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A Dissertation as Partial Fulfillment for The Requirements of Master's Degree Within the Field of Management of Organizations.

Assessing How Agile Project Management Could Improve Risk Management: Insights from Cosider's Project M29.

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In the name of **Allah**, the Most Gracious, the Most Merciful,

We begin by bowing in humble gratitude to Allah, the source of all knowledge and strength, the light in moments of darkness, and the peace in times of doubt. Without His divine will, mercy, and infinite grace, this journey would have remained an unreachable horizon. Every word written, every thought formed, and every challenge overcome is a testament to His blessings. **Alhamdulillah**.

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This dissertation is not just an academic document.

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ABSTRACT

This study explores the potential contribution of Agile Project Management (APM) principles to improving risk management practices in public infrastructure projects. Using Cosider's Project M29 (Algiers Metro expansion) as a case study, we conducted a qualitative analysis based on eight semi-structured interviews with project stakeholders. The data were analyzed using NVivo software to extract thematic insights. The research developed a conceptual framework by mapping selected Agile principles to the five phases of the PMI Risk Management Standard (2019). Findings reveal a strong alignment between Agile values such as continuous feedback, team autonomy, and iterative planning and the risk management needs of dynamic infrastructure environments. The study highlights the presence of informal Agile-like practices already in place at Cosider and proposes actionable insights for embedding Agile thinking to improve risk visibility, responsiveness, and stakeholder coordination.

Keywords : Agile Project Management, Risk Management, Infrastructure Projects, Cosider.

Résume

Cette recherche examine comment les principes de l'Agile Project Management (APM) peuvent contribuer à améliorer les pratiques de gestion des risques dans les projets d'infrastructure publique. À travers une étude de cas portant sur le projet M29 de Cosider (extension du métro d'Alger), une analyse qualitative a été menée sur la base de huit entretiens semi-directifs avec des parties prenantes du projet. Les données ont été analysées à l'aide du logiciel NVivo afin d'extraire les thématiques principales. Un cadre conceptuel a été élaboré en mettant en correspondance certains principes agiles avec les cinq étapes du Standard PMI de gestion des risques (2019). Les résultats mettent en évidence une forte compatibilité entre les valeurs agiles telles que la rétroaction continue, l'autonomie des équipes et la planification itérative et les besoins en matière de gestion des risques dans des environnements de projet complexes. L'étude souligne également la présence de pratiques informelles d'inspiration agile déjà adoptées chez Cosider, et propose des pistes concrètes pour améliorer la visibilité des risques et la réactivité.

Mots-clés : Gestion de projet agile, gestion des risques, projets d'infrastructure, Cosider.

الملخص

تهدف هذه الدراسة إلى تحليل مساهمة مبادئ إدارة المشاريع الرشيقة (Agile) في تحسين ممارسات إدارة المخاطر في مشاريع البنية التحتية العامة، من خلال دراسة حالة مشروع M29 لشركة كوسيدار (توسعة مترو الجزائر). حيث تم إجراء تحليل نوعي قائم على ثماني مقابلات شبه مهيكلة مع أصحاب المصلحة في المشروع. تم تحليل البيانات باستخدام برنامج NVivo لاستخلاص المواضيع الرئيسية. تم بناء إطار مفاهيمي عبر مطابقة المبادئ الرشيقة المختارة مع المراحل الخمس للمعيار الدولي لإدارة المخاطر (PMI 2019). أظهرت النتائج توافقاً واضحاً بين قيم Agile مثل ردود الفعل المستمرة، واستقلالية الفرق، والتخطيط التكراري واحتياجات إدارة المخاطر في المشاريع المعقدة. كما أظهرت الدراسة وجود ممارسات غير رسمية مستوحاة من Agile داخل كوسيدار، وقدمت توصيات عملية لتعزيز وضوح المخاطر وسرعة الاستجابة وتحسين التنسيق بين الأطراف المعنية.

الكلمات المفتاحية: إدارة المشاريع الرشيقة، إدارة المخاطر، مشاريع البنية التحتية، كوسيدار.

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LIST OF ABBRIVATIONS AND ACRONYMS:

Abbreviation	Meaning
HR	Human resource
APM	Agile project management
PMI	Project management institute
TPM	Traditional project management
XP	Extreme programming
TPS	Toyota production system
ART	Agile release train
RTE	Release train engineer
ROI	Return on investment
WIP	Work in progress
SAFe	Scaled agile framework
PRM	Project risk management
ISO	International Organization of Standardization
SWOT	Strengths, weakness, opportunities, threats
RBS	Risk breakdown structure
WBS	Work breakdown structure
ARM	Agile risk management
TRM	Traditional risk management

INTRODUCTION

INTRODUCTION

General Introduction:

Throughout the past decades, project environments especially in infrastructure have grown increasingly complex, uncertain, and dynamic. Traditional project management methods, often based on predictive planning and rigid execution, have shown limitations in managing risks effectively in large-scale operations. As a result, project resilience and adaptability have become essential qualities for success in public infrastructure projects, such as metro system expansions.

A particularly relevant example is the expansion of the Algiers Metro, managed by Cosider's Project M29. This strategic infrastructure project aims to improve urban mobility but also embodies several risk dimensions technical delays, stakeholder misalignment, regulatory issues, and operational uncertainties. These challenges necessitate a more flexible and collaborative project approach, capable of anticipating and adapting to risk as it evolves.

Over the last two decades, Agile Project Management originating in software development has emerged as a transformative approach to managing complexity. By encouraging iterative planning, team empowerment, stakeholder collaboration, and frequent feedback, Agile offers new opportunities to reshape risk management practices, even in traditionally rigid sectors like public works.

Research Interest:

The motivation behind this research stems from the growing interest in integrating Agile principles into non-IT environments, particularly in public infrastructure projects. While Agile adoption is well-documented in technology-driven sectors, its contribution to risk management in construction and infrastructure remains underexplored.

In Cosider's Project M29, Agile is not formally applied, but informal practices such as daily coordination, adaptive responses, and team autonomy suggest potential compatibility. This presents a unique opportunity to explore how APM principles could enhance the way risks are identified, analyzed, and mitigated in such contexts.

Research Objective:

This dissertation aims to assess how selected Agile Project Management principles can contribute to the improvement of risk management practices within a public infrastructure project.

More specifically, the objective is to:

- Identify which APM principles are most relevant to the challenges of infrastructure projects.
- Analyze how these principles align with standard risk management practices.
- Explore how project stakeholders perceive their relevance.
- Propose improvements for risk management processes at Cosider through Agile thinking.

Research Problem:

Despite the presence of risk management procedures at Cosider, challenges remain in predicting, adapting to, and communicating risks. Agile practices are largely absent from the formal project management process, which raises the following central research question:

"How can Agile Project Management principles improve risk management practices in public infrastructure projects such as Cosider's Project M29?"

5. Research Sub-Questions:

- What are the current risk management practices in Cosider's Project M29?
- Which Agile principles align with the needs of infrastructure risk management?
- How do project stakeholders perceive the contribution of Agile to managing risks?
- What improvements can be suggested for integrating Agile thinking into Cosider's risk approach?

Research Methodology:

This study adopts a qualitative, interpretivist approach grounded in constructivist epistemology, aiming to explore human perceptions and practices. Data is collected through semi-structured interviews with project stakeholders at Cosider and analyzed thematically using NVivo software. A mapping matrix between Agile principles and risk management practices forms the basis of the conceptual framework, helping to validate theoretical insights against practical realities.

Structure of the Dissertation:

The dissertation is organized into three main chapters:

Chapter 1: Theoretical Framework: Reviews the literature on Agile Project Management, traditional risk management standards, and Agile-Risk integration models.

Chapter 2: Methodological Framework and Case Context: Describes the epistemological approach, qualitative methodology, and data collection strategy. It introduces Cosider's Project M29 and presents the mapping matrix.

Chapter 3: Results and Discussion: Presents the interview findings and interprets them in relation to the conceptual framework. It examines whether Agile principles can realistically enhance Cosider's risk management and proposes practical recommendations.

CHAPTER I: Integrating Agility and Risk: A Holistic Approach to Project Management

This chapter introduces the core concepts that support our study. It begins with Agile Project Management (APM), focusing on relevant principles for infrastructure projects. It then presents traditional risk management practices, especially the ISO 31000. Finally, it explores Agile Risk Management by connecting agility to risk processes, laying the foundation for the conceptual framework and empirical analysis.

Section One: Understanding Agile Project Management (APM)

This section will trace a clear map and make an understandable plan to define Agile Project Management, it's Frameworks, challenges and APM benefits:

1.1. Definition and Principles of Agile Project Management:

1.1.1. Origins of Agile methodologies

In practice, different people have different ideas on what Agile means. Furthermore, Agile methods are hard to define because they are a broad category of clearly defined approaches with different practices. This section will demonstrate how this word was defined in the literature by both its proponents and other scholars.

Allowing an organization to be agile is the aim of agile methods, but what exactly does be agile mean? being agile is having the ability to "Deliver swiftly." Quickly change. Frequently change. Agile approaches differ in their methods and priorities, but they all have iterative development, engagement, communication, and the elimination of resource-intensive intermediary objects as commonalities. **(Cohen et al., 2004)**

Agile is often described as a philosophy by certain researchers, "being agile means being successful and maneuverable." Agile processes are lightweight and adequate. Being light helps you stay maneuverable. Remaining in the game is the key to sufficiency. Agile approaches are "an off shoot of quick prototyping and rapid development experience as well as the rebirth of a mentality that programming is a craft rather than a an industrial process".**(Abbas et al., 2008)**

When 17 software development professionals met in Snowbird, Utah, at the beginning of 2001 to exchange ideas about various software development methodologies, they came up with the concept of Agile. A set of values and 12 matching principles were developed as part of a manifesto for Agile software development. Agile was just what developers needed to handle a wider range of client requirements. Furthermore, Agile does not necessitate a

system of documentation for the product; instead, it focuses the customer in a way that creates trust between the client and the development team. This could be the primary flaw in the Agile methodology.**(Zayat & Senvar, 2020)**

The author views:

Our understanding of Agile methodologies was shaped in large part by the earlier reviews and conversations. In order to demonstrate our comprehension, we shall define an Agile process in this subsection. Stated differently, what distinguishes an Agile development methodology? Agile approaches are adaptative, iterative and incremental, and people-focused.

