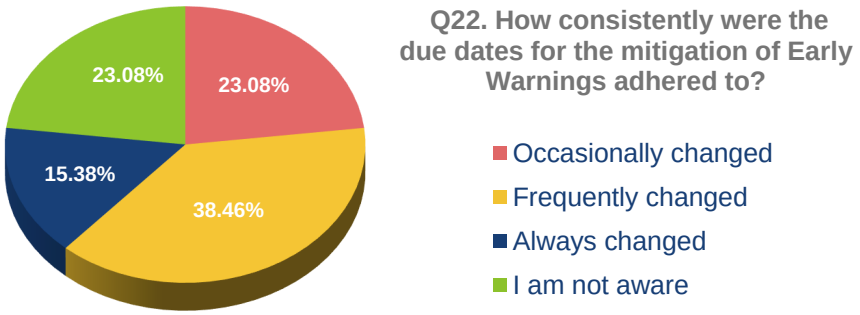


Figure C.15: Responses to Question 22

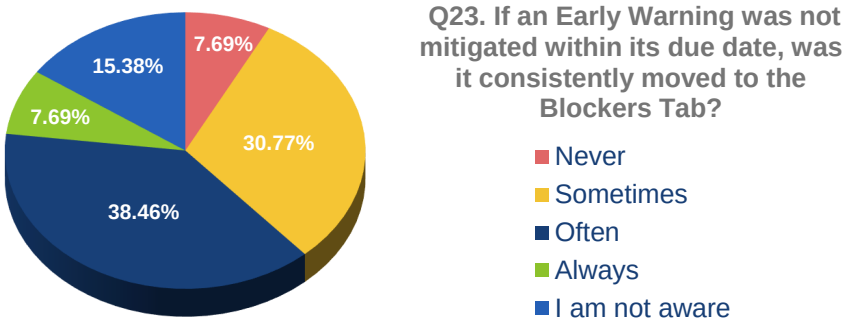


Figure C.16: Responses to Question 23

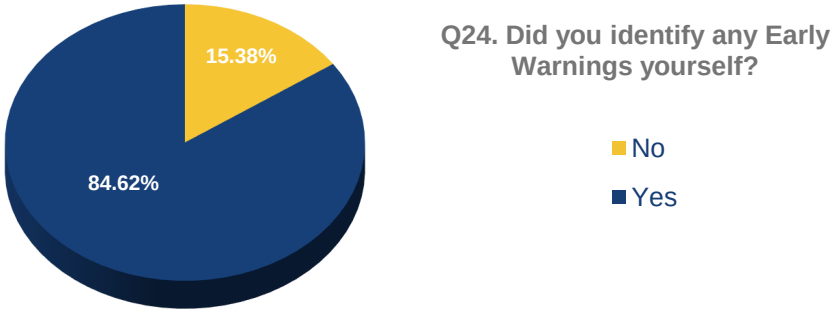


Figure C.17: Responses to Question 24

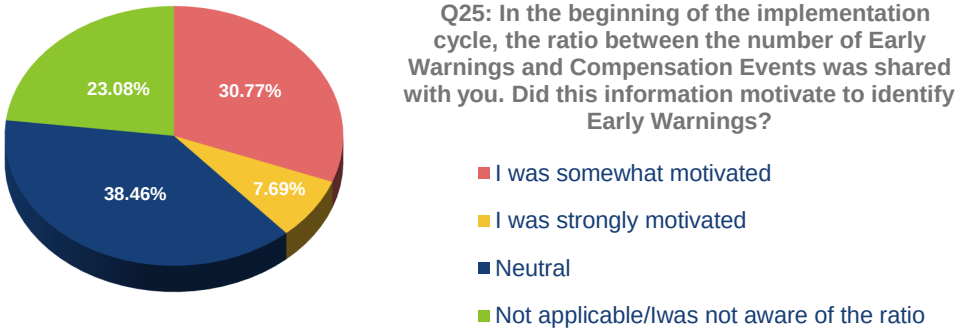


Figure C.18: Responses to Question 25

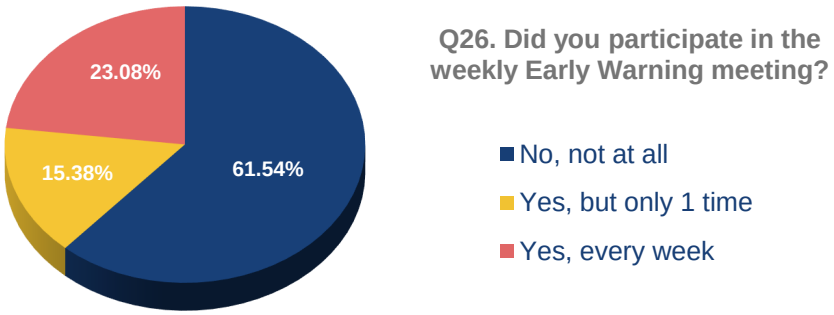