- **Adaptive**: an Agile approach embraces modifications to requirements and technology, even to the extent of altering the approach itself. Furthermore, it reacts to criticism of earlier work. An adaptive process is one that may provide control over uncertainty.
- **Iterative and incremental**: From planning to delivery, the software is created in multiple iterations. Every iteration involves the development, testing, and improvement of a new system component. The functionality will be enhanced with each iteration. Additionally, as new features are added with every version, the system is expanding gradually. To gather input, a release will be sent to the client following every new version.
- **People-focused**: "people come first, regardless of the process". Every time, good individuals with a good process will perform better than good people without one. People are the main force behind project success in an Agile methodology. As a result, the process's function in an Agile approach is to assist the development team in deciding how to best manage the work. Additionally, an Agile approach places greater importance on in-person interactions than written papers, both within the team and with the client who is actively involved in the development process.(Abbas et al., 2008)

1.1.2. The agile management:

The Agile Manifesto, which established 12 principles and basic values for Agile software development, was developed in 2001 by a group of 17 software professionals in Snowbird, Utah. Agile prioritized client collaboration over documentation in order to better manage

evolving customer requirements. Although this fosters confidence between clients and developers, the absence of official documentation may also be a disadvantage.(**Zayat & Senvar, 2020)**

Agile management is a gradual and developmental approach for information system components that operate in brief cycles. Its primary objective is to adjust the project's goals and plans before it is completely developed in order to accommodate shifting customer expectations, which typically arise during the project.**(Benmounah & Boughlita, 2022)**

The software development methodology known as "agile management" emerged in opposition to strict, documentation-heavy approaches. It places a high value on adaptability, teamwork, and customer responsiveness. Its foundation is the Agile Manifesto (2001), which emphasizes matching development procedures to changing business and technological contexts as well as dynamic client requirements.**(Dong et al., 2024)**

1.1.3. Principles of agile management

Its primary goal is customer satisfaction through timely and consistent delivery of useful software, all the while accepting and embracing changes, even at the very end of development. Additionally, building projects depend on driven workers who are given the right conditions, the required assistance, and the confidence to do the work. In-person discussions are the most efficient means of knowledge exchange and communication amongst the members of the development team.**(Benmounah & Boughlita, 2022)**

1.1.4. The agility tools:

To achieve the intended outcomes, the agile management methodology offers a variety of tools. The most popular and widely used tools in the service industry are listed below:**(Abbas et al., 2008)**

- **Constant enhancement:** A Japanese technique for implementing gradual, straightforward, and ongoing enhancements to goods, services, and procedures that lower expenses and various wastes while boosting output
- **Multifunctional human resources:** To offer a wider range of services, HR personnel need to be taught to do several tasks.

When workers cycle between several workstations, they can develop a variety of abilities that can help them understand the work in all of its dimensions.

- **Six sigma:** This tool indicates that any changes or deviations in any system process are the main focus. It enables the company to estimate the average number of problems that are occurring during the process. Because these flaws deviate from previously established regulatory limits, a product becomes defective if it falls outside of them.

1.1.5. Adopting Agile Management:

Adopting agile management requires significant changes to move away from traditional management methods. One of the first and most important changes involves transforming the organizational culture. In agile environments, individual roles are less emphasized, and instead, teamwork becomes the focus. Human resources are no longer trained individually, but collectively with an emphasis on communication, sharing opinions, giving and receiving feedback, problem-solving, and collaborative decision-making. Additionally, the transition includes moving from long, process-heavy development phases to short, iterative, and thoroughly tested development cycles. **(Benmounah & Boughlita, 2022)**

1.1.6. Agile manifesto and core values:

A. Agile project management:

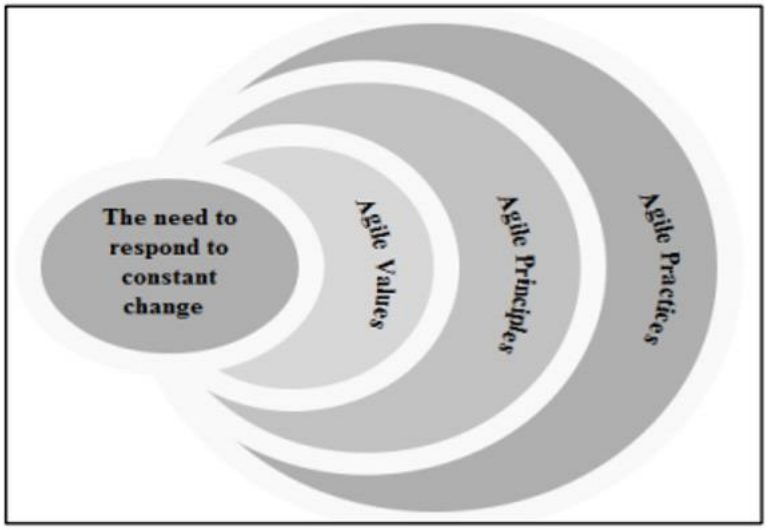
In any software development process, project management is a crucial and essential component. The core of project management is team management, customer relations, cost containment, risk management, and sticking to the project budget and schedule. The way these fundamental duties are carried out varies significantly depending on the agile framework, but they are always the same. The way that people think is what is so profoundly different.**(rashina et al., 2008)**

Agile can offer a departure from the classic plan-execution process and has been widely adopted and changed in a variety of project contexts beyond software development. logic. Projects are defined as "temporary initiatives to create value through distinctive products, services, and processes" by the Project Management Institute (PMI) (2023). The conventional definition of projects, which aims to achieve known and precise project objectives, seems to be at odds with the prevalent definitions of Agile Project Management, which include modifications to user and project requirements.**(Dong et al., 2024)**

B. Principles of Agile project management:

An iterative method for organizing and carrying out project procedures is called agile project management. Through self-organization, planning, development, and early project delivery, it is a collection of tools and techniques used in the software development process that are necessary for cooperation and integration amongst all stakeholders. Additionally, it is the adaptability. According to the Agile Manifesto, Agile methodologies are based on twelve principles and four values. Figure 1 provides the clearest illustration of Agile management. **(Ahmed & Mohammed, 2019)**

Figure 1: Agile, values, principles, and practices.



Source:(Ahmed & Mohammed, 2019)

Many proponents of Agile methods have positioned the values of traditional items to the left and the values of Agile statements to the right. It is important to understand that these arguments represent values rather than priorities; the left side is more important, while the right side's issues are required.

By doing it ourselves and assisting others, we are discovering more effective methods for creating software. **(Fowler et Highsmith, 2001)**We have learned to value:

- People and interactions over procedures and equipment as a result of this effort.
- Functional software instead of detailed documentation.
- Customer participation during contract negotiations.
- Adapting to change rather than sticking to a plan.

In other words, we place a higher value on the things on the left than the ones on the right.

We adhere to the following principles**(Fowler & Highsmith, 2001)**:

- Ensuring customer satisfaction through timely and consistent delivery of important software is our top concern.
- Changes in requirements are welcome, even at this late stage of development Agile methods leverage change to give the client a competitive edge.
- Provide functional software on a regular basis, preferably within a few weeks rather than several months.
- Throughout the project, developers and businesspeople collaborate every day.
- Organize projects around driven people. Give them the space and assistance they require, and have faith in their ability to do the task.
- Face-to-face communication is the most effective and efficient way to communicate with a development team.
- The most important indicator of progress is functional software.
- Sustainable growth is facilitated by agile processes. It should be possible for the developers, sponsors, and users to keep up a steady pace indefinitely.
- Agility is improved by constant attention to technical perfection and sound design.
- It is crucial to practice simplicity, which is the skill of maximizing the amount of effort that is not done.
- Self-organizing teams produce the best requirements, designs, and architectures.
- The team evaluates how it can improve its effectiveness on a regular basis and then modifies its behavior accordingly.

1.1.7. Differences between Agile and traditional project management:

The Agile Manifesto's principles and values place a strong emphasis on flexibility and teamwork, as we previously observed. We now examine the main distinctions between APM and Traditional Project Management (TPM) with regard to delivery methodology, adaptability, and structure.

A. Agile Project Management:

The flexible, adaptable approach to project management known APM helps businesses react swiftly to shifts in a fast-paced business environment. It places a strong emphasis on teamwork, consistent value delivery, and flexibility in response to changing needs.

APM is founded on a set of values, concepts, methods, and tools intended to manage change and uncertainty. Its roots are in software development and were codified in the Agile

Manifesto (2001). It aims to achieve the best possible balance between stability and adaptability, enabling teams to consistently match project results with changing client requirements.**(Ciric et al., 2019)**

Agile project management is essentially a philosophy that places a higher priority on:

- Customer cooperation
- Rapid change adaption
- Delivery of functional solutions in stages
- Cross-functional and empowered teams

B. Traditional project management:

The main goal of TPM is to complete a project on time, within budget, and to the specified scope based on a thorough initial plan. However, in practice, many projects face uncertainty and changing requirements, which the traditional model struggles to accommodate, and as a result, it may lack the flexibility needed in dynamic environments. **(Ciric et al., 2019)**

TPM's key characteristics include:

- Predictability and control.
- Fixed scope time, and cost.
- Emphasis on documentation and planning
- Almost nothing has changed since the project started
- success is determined by following the original plan.

There are distinctions between the agile working style and the conventional methods of software development. The table 1 highlights a few of the more notable. **(Rashina, james, et. Stuart 2008)**

Table 1: Comparative table Traditional vs Agile

Categories	Traditional	Agile
Development Model	Traditional	Iterative
Focus	Process	People
Management	Controlling	Facilitating
Customer involvement	Requirements gathering and delivery phases	On-site and constantly involved
Developers	Work individually within teams	Collaborative or in pairs
Technology	Any	Mostly Object Oriented
Product Features	All included	Most important first
Testing	End of development cycle	Iterative and/or Drives code

Source:(Rashina et al., 2008).

1.2. Agile Frameworks and Approaches:

1.2.1. Scrum:

Scrum is a framework that enables individuals to handle challenging issues while retaining high productivity and producing high-caliber outputs(Schwaber & Beedle, 2002). Agile software development includes Scrum. Scrum, which derives its name from rugby, is a team structure in which each member plays a specific function and strategies are quickly adopted.**(Zayat & Senvar, 2020)**

Figure 2: Scrum model.

Source:(Hayat et al., 2019)**.**

A. Scrum team:

Each Scrum team consists of a Development Team, a Scrum Master, and a Product Owner. Scrum teams can choose how to work because they are self-organizing and cross-functional. They are made to be adaptable, encouraging innovation and efficiency. Iterations in product delivery allow for frequent client input.**(Zayat & Senvar, 2020)**

a. **Producer owner**: Ensuring high product quality is the primary duty of the product owner. This entails managing the product backlog, which entails identifying things,
   - setting priorities for them according to project objectives,
   - enhancing the work of the development team,
   - providing the team with clarification on the backlog.
   - Every backlog item needs to be sent to the Product Owner for revisions, even if a committee decides on priorities.

Everyone on the Scrum team needs to respect the decisions made by the Product Owner, which are reflected in the product backlog, for the team to succeed.**(Zayat & Senvar, 2020).**

b. **Scrum master:** In accordance with the Scrum Guide, the Scrum Master is in charge of making sure Scrum is applied correctly. They guide newbies in efficiently working with the team and assist everyone in understanding Scrum philosophy, principles, and values. Aiming to improve the project's overall performance without assuming a managerial role, the Scrum Master should only concentrate on one project at a time in order to maximize attention and effectiveness.

c. **Development team:** Based on the product backlog,**(Zayat & Senvar, 2020)** the Development Team produces a product increment at the conclusion of each sprint. This group of experts is in charge of creating the product in accordance with the necessary requirements. A well-functioning team structure improves output. The Development Team's self-organization, cross-functionality, lack of titles or sub-teams, and people with specialized yet adaptable abilities who can work in a variety of fields are some of its key attributes.

B. Scrum framework:

Under the direction of the Scrum Master, the Scrum framework starts with the organization of the product backlog. Sprint planning, the actual sprint, and the release of a product increment come next. After then, the procedure is repeated in iterative cycles.**(Zayat & Senvar, 2020)**

- **Product backlog**: Product Owner oversees the Product Backlog, listing and ranking user stories according to their significance, impact, risk, and potential for future learning. This guarantees project clarity by prioritizing important features, then less important ones, and eliminating those that don't match the timeline.
- **Sprint planning:** The Development Team chooses which high-priority backlog items to work on and how to construct them during Sprint Planning. They are encouraged to ask the Product Owner and stakeholders questions to elucidate feature needs, and they concentrate on items that are ready without going into excessive detail.
- **The sprint**: The Development Team prioritizes user stories from the product backlog and works on them during a sprint with the goal of finishing them in that time frame. To guarantee progress and permit only minor modifications to the sprint backlog, sprints start with daily meetings. A tested, deliverable product increment is the end result of each sprint, which operates as a micro project with defined objectives. Sprints never last more than a month, but usually last two to four weeks. Due to potential backlog changes, longer sprints might result in higher risks, expenses, and complexity.
- **Completed sprint:** When the work is finished and the final product is prepared for delivery, a sprint is said to have ended. At this point, the client or other stakeholders may conduct tests, and automation can assist save money and time.

- **Review**: A review meeting is conducted following a sprint to assess what worked and what didn't, with the goal of enhancing subsequent sprints. While adhering to ground principles to preserve a pleasant environment, the Scrum team seeks to retain effective practices and remove obstacles.
- **Repeat**: Starting with the highest priority backlog items and continuing in the same manner, the cycle is continuously repeated while process improvement and new ideas are applied to attain high quality and increase performance.

In summary, only competent teams can use Scrum successfully. Its execution frequently suffers from underestimating budgets and schedules. Burnout charts and team velocity can be used to assess Scrum performance. These technologies, along with measurements, were used by **(Rajani Dixit & Brij Bhushan, 2019)** to track software problems and evaluate the accuracy of sprint planning.

1.2.2. Kanban:

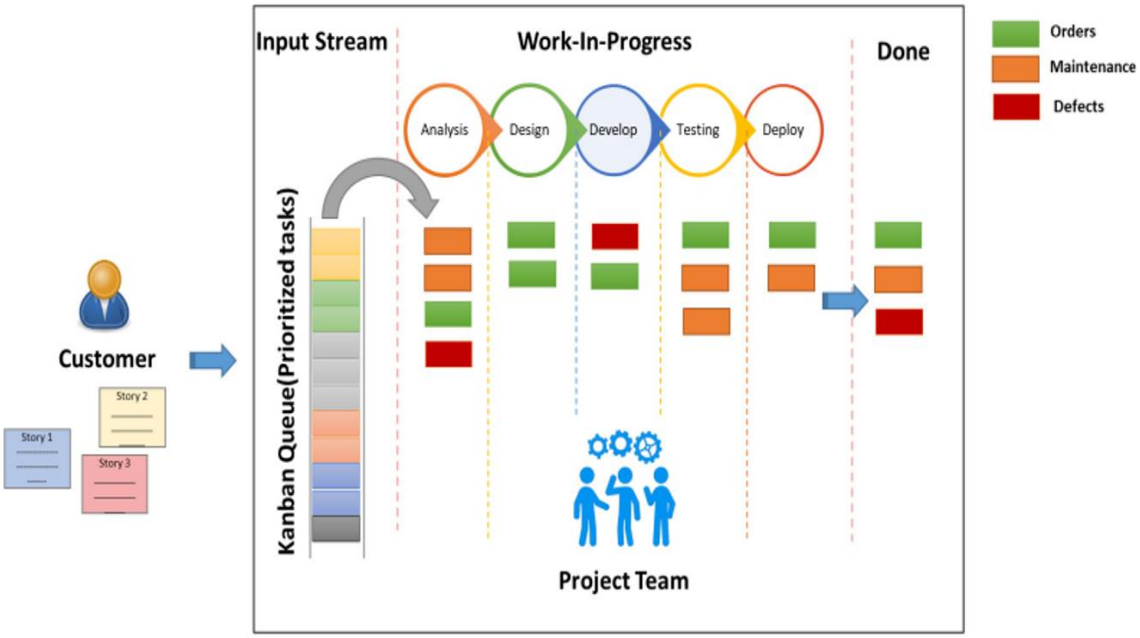
The term "kanban" which translates to "visual signal" was initially used by Toyota employees to monitor manufacturing system activities. Because Kanban is a straightforward tool that gives information on what has to be done and when, teams were able to communicate more effectively **(Lei et al., 2017).**The notion of Kanban is a key component of Lean manufacturing and just-in-time (JIT) production methods. Kanban is a scheduling method that gives information about what is needed, when to supply it, and how much is needed. Kanban ideally controls the entire value chain, from the supplier to the client. **(Zayat & Senvar, 2020)**

A. Kanban framework:

- **Visualize Work**: **(Zayat & Senvar, 2020)** To begin implementing Kanban, a board is separated into columns that correspond to workstream stations. Cards are then moved between columns to replicate real-world system events. Every action may be readily watched, monitored, and assessed when the work is visualized in this manner.
- **Focus on the Flow**: The flow of work through the processes can be examined in order to optimize the kanban system. Limiting the amount of work in progress and preventing system bottlenecks can be achieved by adhering to a few fundamental principles.
- **Continuous Improvement:** A mechanism for improving performance over time is always present in great systems. In order to achieve a shorter lead time, better quality,

and a more coherent flow, this mechanism is processed in Kanban by removing issues from the system.

Figure 3: Framework Study for Agile Software Development



Source : Kanban board adapted from (Kumar et al., 2019)

B. Kanban board:

(Zayat & Senvar, 2020) said that there are Three primary columns are included in a basic Kanban board:

- **To do**: This column contains a list of every task that has not yet been initiated. Tasks are often arranged based on arrival timings, however occasionally this isn't the case. in accordance with priorities.
- **In progress**: the tasks that are currently being worked on are listed in this column.
- **Done**: displays the tasks that have been finished.

This straightforward method can help clarify what needs to be done and highlight any bottlenecks that may be present. Indeed, as seen in Fig. 3, the board can be expanded to accommodate as many columns that are necessary for the structure.

C. Differences Between Scrum and Kanban:

Table 2: A comparison between the two agile methodologies

	scrum	kanban
application	Software development	Operational support (helpdesk)
Product release	At the end of each Sprint upon the discretion of the Product Owner	Constant development
Iterations	Yes (Sprints)	No
Prescribed team roles	Product Owner Scrum Master Development Team	Does not prescribe any roles
Teams' cooperation	Intense cooperation on each backlog item	Cooperation for accomplishing the project goals
Change management	Changes can only be made at the beginning of a new Sprint.	Prompt response to any change
Meetings	Planned meetings	No meetings required
WIP	Limited per sprint	Limited per workflow state
Who determines the WIP	Product Owner	According to assigned roles (if any)
Product backlog	Listed prioritized items	Board cards
Visualization	Board, product backlog, sprint backlog	A board to visualize the process
Managing bottlenecks and work impediment	Addressed immediately	Avoided
Teams	Cross functional	Specialized

Source : (Yordanova et Toshkov 2019)

1.2.3. Extreme Programming:

XP has four fundamental activities: coding, testing, feedback, and courage, in addition to four values: communication, simplicity, and courage. both debugging and listening. The

planning game, small releases, metaphors, simple design, testing, refactoring, pair programming, collective ownership, continuous integration, 40-hour weeks, on-site customers, and coding standards are the 12 core practices of XP, according to **(Erickson et al., 2005).**

developers on the team as opposed to the business's owner or manager. This approach gets its name from the extremes to which classical programming techniques are carried. Creating a lightweight process model was the main goal of this model's development. Among the agile frameworks, XP is the most detailed when it comes to proper engineering practices in software engineering. It facilitates the development of software in accordance with client specifications.**(Shrivastava et al., 2021)**

Extreme programming is one of the agile process approaches utilized in the creation of software products. It is a somewhat well-known process for producing goods of exceptional quality. while simultaneously satisfying clients, and it was developed in generally small groups with cooperative team members**(Sankhe et al., 2022)**

A. Principles and values:

according to **(Shrivastava et al., 2021)**The XP technique has five key values. They are as follows:

- **Interaction**: The main goal of software development is to comprehend client needs and putting it into practice. It is critical that team members communicate with one another. This approach encourages communication through the use of sketching tools.
- **simplicity:** It plans ahead in an effort to simplify things as much as feasible. Developers can focus better and avoid unnecessary things thanks to it. Additionally, it encourages focusing on current needs rather than making predictions about the future. For the sake of upkeep and enhancement, the system architecture should also be kept straightforward.
- **Input**. They can pinpoint their areas of improvement and simplify the design with ongoing feedback from earlier projects.
- **Bravery: When** whatever you're working on fails, it causes a great deal of anxiety. During these periods, the to avoid outcomes that hurt the team, prior concepts should be remembered.
- **Show respect**: Respecting one another and taking criticism well will make a project succeed. This applies to both the customer and the programmer

B. A comparison Extreme Programming with:

- **Scrum:** Scrum is a kind of Agile framework that uses an iterative process called sprints to help people solve complicated problems while maintaining high quality, productivity, and innovation. For more information, see Table.

Table 3:XP vs SCRUM

Extreme Programming	Scrum
The team works for 1-2 weeks	The team works iteratively, known as sprints. Usually, 1-2-month long sprints
Has a flexible timeline	Does not allow any changes in timeline or guidelines.
Emphasizes on Software Engineering methodologies	Emphasizes on self-organization
Team has to strictly follow the predetermined priority order	The team decided the order of the priority
Ready to apply without any changes.	Not complete, will have to fill the framework with any other software engineering technique

Source :(Shrivastava et al., 2021).

- **Agile and Extreme Programming:** Agile was created in the early 2000s with the goal of raising the caliber of products. It features self-managing teams and high levels of consumer engagement, in contrast to traditional methods.

  Both of them have similar characteristics because XP is an agile methodology as well. There is no middleman between the client and the development team, in contrast to agile approaches. The project is broken up into manageable chunks, and the plans for each chunk can be altered as needed.**(Shrivastava et al., 2021)**

- **Extreme Programming and Kanban**: The primary distinction between the two is that the process in Kanban is not segmented into discrete steps.**(Shrivastava et al., 2021)**

1.2.4. Lean software development:

It is often known that the software development literature lacks a clear definition for the phrases “agile” and “lean” and that their application is frequently careless, multifaceted, unclear, and inconsistent **(Conboy, 2009).** But for the sake of our research, we must make it as clear a definition of lean software development as possible. Lean concepts, lean principles, and lean practices are the three primary components of lean software

development, which aligns with the generally acknowledged agile values, principles, and practices.