Figure C.19: Responses to Question 26

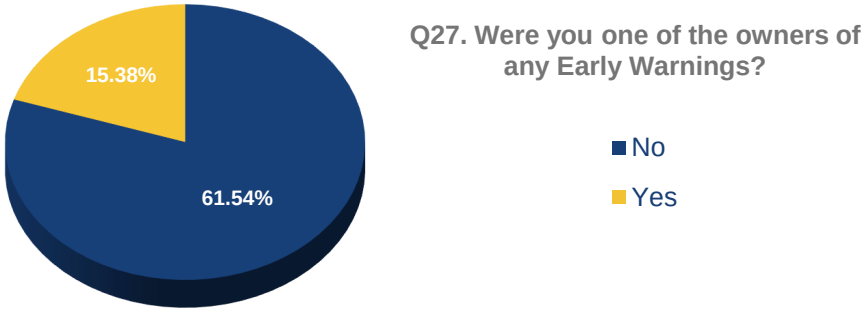


Figure C.20: Responses to Question 27

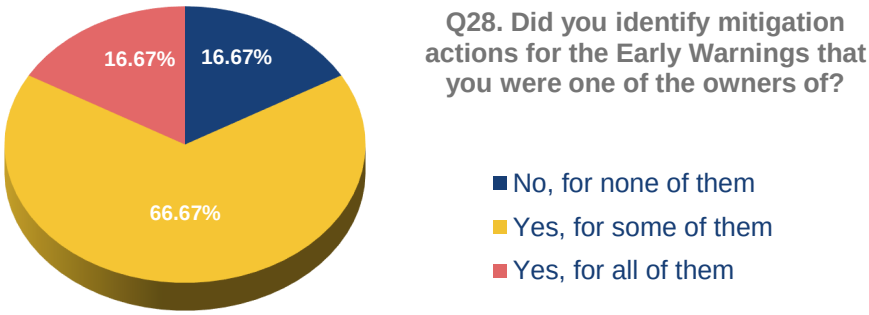


Figure C.21: Responses to Question 28

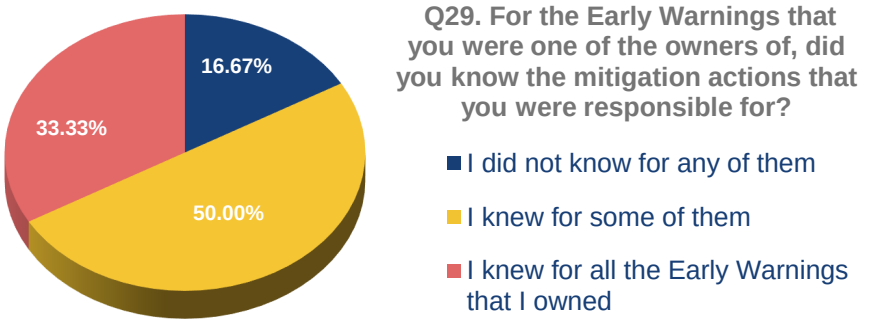


Figure C.22: Responses to Question 29

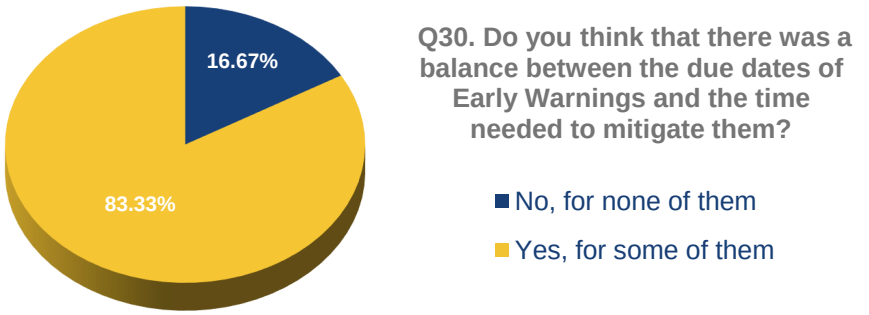


Figure C.23: Responses to Question 30

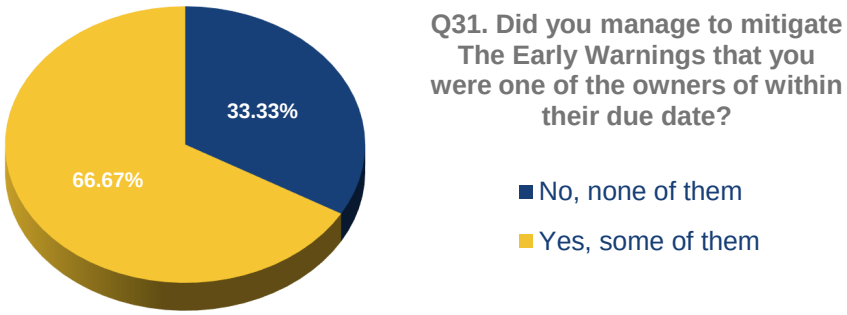