Using core characteristics including communication, simplicity, feedback, respect, and courage, **(Kumar et al., 2019)** XP is an agile software development process that prioritizes collaboration between management, consumers, and engineers. It emphasizes short development cycles, frequent releases, and a set of specific, useful techniques to improve software quality and adjust to changing customer needs.

A. Lean Concept:

Similar to agility, leanness is not a phrase specific to software development.**(Wang et al., 2012)** The majority of the literature traces its roots to the Toyota Production System (TPS) in the 1950s, although it actually has a far older history that stems from other disciplines. One method of thinking that helps businesses "specify value, line up value-creating activities in the most efficient order, carry them out continuously whenever someone asks for them, and do them with increasing efficiency".

(womack & jones, 1996) Lean thinking is based on five fundamentally connected guiding concepts:

- **Value**: is determined by the client, therefore it is critical to comprehend exactly what that means;
- **A value stream** is a map that shows each stage of the procedure and groups them according to of the benefit it provides;
- **Flow**: It's critical that the manufacturing process runs smoothly;
- **Pull:** When a customer requests a pull product, nothing is constructed before it is required;
- **Perfection:** Constantly detecting and eliminating waste in order to strive for process perfection.

B. Lean principles:

The identification and removal of waste from the process in relation to customer value is the main goal and tenet of lean. Different lean principles for software development have been developed and are continuously changing while adhering to the fundamental idea of lean. Several sets of well-known lean concepts are included in Table. within the agile community. The core and essence of lean techniques are reflected in the significant overlap between these sets of lean principles.**(Wang et al., 2012)**

Table 4: Lean principles relevant to software development

Lean Software Development Principles (Mary & Tom, 2003)	**The Principles of Product Development Flow (Reinertsen, 2009)**	**The Kanban Principles(Anderson, 2010)**
➢ Eliminate waste ➢ Build quality in Create knowledge ➢ Defer commitment ➢ Deliver fast Respect ➢ people Optimize the whole	➢ Use an economic view ➢ Manage queues ➢ Exploit variability ➢ Reduce batch size ➢ Apply WIP (Work in Progress) constraints ➢ Control flow under uncertainty ➢ Use fast feedback ➢ Decentralize control	➢ Visualize the workflow ➢ Limit WIP ➢ Manage flow ➢ Make process policies explicit ➢ Improve collaboratively (using models & the scientific method)

Source:(Wang et al., 2012)

C. Lean Practices:

Some lean software development practices, though predating agile, are now commonly integrated into agile methods. One notable example is Inspections from the 1970s, which emphasized early detection and group correction of errors to reduce costly rework. This practice aligns with lean's core principle of identifying and fixing defects early. To better understand lean's distinct contributions to software development, researchers compiled a list of lean-specific practices-less prominent in agile literature but frequently observed in lean contexts offering a foundational framework for categorizing lean approaches despite some subjectivity in selection.**(Wang et al., 2012)**

Table 5:Lean practices relevant to software development.

Lean Software Development Practices
➢ Take care of bottlenecks ➢ Stay clear of excessive local optimization. ➢ Put off making decisions. ➢ Create suitable rewards and objectives. • constant reflection, admitting one's own problems, and resolving to improve ➢ reducing output and balancing the workload. It aims to decrease waste ➢ Hide individual performance. ➢ human-touched automation, or intelligent automation. Machines should not be served by humans, but instead by machines. ➢ dramatic change in a short period of time ➢ connect the customer's voice with their requirements. ➢ Make everything clear: • Make the state of the project very clear. • View every task item. ➢ Measure and manage: • Use queuing theory, but make sure to measure the appropriate things. • The FIFO (First-In-First-Out) queue**.** ➢ Introduce variability downstream ➢ Plan-Do-Check-Act (PDCA) cycle ➢ defect detection and prevention. ➢ Governing pragmatically. ➢ Pull the andon cord by encouraging a "safe to fail" atmosphere and developing a "stop the line" mindset. ➢ Deployment of the Quality Function: convert feedback from clients into engineering traits and suitable testing techniques ➢ Cut down on waste ➢ Analysis of root causes: The Five Whys? ➢ Employ pulls systems: kanban boards, batch control processing, limited work in progress, CONWIP, and minimal marketable features. ➢ Value Stream Mapping: assess and design the procedure required to provide a customer with a good or service.

Source:(Wang et al., 2012)

1.2.5. Scaled agile framework SAFe:

SAFe, or the Scaled Agile Framework, asserts that it offers a formula for implementing agile at the corporate level. It includes the optional value stream level in addition to the levels of teams, programs, and portfolios. It uses Scrum with XP engineering processes at the team level, while Kanban can also be used. The idea of an agile release train (ART), which functions at a slower pace and is comparable to sprints at the team level, is defined at the

program level. Other jobs, such as system team, product manager, system architect, release train engineer (RTE), and release management team, are found at the program level.**(Paasivaara, 2017)**

Scrum, Lean, Kanban, and a variety of Agile approaches are all included in SAFe, a scalable Agile framework. With distinct degrees of responsibilities, procedures, and organizational structures, SAFe offers many tiers to accommodate varying corporate requirements and complexity levels. The most widely used scaled Agile framework, SAFe, has multiple layers and meets a wide range of objectives, however because to its extensive scope, it has been called complicated and similar to the waterfall technique.**(Christopher & De Vries, 2020)**

A commercial agile development framework called the SAFe was created to assist businesses in scaling lean and agile practices throughout sizable organizations. It facilitates alignment, cooperation, and delivery across numerous agile teams by offering structured principles, roles, organizational layers, and workflow patterns. To coordinate architecture and cross-team work inside the Agile Release Train (ART), SAFe provides important positions like the System Architect and Release Train Engineer (RTE). SAFe functions at several levels, including team, program, portfolio, and organizational.**(Gustavsson et al., 2022)**

A. SAFe Principles and Their Role in Organizational Alignment and Effectiveness:

(Knaster & Leffingwell, 2020)provide 10 fundamental SAFe principles that operate as a useful manual for big businesses in order to successfully apply SAFe Agile at all organizational levels and guarantee team alignment. These guidelines support cross-team cooperation, coordination, communication, and strategic alignment. Although not all ten are listed in the text, the SAFe model's ten main concepts usually include

- **take an economic view**: When implementing SAFe, an economic perspective is crucial since it guarantees that businesses prioritize consumer demands and base their product selections on return on investment (ROI). The Agile Release Train (ART) team's efforts are better aligned with shared organizational and customer objectives thanks to this method. Teams that think about how their decisions will affect the economy, like focusing on markets with more returns, enhance coordination, communication, and teamwork, which eventually increases organizational success.

- **Apply Systems Thinking:** The SAFe Agile "apply system thinking" idea can be implemented in three main ways:
  - The solution itself;
  - The value streams;
  - The enterprise building system.

The term "enterprise building system" describes the personnel employed by the company as well as the procedures utilized to manage them. Therefore, one benefit of the enterprise building system is that it facilitates simple coordination between several ARTs.

- **Assume Variability and Preserve Options:** Since results aren't guaranteed, assuming variability is admitting that there is uncertainty involved in developing products or solutions. Organizations should employ economic-based empirical data to inform their decision-making in order to manage this. This method assists in locating value stream gaps, investigating alternate approaches, and maintaining flexibility to enhance results.
- **Build Incrementally with Fast, Integrated Learning Cycles**: Organizations should execute solutions in brief iterations known as Program Increments (PIs) once risks have been evaluated and mitigation strategies have been determined. Prior to the final release, these act as learning cycles that incorporate user feedback. Unmarketable solutions serve as prototypes for testing and validation. They become Minimum Viable Products (MVPs) once they are feasible and can be enhanced over time in response to changing economic knowledge.
- **Base Milestones on Objective Evaluation of Working Systems:** Organizations should assess success using measurable results rather than arbitrary status reports. Stakeholders may make sure value delivery is in line with strategic goals by coordinating teams and conducting ongoing evaluations throughout the development lifecycle.
- **Enable Continuous Value Flow by Managing WIP, Batch Sizes, and Queues:** SAFe recommends minimizing batch sizes, controlling queues, and restricting Work-In-Progress (WIP) in order to maximize productivity. This method avoids resource bottlenecks, reduces delays, and enables faster feedback. teams are empowered to maintain a consistent value stream while making adjustments in response to real-time feedback.
- **Apply Cadence and Synchronize with Cross-Domain Planning:** The development process gains rhythm and predictability via cadence. It improves cooperation and lessens the effect of uncertainty when it is coordinated across teams and domains. Even in the

face of intricate cross-functional planning and execution, this predictability lowers stress and promotes consistent delivery.

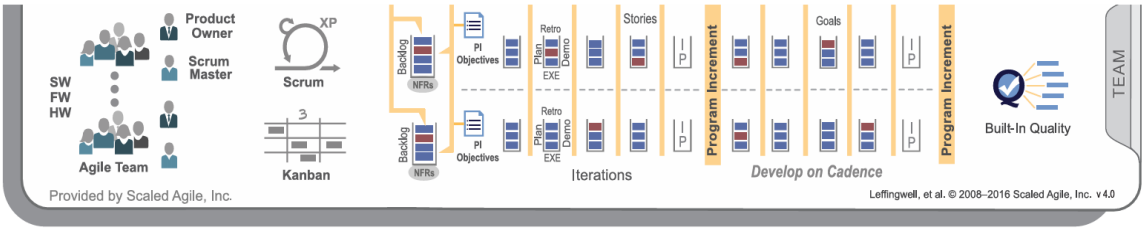
- **Unlock the Intrinsic Motivation of Knowledge Workers: For** motivation to last, teams must be empowered via autonomy, mastery, and purpose. Instead of depending exclusively on outside incentives, organizations ought to prioritize facilitating personal development and skill enhancement. A culture that prioritizes learning fosters creativity and improves teamwork.
- **Decentralize Decision-Making: Decentralized** decision-making improves responsiveness and team ownership. Daily operational decisions are left to people closest to the task, but strategic decisions are still made centrally. At all organizational levels, this improves responsibility, decreases delays, and promotes agility.
- **Organize Around Value: ARTs** should be organized around value delivery, not conventional functional departments, according to SAFe. Teams are guaranteed to concentrate on important results, like ROI, employee engagement, and customer happiness, because to this alignment. Strategic emphasis and ongoing improvement are guided by unambiguous value-driven KPIs.

B. Levels of Scaled Agile Framework (SAFe):

Organizations must take into account the SAFe levels in order to apply SAFe effectively. When doing this, **(Anthony et al., 2024)**states that there are four important levels to take into account, which are as follows, from lowest to highest:

- **The Team Level (SAFe Level 1):** For the activities of Agile Teams, the team level offers an organization, artifact, role, and process model, as shown in Figure

Figure 4: SAFe team levels.

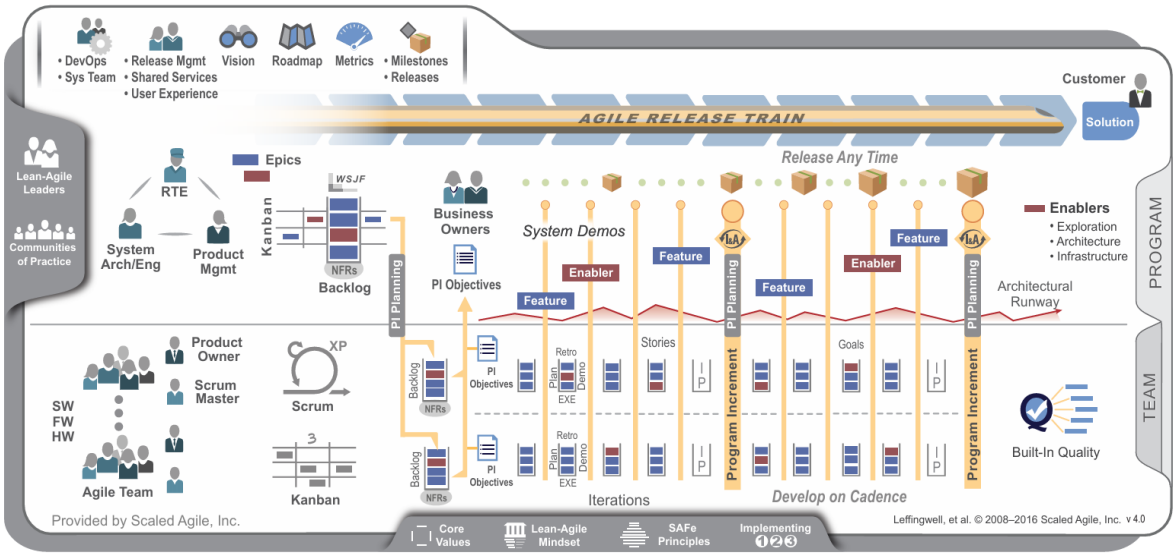


Source: (Leffingwell, 2017)

Experts or professionals working on the organization's goals or objectives make up the team level, which is the main SAFe level. These individuals could be product owners, testers, or business analysts. These individuals collaborate to guarantee the value of the product.

- **The Program Level (SAFe Level 2)**: The core of SAFe is the program level, as shown in Figure 3, which combines the team level via reference and centers on the company known as the "Agile Release Train".

Figure 5: Program level



Source:(Leffingwell, 2017).

Teams working on solutions that will be delivered via the Agile Release Train (ART) are defined at the program level. 50-125 individuals typically make up the ART, which is then divided into 5-12 teams. Therefore, a group may include six to fifteen individuals. By using Program Improvement (PI) to uncover new areas for improvement and troubleshoot to limit risk, ART makes sure that the most critical things come first.

- **Spanning Palette:** Numerous other icons are shown on this level; they are situated on the Big Picture at the intersection of the program level and value stream. The "spanning palette" is what this is known as seen in:

Figure 6: Spanning palette.

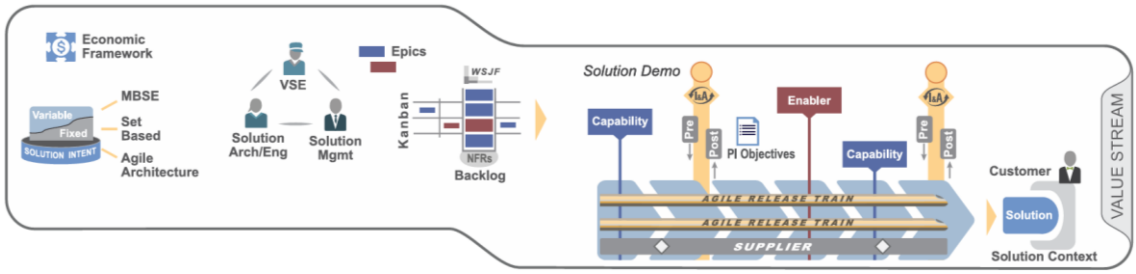
Source:(Leffingwell, 2017).

According to the articles on "Vision", "Roadmap", "Metrics", "Milestones" "Releases" "DevOps", "System Team", "Release Management", "Shared Services", and "User Experience", each of these roles and artifacts contributes to the ART and program level. But

these components also "span" the levels due to Many of them are helpful on other levels as well.

- **Value Stream Level (SAFe Level 3):** Businesses developing extensive, multidisciplinary software and cyber-physical systems those facing the biggest systems challenges benefit from the value stream level. Constructing these solutions using a Lean-Agile method calls for extra coordination, artifacts, and constructions. Figure 7 provides an illustration of the value stream level constructions:

Figure 7: Value stream.

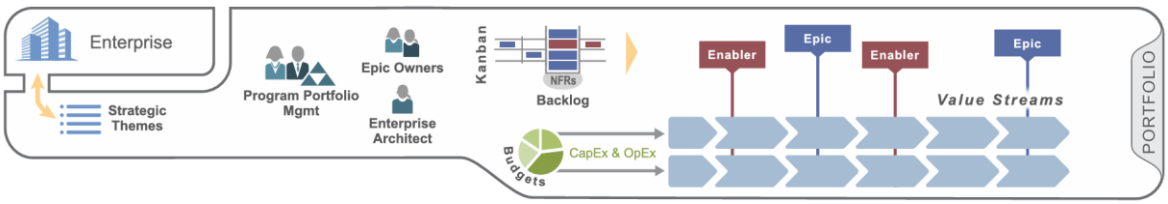


Source:(Leffingwell, 2017).

A "solution train" which consists of two or more ART, is another name for the huge solution level. Each ART team often develops a specific solution, which also depends on the efforts of other teams. SAFe level 3 essentially manages the interdependent and cooperative works of several ARTs, making sure that each one complies with the goals of the organization.

- **The Portfolio Level (SAFe Level 4):** The SAFe portfolio represents SAFe's highest level of concern as seen in figure 8. Each SAFe portfolio contains the value streams, individuals, and procedures required to supply funding and oversight for the goods, services, and solutions needed to carry out the overall business plan.

Figure 8: Portfolio level.



Source:(Leffingwell, 2017).

The highest SAFe level, the portfolio level, captures the essence of the company. Accordingly, the portfolio level focuses on implementing the SAFe level 3 solution using

innovative concepts **(Anthony et al., 2024)**This stage guarantees that the SAFe level 3 solution is in line with the organization's values, goals, and priorities.

Effective collaboration is necessary for each SAFe level to cooperate for the SAFe Agile framework to be implemented.

C. The three C's of Scaled Agile Framework (SAFe):

Each SAFe level needs to collaborate with the others in order for the SAFe Agile framework to be implemented effectively. Cooperation; Conversation; Coordination.

In conclusion, for large organizations looking to scale Agile effectively while preserving coordination, communication, alignment, and cooperation across all teams and levels, SAFe is crucial. It uses ten fundamental concepts to tackle issues including release planning, team alignment, and performance evaluation. When properly applied, SAFe promotes value-driven decision-making, increases organizational performance, and guarantees that all Agile Release Trains (ARTs) collaborate to achieve shared strategic and financial objectives.

1.3. Benefits and challenges of agile in infrastructure projects:

1.3.1. Benefits of agile project management:

Compared to more conventional approaches, especially the waterfall model, APM has a number of advantages. Its adaptability and reactivity to change, which lower expenses, speed up delivery, and increase customer satisfaction, are its main advantages**. (Masood & Farooq, 2017).**

- **Economy of cost:** Because of its strict planning and inability to adjust to changes, traditional project management frequently results in expensive rework. However, APM employs an iterative methodology that adapts to changes as they occur during the project lifespan, limiting budget overruns and the need for extensive revisions.
- **saving time:** APM speeds up project completion by removing last-minute adjustments and copious documentation through rapid iterations and short-term planning.
- **Enhance client contentment:** Stakeholders are continuously involved in APM throughout the project. This continuous involvement guarantees that the finished product closely matches the needs of the client and boosts their sense of satisfaction and ownership**.**
- **Promotes Team Autonomy and Innovation:** Agile encourages independence, teamwork, and a flat organizational structure, which stimulates innovation and creativity.

Empowerment increases confidence and morale, both of which are essential for problem-solving and ongoing development.

- **Increased visibility of performance:** Real-time visibility into project progress is provided by frequent meetings, sprint reviews, and customer feedback loops. This guarantees improved alignment with client expectations and permits prompt remedial actions.
- **Perfect for small and medium-sized business:** APM is more flexible, less bureaucratic, and easier than complicated old approaches, which makes it ideal for small and medium-sized businesses with little funding.
- **collaboration and team building:** Delegation, responsibility sharing, and cooperation between team members and stakeholders are all emphasized by APM. This fosters knowledge exchange, personal development, and a more cohesive team dynamic.

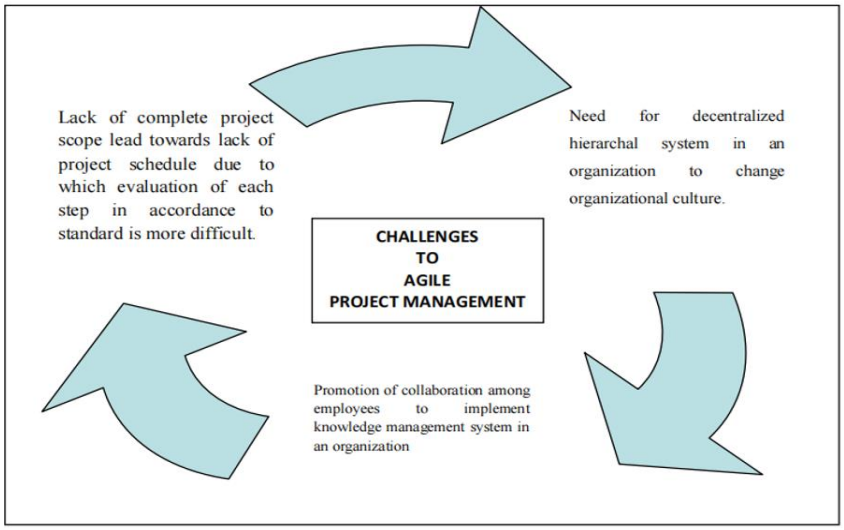
1.3.2. Challenges of project management:

Although Agile Project Management provides flexibility and adaptation, there are a number of important drawbacks to consider **(Masood & Farooq, 2017)**

- **Scheduling challenges:** Because APM eschews thorough advance preparation, it is challenging to forecast the project's overall timeline. Planning resources is made more difficult by this unpredictability, which also puts the project at risk for delays in resource acquisition and cost overruns**.**
- **Problems with scope management:** Because of its adaptability, APM frequently undergoes changes, which may cause scope creep. Teams may find it difficult to discern between necessary and non-essential adjustments in the absence of explicit initial requirements, which makes quality, timeliness, and cost control more difficult.
- **Issues with quality assurance:** Measuring performance and guaranteeing quality are challenging since there are no set requirements at the outset. The lack of established criteria makes it more difficult for the project manager to determine whether the product is progressing as intended.
- **Challenges in knowledge management:** By depending more on informal communication, APM decreases the amount of formal paperwork. This results in knowledge being stored in team members' heads, which is tacit. This weakens managerial control and makes it difficult to transfer or keep organizational knowledge.