Figure C.24: Responses to Question 31

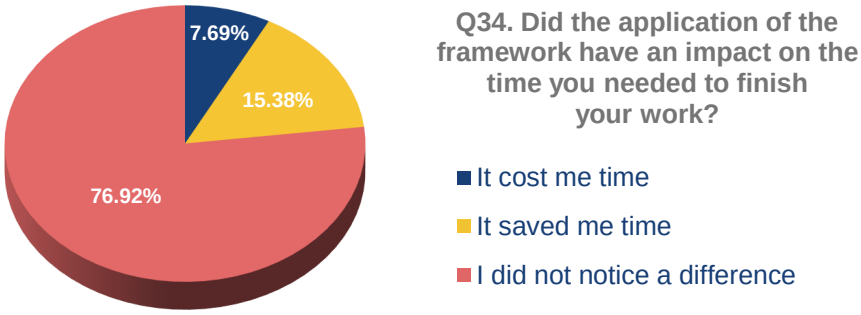


Figure C.25: Responses to Question 34

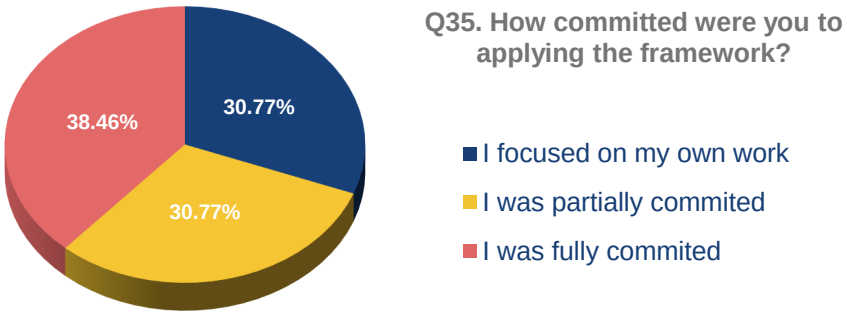


Figure C.26: Responses to Question 35

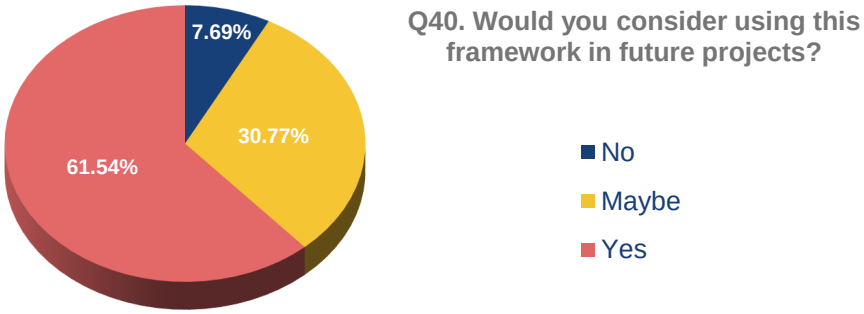


Figure C.27: Responses to Question 40

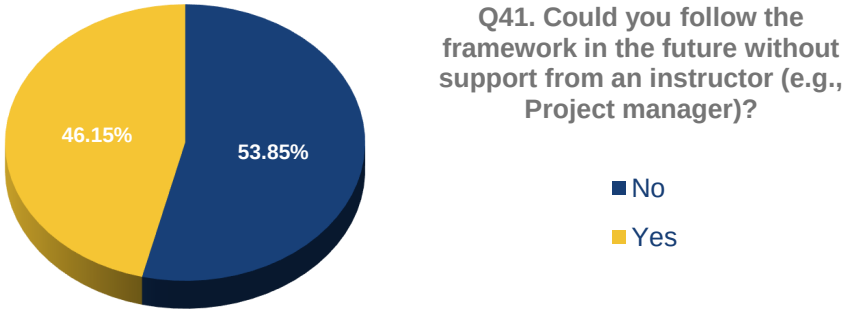


Figure C.28: Responses to Question 41