- **Concerns about people**: Teamwork, communication, and incentive are essential to agile. Traditional, inflexible organizations may find it difficult to change. Diverse stakeholder backgrounds, perspectives, and skill levels can also make it more difficult for a team to work together cohesively.

Figure 9: Key Organizational Challenges to Agile Project Management Adoption



Source:(Masood & Farooq, 2017)**.**

- **Teams dispersed geographically:** Communication and coordination problems arise in international projects due to time zones, distance, language obstacles, and cultural differences. Agile methods that depend on constant and intimate communication are less effective as a result of these problems.
- **Applicability to non-it projects and scalability:** Agile is effective in product and IT development, but it has challenges with large-scale or building projects. Because of safety, financial, and complexity issues, these projects have a large number of stakeholders and are less tolerant of frequent modifications.
- **Needs for organizational transformation:** It can be challenging to manage and sustain a decentralized structure, which is frequently necessary for the successful implementation of APM. Adoption of agile necessitates team preparation, process modifications, and cultural shift.

Section Two: Understanding and Managing Risk

Every sort of an infrastructure project known for its complexity and risks, and to deal with those risks should first know what is Risk and Project Risk Management. In this section will see all what we can see about PRM.

2.1. Fundamentals of Risk Management:

2.1.1. Risk definitions:

For **(AS ISO 31000:2018 Risk Management - Guidelines, 2018),** the document examines definitions and terms of a risk, has been mentioned on it. They defined the risk as the impact of uncertainty on objectives as the effect is the deviation from the established expectations, and it can be addressed in terms such as:

- **Source**: such as the elements that can individually or combined to generate risk.
- **Event:** by manifesting or alteration of a specific set of circumstances.
- **Consequences:** is the result of influence of the event on objectives.
- **Likelihood:** which means the happing probability of something (Hutchins, 2018).

Furthermore, "The standard for Risk on (Portfolio, Program, Project)" they defined Risk at the organizational level as an uncertain event or condition, can have a positive or negative impact on one or more objectives. Overall risk is defined as the effect of uncertainty that influences objectives across different domains and levels. This uncertainty arises from various sources, including individual risks within portfolios, programs, and projects**(Project Management Institute, 2019).**

Finaly, the Risk is a dimension of uncertainty. when risk take a place can affect the objectives of a project in two ways a positive or a negative way. And PMI mentioned that negative risks are termed threats, while positive risks are referred to as opportunities, and all the projects include risk due to their distinctive nature and level of uncertainty .**(Project Management Institute, 2021).**

To conclude, based on the three definitions that we saw we can tell that Risk is the uncertainty that impacts objectives, positively or negatively. It is inherent in projects and encompasses both threats and opportunities, as defined by frameworks like PMI and ISO 31000, which highlight its sources, events, consequences, and likelihood.

2.1.2. Risk management project definitions:

A systematic approach to detect, evaluate, and mitigate risk that could affect project outcomes is known. These processes include risk management planning, identification, analysis, response planning, implementation, and continuous monitoring throughout the project lifecycle.

The primary goal of Project Risk Management is to enhance the likelihood and impact of beneficial risks while minimizing the probability and severity of adverse risks, thereby optimizing the project's chances of success. Organizations may reduce uncertainty, make informed decisions, and ensure alignment with project objectives by proactively managing risks **(Project Management Institute, 2017).**

And for **(Institute Project Management, 2019)** they define it Project Risk Management constitutes a critical knowledge area within project management, focuses on identifying, assessing, and mitigating risks that may impact cost, schedule, or scope baselines. It integrates risk planning, analysis, response implementation, and monitoring throughout the project lifecycle, aiming to maximize opportunities and minimize threats. By combining proactive and adaptive strategies, it ensures project baselines remain responsive to evolving conditions. Risks undergo qualitative and, when necessary, quantitative analysis to support informed decision-making, ultimately enhancing project success.

2.1.3. Risk typology:

Risk has a multiple shapes and countless types that we can’t mention all of them and we will focus on the most popular ones that keep reputed in scientific papers and for that we choose some of them whom classes them based on multiple criteria. For the field of infrastructure projects, we have a considerable risk type based on their categorizations **(Sanchez-Cazorla et al., 2016)** they propose an homogeneous model that contains a most likely risks that could happen in any mega-project, and they classified them based on a review that conducted by them on 83 different references that has the same scientific purpose. To conclude, by these nine risks as that could be represented on this figure

Table 6: The nine risks categories.

<table>
<tr><th>Planning Phase</th><th>Operational Phase</th><th>Execution Phase</th></tr>
<tr><td rowspan="2">• Desing risks</td><td>• Operation and maintenance
• Demand risks
• Market risks
• Social profitability risks</td><td>• Construction risks</td></tr>
<tr><td colspan="2">• Labor risks
• Environmental risks
• Financial risks
• Economic risks</td></tr>
<tr><td colspan="3">• Legal/Political risks
• Contractual risks
• Risk of impact on local groups
• Reputational risks
• Force majeure risks</td></tr>
</table>

Source :(Sanchez-Cazorla et al., 2016).

As showed in the table they categorized risks based on the timing on a project lifecycle phases (Planning/ development phase, Operational phase, Construction/ Execution phase), based on that they defined these risks:

A. Desing:

Design hazards are mostly related to a megaproject's planning and design stages. These risks include things like contract formation, delivery method selection, bid cancellation (which includes pre-investment risks and the possibility of not recovering pre-investment costs), difficulties with land use and acquisition (risks related to site availability), feasibility analysis, and project scope and control management.

B. Legal/ political:

These categories of risks brought on by changes to the country's governing legislation Megaprojects like concession cancellation, changing political players, government regulations, and authorization needs are underway.

C. Contractual:

The difficulties involved in contract renegotiation give rise to contractual hazards. These include problems arising from imprecise or ambiguous contractual provisions that may cause

misunderstandings or disputes during implementation, as well as midstream modifications to the project's scope that may interfere with goals.

D. Construction:

Over the course of the megaproject's entire life cycle, construction risks are typically the most important. These can happen at any stage of the megaproject, although they typically happen during the building phase. If these risks materialize, there could be repercussions in the form of project schedule delays and/or cost overruns (or cost escalation). This category of risks includes things like construction errors, unforeseen technical challenges, noncompliance with agreed-upon quality standards, coordination issues, and improper design or accidents during construction.

E. Operation and maintenance:

Risks associated with the operational phase that may impact operation cost, operation capacity, or quality are known as operation and maintenance risks. These include problems with economic viability, excessively high operating expenses, subpar construction, and operator incompetence.

F. Labor:

Workers are exposed to labor hazards such as cultural differences, language barriers, training, and accident costs. These hazards may appear at any point during the megaproject, but they are most likely to do so during the operating and building stages.

G. Costumer, user, society:

Risks to customers, users, and society are those that have an impact on profits. Users are those who use the product or service, customers are people who purchase it, and society is the group that gains from the project's social profitability. Among these dangers are:

a. **Demand risks**: Demand hazards are associated with sales volume in large-scale projects where customers pay fees during the operational stage. Variations in the rate of inflation, pricing trends, and price range are some of the elements that impact these.
b. **Market risks**: Market risks include things like changes in the needs of the client and whether there is a market for the megaproject.

c. **Social profitability risks**: The social profitability risk asks if the initiative will benefit society as anticipated.
d. **Social impact:** Social impact: this refers to the possibility of having an effect on society, local communities, and the participants' acceptance of the megaproject. When an area's residents pose a risk because they are not properly controlled, there is a chance that it will have an effect on nearby groups. The NIMBY (Not-In-My-Back-Yard) groups are included in this grouping as reaction opposition.
e. **Environmental risks:** Environmental impact assessments are another name for environmental risks (Owens et al., 2012). Such as pollution and its components: air, soil, water. And resource depletion: water, minerals. Finally, Biodiversity loses.
f. **Reputational risks:** Risks to one's reputation, such as control over the media and marketing as **(Owens et al., 2012)** mentioned.

H. Financial, Economic:

include a range of circumstances pertaining to the megaproject's performance and funding. These are made up of:

- **Economical risks**: Associated with investing in the megaproject or its economic structure include residual transfer value, asset residual value risk (i.e., technical obsolescence), lower-than-expected profitability, and improper project measurements.
- **Financial risks**: Brought on by the high level of leverage, which affects the megaproject's solvency due to high leverage age or credit downgrading; liquidity issues, such as credit limitations and lack of available funds; and risks brought on by fluctuations in the interest rate and/or exchange rate, which arise from the long-term contracts made for this kind of project.

I. Force major:

Risks associated with force majeure, such as terrorism, natural disasters, war, severe weather, or a natural collapse.

Form a different perspective **(A. A. Lawrence, 2024)** mentioned in his article on the Journal of Business and Management, can classify risk into financial, environmental, regulatory, social, and technical risks. As been shown below:

A. Financial risk:

a. **Cost overruns:**

One of the common financial risks, and it refers to when the actual cost exceeds the projected budget. All that can be result of various causes imprecise cost estimations or benefits overestimation or could be from unpredicted price surge of labor and materials.**(Flyvbjerg et al., 2016)**

b. Budget fluctuations:

Projects frequently face a budget fluctuation due to various causes such as inflation, exchange rate changes and economic circumstances. These changes can create a financial pressure that can lead to explore more funding options to ensure the progress of the project **(A. A. Lawrence, 2024).**

c. Financing delays:

Securing adequate financing is a core condition to guarantee the start and continuity of the project, and any delay in fund acquisitions can lead to serios outcomes such as a disrupt the progress, threaten project schedule, and increase expenses **(A. A. Lawrence, 2024)**

B. Environmental risk:

a. Ecological effect:

Infrastructure project known of its noticeable impact on ecological systems and a great example is Panama Canal which caused a real damage in various ways such as diminishing of water volume and reshaping mountains which lead to a significant harm for the wildlife by emigrating species or even make some of those species extant by the time. Neglect environmental safeguards due to cost pressures highlighting the need of comprehensive assessment and responsible design practices to address and reduce risks **(Siemiatycki, 2009).**

b. Pollution:

Are about unwanted changes that effect negatively air, water, soil. Furthermore, construction works always have a side hazardous effect as noise, soil, water or air pollution as an effected elements by it **(Sholanke et al., 2019).**

c. Resource depletion:

It’s the exorbitant usage of naturel resources of a specific area which can cause a naturel resources exhaustion and a disrupted eco-system **(Wu et al., 2018).**

C. Regulatory risk:

a. Permit delays:

The most common one among regulatory risks which permits risk and its complex and time-consuming process and for that it can affect the project in many ways, in a cost way by increasing it or in another way by halting the project.

b. Changes in regulations:

Regulatory frameworks known for its constant evolving in project's life cycle like which impose to react and seek the adjustment needed to update the project plans.

c. Non-Compliance issues:

Breaching any of the legal obligations might provoke serious impacts such as legal penalties, delays in the project time-line, and this what oblige the organization to compliance the regulatory frameworks.**(A. A. Lawrence, 2024)**

D. Social risk:

a. Community disruption:

An infrastructure project construction known for disrupting the local community in many ways: noise, hard access to public roads, and this which cause a resistance and conflicts.

b. Relocation challenges:

Large number of projects in need of relocate residences or businesses which can cause a logistical or a cultural difficult situation.**(A. A. Lawrence, 2024)**

c. Safety concerns:

Safety of individuals and the equipment's are a primary focus cause all what infrastructure construction project known for is high rate of injuries and propriety damage **(Baghdadi, 2024)**

E. Technical risk:

a. Desing flaws:

Design flaw is issue or weakness present in a design that can compromise the functionality or the constructability of the final product **(M. Lawrence et al., 2020)**

b. Construction defects:

Generally defined as deficiencies in design, workforce or materials and these defects may not always be noticeable but can deliver a structure or a component that is inadequate for its intended purpose. The term Construction defects doesn't only mean construction defects but include both design and construction defects that could be financially hazardous for its owner **(Gashi, 2018)**

c. Material failures:

The failure of materials due to defects or improper usage of it can cause a serious schedule delay or unwanted additional costs. To avoid this situation is by selecting high-quality materials, and maintain proper storage **(A. A. Lawrence, 2024).**

At the end, we conclude that the risk typology is unlimited, and based on the perspective that you've started from to assess your risk. The risk assessment is a crucial pillar on the risk management process.

2.2. Risk Management Process in Projects:

As a fundamental component of organizational management and decision-making, risk management ought to be methodically integrated into the organization's operations, structure, and fundamental procedures. This method works at all levels, including program, project, operational, and strategic layers. The process of risk management project gets valued from multiple perspectives and based on our litterateur review we can bring some definitions that can define risk management process.

2.2.1. Project risk management Process definitions:

(Rodrigues-da-Silva & Crispim, 2014) consider it as a logical series of actions done by decision-makers to maintain the project's implementation under specific conditions is known as a risk management process. In order to act on the risks in the project's favor, the decision agents must recognize, assess, and evaluate the risks throughout the whole project life cycle. They must also employ their administrative procedures and organizational structure.

And for the definition of a Project risk management process we choose, based on the two definitions that we saw, we can found a Project risk management process definitions for **(Project Management Institute, 2017)** they defined as the methodical procedures of planning, recognizing, evaluating, reacting to, executing, and tracking risks during the course of a project are all included in project risk management. In order to maximize the possibility of project success, its main goals are to: first, increase the likelihood and positive

impact of positive risks (opportunities) and second reduce the likelihood and negative consequences of negative risks (threats).

Then the standard **(AS ISO 31000:2018 Risk Management - Guidelines, 2018)** say's is a systematic application of policies, procedures, and best practices at every level of risk communication, contextual analysis, assessment, treatment, monitoring, review, documenting, and reporting is what is meant by the risk management process.

Lately,**(Hakimah Hamir & Rabihah Md. Sum, 2021)** decided to define a risk management process as an organized and methodical strategy to recognizing, evaluating, and mitigating risks among an organization is known as risk management. It involves every employee in the company and aims to minimize the chance and impact of unfavorable events while increasing the chances and advantages of favorable ones. The procedure entails identifying possible risks, analyzing them by determining their probability and probable outcomes, and putting the right policies in place to successfully manage or reduce such risks.

2.2.2. Project risk management process:

Based on our review litterateur we've observed there are various RMP's schema, and most commune used or taken as a base, and worked on is **(*AS ISO 31000:2018 Risk Management - Guidelines*, 2018)** schema that will be well demonstrated in this figure10, but before that we will address the different steps that been mentioned on the figure:

A. Communication and consultation:

Stakeholders can better understand risks, decision-making justifications, and necessary actions through communication and consultation. Consultation actively solicits input to guide decisions, whereas communication cultivates risk awareness and comprehension. As long as confidentiality, data integrity, and individual privacy rights are respected, efficient coordination across these activities guarantees that information flow is factual, timely, relevant, accurate, and understandable. All stages of the risk management process should involve internal and external stakeholders in these activities. In particular, consultation and communication serve to:

- Integrate a range of knowledge at every level of the process.
- Take into account many viewpoints while creating risk criteria and carrying out assessments.
- Provide sufficient information for well-informed risk governance and decision-making.
- Encourage inclusivity and a sense of ownership among all who are impacted by risk.

B. Scope, Context and criteria:

By defining the scope, context, and criteria, the risk management process can be customized to guarantee both efficient risk assessment and suitable remedial actions. This includes:

- Clearly outlining the parameters (scope) of the procedure.
- Conducting a thorough examination of the internal and external settings (context).
- Establishing unified guidelines (criteria) for risk assessment.

a. Defining scope: The scope of risk management procedures, which can be implemented at several levels like strategic, operational, programmatic, or project-specific activities, must be precisely defined by organizations. Determining the scope makes pertinent goals clear and guarantees connection with organizational objectives. A number of crucial factors must be addressed for planning to be effective:

- Objectives and critical decisions to be tackled;
- Expected outcomes from the process steps;
- Timeframes, locations, and any inclusions or exclusions;
- Suitable risk assessment tools and methodologies;
- Allocation of resources, responsibility distribution, and record-keeping practices;
- Relationships and integration with other projects, processes, or activities.

b. External and internal context:

The environment in which an organization functions to establish and accomplish its goals is included in the external and internal context. Understanding the internal and external environments of the company, as well as the particular activity to which the process is applied, is necessary to establish the context for risk management. Understanding the background is crucial because:

- Risk management is carried out in accordance with the goals and operations of the company.
- Risk may originate from organizational variables.
- There may be an overlap between the goals of the risk management process and more general organizational objectives.

And for the organization to establish such a process (external and interne context), it's obligatory to consider factors that shape this context for the external context we have included but not limited factors such:

- In worldwide, national, regional, and local contexts, the organization is influenced by social, cultural, political, legal, regulatory, financial, technological, economic, and environmental elements.
- Important forces and new developments that influence and mold the organization's goals.
- Connections with external stakeholders, encompassing their requirements, expectations, values, and perceptions.
- Commitments and duties outlined in contracts that bind the company.
- The intricacy of interdependencies, networks, and organizational linkages.

And for the internal context factors include and not for the limitation we have:

- The vision, mission, and core principles of the organization.
- The governance framework, which encompasses the roles, responsibilities, and organizational structure.
- The creation of policies, goals, and strategic planning.
- The impact of organizational culture on operations.
- Adopted models, rules, and standards that direct organizational operations.
- Knowledge and resource-related capabilities, including cash, time, staff, intellectual property, systems, procedures, and technologies.
- Information systems, data management, and information flow inside the company.
- Interactions with internal stakeholders, taking into account their opinions, beliefs, and input.
- Contractual duties and pledges that regulate internal activities.
- The organizational ecosystem's interdependencies and links.

c. Defining risk criteria: In light of their objectives, organizations should assess the type and level of risk they are willing to take. To make decision-making easier, criteria for assessing risk importance must also be created. These standards must to be customized to the particular goal and extent of the activity while also being aligned with the general risk management framework. They must also be consistent with established risk management policies and statements and represent the organization's basic beliefs, goals, and resources. The organization's responsibilities and stakeholders' viewpoints should be taken into account while developing risk criteria. Even though these standards are usually specified at the beginning of the risk assessment procedure, they must be flexible enough to be reviewed and adjusted as necessary to address changing conditions. To set a risk criteria we should consider:

- The categories and nature of uncertainties that could affect results and goals, including both concrete and intangible components.
- Techniques for characterizing and quantifying the likelihood of repercussions, both good and negative.
- Time-related elements that could affect risk management and assessment procedures.
- Making ensuring that measures are applied and interpreted consistently.
- Methods for figuring up total risk levels.
- Taking into consideration how various risks interact, combine, and occur in sequence.
- Assessing the organization's ability to successfully handle and manage risks that have been identified.

C. Risk assessment:

The thorough process of risk identification, analysis, and evaluation is included in risk assessment. The evaluation should be carried out methodically, iteratively, and cooperatively, incorporating the viewpoints and knowledge of stakeholders, in order to guarantee its efficacy. In order to improve accuracy and dependability, it should make use of the best information available while also permitting more research and inquiry as needed.

D. Risk identification:

Finding, recognizing, and characterizing possible risks that could help or impede an organization in accomplishing its goals is the main objective of risk identification. For hazards to be effectively identified, information must be current, accurate, and relevant. To find uncertainties that might affect one or more of their goals, organizations might use a variety of approaches and strategies. And the following factors and its relation should be considered:

- Risk sources include both tangible and immaterial sources.
- Triggers: Opportunities, dangers, events, and causes.
- Vulnerabilities: Capabilities and weaknesses.
- Contextual changes: Changes in the internal and exterior environments.
- Emerging Risks: Early warning signs and indicators.
- Assets: Characteristics and worth of organizational assets.
- Impact: Repercussions and how they affect goals.

- Knowledge Limits: Uncertainty brought on by gaps and the dependability of facts.
- Time Factors: Risk analysis that takes time into account.
- Human Factors: Preconceptions, biases, and beliefs that influence viewpoints.

E. Risk analysis:

Understanding the type, traits, and degree of risk is the main objective of risk analysis. It looks at events, scenarios, likelihood, origins, effects, uncertainties, and the efficiency of controls. Events can affect different goals and have a variety of causes and effects. The intention, the quality of the material, and the available resources all influence how detailed and complicated the analysis is. Depending on the situation and desired results, techniques might be qualitative, quantitative, or a combination of both. And for this step should consider some points such:

- The likelihood of occurrences and the resulting effects.
- The type and extent of possible impacts.
- The intricacy and interaction of risks.
- Risks are impacted by volatility and temporal considerations.
- The effectiveness and sufficiency of current controls.
- Risk assessment sensitivity and confidence levels.

F. Risk evaluation:

By contrasting the results of risk analysis with predetermined risk criteria, risk evaluation seeks to aid in decision-making. This procedure aids in highlighting areas that require additional action or intervention. This can lead to a decision to:

- Take no further action regarding the risk.
- Consider possible options for risk treatment.
- Perform more research in order to comprehend the risk.
- Preserve and enforce current controls.
- Reassess and modify organizational objectives as needed.

G. Risk treatment:

The main objective of risk treatment is to pinpoint and use the most effective methods to deal with risks. This includes selecting and implementing into action plans to reduce, transfer, accept, or avoid risks while making sure they are aligned with the organization's objectives and standards. Risk treatment contains:

- Create and select suitable risk-reduction strategies.
- Arrange and carry out the application of chosen treatments.
- Assess how effectively the risk treatments that have been implemented are responding.
- Assess if the remaining risk is tolerable.
- Take further therapeutic measures if the residual risk continues to be unacceptable.

H. Risk treatment option selection:

When selecting a suitable risk treatment method, one must balance the possible advantages of reaching the objectives against the expenses, work, and potential drawbacks of putting it into practice. This ensures the best possible balance between resource efficiency and risk management efficacy. And treatment of the risk could be one or more of these treatments:

- Avoiding the risk by deciding not to initiate or maintain out the activity that leads to it.
- Taking up more risk in order to take advantage of an opportunity.
- Addressing the risk's source.
- Changing the possibility that the risk will occur.
- Changing the risk's outcomes.
- Sharing the risk, as in insurance or contracts.
- Retaining the risk via an informed decision.

I. Preparing and implementing risk treatment plans:

Outlining the execution procedure for chosen treatment options and making sure that all parties involved understand the arrangements are the objectives of risk treatment plans. The strategy must explicitly outline the priority and order in which risk treatments are to be implemented, and it additionally needs to make progress monitoring less difficult. The information provided should include these points:

- The justification for treatment choices, emphasizing anticipated advantages.
- Determining who is accountable and responsible for implementation and approval.
- Suggested measures to mitigate the risk.
- Resources needed, such as backup plans.
- Performance metrics to assess advancement.
- Implementation-related constraints.
- Reporting and oversight obligations.

- Schedules for establishing and completing tasks.

J. Monitoring and review:

The quality and efficacy of process design, execution, and results are improved via monitoring and review. They include planning, data analysis, documentation, and feedback and are integrated at every stage of risk management. The outcomes should guide reporting, measurement, and organizational performance for ongoing development.

K. Recording and reporting:

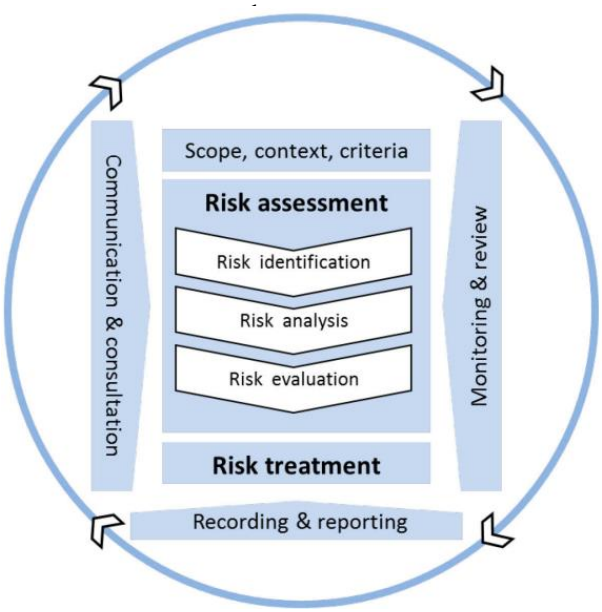
The risk management procedure and its results must to be systematically recorded and disseminated via the proper channels. Recording and reporting are done for the following reasons**:**

- Disseminate risk management actions and results throughout the organization.
- Deliver important information to assist in decision-making.
- Improve and hone procedures for risk management.
- Encourage interaction with all parties involved, especially those in charge of risk management initiatives.

The intended purpose of the information, its sensitivity, and the organization's internal and external context should all be taken into account when making decisions about its development, retention, and management. As a crucial component of organizational governance, reporting should enhance stakeholder communication and assist upper management and oversight organizations in performing their obligations. A few things to take into account about when it comes to reporting are:

- different stakeholder needs and information requirements;
- cost-effectiveness, frequency, and timeliness of reporting;
- report delivery methods;
- information relevance to the organizational objectives and decision-making procedures.

Figure 10 :RMP



Source:(Kaustell, 2020).

For the principles of the risk management **(AS ISO 31000:2018 Risk Management - Guidelines, 2018)** they demonstrate the principles of the risk process as will be shown on the following Table:

Table 7: RM principles.

PRINCIPELS	DESCRIPTION
Integrated	Risk management is embedded in all organizational activities.
Structured and comprehensive	A systematic approach is applied to risk management.
Customized	Risk processes are tailored to the organization's context.
Inclusive	Stakeholders are engaged appropriately and timely.
Dynamic	Risk management adapts to emerging or changing risks.
Best available information	Decisions are based on historical, current, and predictive data.
Human & culture factors	Recognizes the influence of behavior and culture on risk.
Continual improvement	Risk processes evolve through learning and experience.

Source:(AS ISO 31000:2018 Risk Management - Guidelines, 2018).

2.2.3. Risk management techniques:

These techniques will be inspired by the (Institute Project Management, 2019) :

A. Risk Identification:

the techniques of risk identification are endless and will we focus only on four techniques that align with our study:

a. Assumptions and constraints Analysis: The role of assumptions is significant when assessing the effects of risks within portfolio, program and project management. Assumptions are statements accepted as fact at a specific moment in time, but they demand systematic validation and continuous monitoring throughout the iterative process and risk management lifecycle. Further, the use of assumptions requires practitioners to follow a systematic three-step process:

- **Identify All Assumptions**: The first step requires all statements or conditions believed to be true to be compiled into a list. You will want to examine things such as project constraints, resource availability, and market factors.
- **Validate All Assumptions:** You will analyze each assumption for its accuracy. This involves examining experience, judgment, and available evidence about a specific condition to confirm whether the assumption is true and/or credible. This achieves two outcomes – a better-informed judgment and a transparent process by which decisions can be validated.
- **Assess Outcomes of All Assumptions**: The final step is to evaluate the impact of each assumption on the overall project, program, or portfolio of work. Clearly certain values will be flawed or at least uncertain, and you will have to correct those to allow you to manage the consequent risks.

Given that project environments are constantly changing and therefore the assumptions within a project are also time-bound and subject to new conditions, keeping the assumptions verified and monitored encourages flexibility and robust risk management practices. The outcome of using an iterative approach to assumptions will benefit routine risk identification and ultimately will lead to better project outcome delivery and strategic fit. And the following figure will well-demonstrate it:

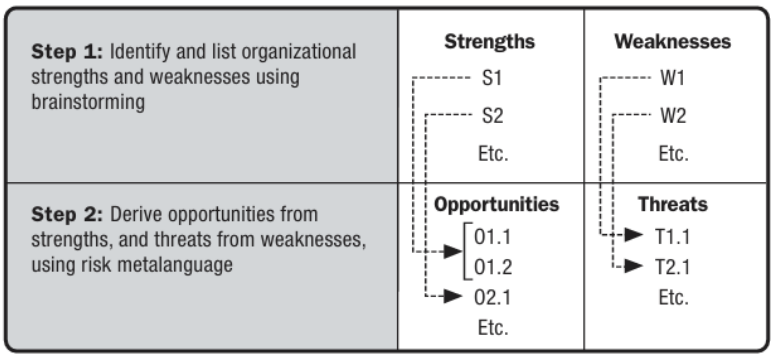
b. Brainstorming: Brainstorming is a useful technique for identifying spontaneous ideas, individually or as a group. In risk identification, group brainstorming enables group thinking, where group participants' ideas can spur on insights from other group participants.

Brainstorming increases the completeness and diversity of risk assessment, helping the group to identify threats that have not been initially considered. Brainstorming allows groups to talk freely, making it a flexible and fluid method of identifying risks and developing mitigation approaches.

c. **Interviews:** This technique based on interviews with project participants, stakeholders, and experts provide valuable insights into potential risks. As a key data-gathering method, interviews help uncover hidden challenges and support proactive mitigation for project success.

d. **S.W.O.T:** To improve risk recognition, SWOT analysis assesses an undertaking from four main angles: strengths, weaknesses, opportunities, and threats. It ensures an effective plan that takes into consideration both potential risks and advantages. By analyzing internal factors (organizational strengths and weaknesses) alongside external influences (opportunities and threats), this technique helps organizations to address risks while leveraging potential benefits. And the illustrate the mentioned technique:

Figure 11: SWOT technique



Source:(Institute Project Management, 2019)

B. Qualitative risk analysis:

a. **Probability and impact matrix:** A probability and impact matrix help prioritize risks by distinguishing between minor and major threats to business activities. Risks are categorized by their likelihood and severity, typically classified from very low to very high, enabling efficient resource distribution and effective mitigation. And the Figure will demonstrate an example of this technique:

Figure 12: An example for the previous technique.

Probability and Impact Risk Ranking											
Probability	Threats					Opportunities					Probability
VH	L	M	M	H	H	H	H	M	M	L	VH
H	L	L	M	H	H	H	H	M	L	L	H
M	L	L	M	H	H	H	H	M	L	L	M
L	L	L	L	M	H	H	M	L	L	L	L
VL	L	L	L	L	M	M	L	L	L	L	VL
	VL	L	M	H	VH	VH	H	M	L	VL	
	Impact (Threats)					Impact (Opportunities)					

Source:(Institute Project Management, 2019).

b. **Risk categorization:** Project risks can be systematically classified based on sources of risk, the affected project areas, or other relevant categories such as budget, phase, and responsibilities. Techniques like the Risk Breakdown Structure (RBS) and Work Breakdown Structure (WBS) help identify the most vulnerable parts of a project, ensuring targeted risk mitigation. Additionally, risks can be grouped by common root causes, allowing teams to develop generalized risk responses. Defining risk categories within the risk management plan enables a focused approach, directing efforts toward high-risk areas and improving overall project resilience. **(Project Management Institute, 2017)**

C. **Quantitative risk analysis:**

a. **Monte Carlo simulation:** Monte Carlo simulation is a statistical technique used to model probability distributions for risk assessment. By sampling random events, it determines the average behavior of a system, helping to reduce uncertainty in decision-making. This method is particularly useful in scenarios where estimates are uncertain, allowing for a range of possible outcomes rather than a single fixed value. Each estimate is accompanied by a confidence level, indicating the probability of its accuracy, making Monte Carlo simulation a powerful tool for analyzing risks associated with various objectives**.(Institute Project Management, 2019).**

b. **Decision trees:** Decision tree diagrams are used to formulate problems and assess possible options, providing a structured approach to decision-making. These graphical models visually represent a project's choices, allowing teams to analyze potential outcomes and understand the impact of each decision. By mapping different paths and consequences, decision trees aid in making strategic and informed choices throughout the project lifecycle **(Mhetre et al., 2016).**

D. Plan Risk response:

a. **Contingent response strategies:** Some risk responses are designed to be implemented only if specific events occur. In such cases, project teams develop contingency plans that remain inactive unless predefined triggering events, such as missed milestones or priority shifts, require action. These plans provide structured responses to anticipated risks, ensuring preparedness without unnecessary resource allocation. Additionally, fallback plans serve as alternative strategies when initial responses prove ineffective, helping maintain project stability and adaptability.**(Project Management Institute, 2017)**

b. **Multicriteria selection technique:** Choosing an appropriate risk response involves evaluating multiple factors, including cost, schedule, technical requirements, and the nature of the risk itself. Risk attributes such as probability, impact, and type also play a crucial role in determining the best course of action. To ensure an optimal selection, multicriteria decision-making techniques can be applied, with weightings assigned to reflect the importance of each criterion, enabling more strategic and balanced risk mitigation **(Institute Project Management, 2019).**

c. **Scenario analysis:** Scenario analysis prepares organizations for various possible outcomes by assessing risks and response strategies. It compares alternative scenarios based on cost and effectiveness, helping in decision-making or contingency planning when external factors impose conditions. Ordinarily, scenarios include optimistic, most likely, and pessimistic assessments, helping managers anticipate risks and opportunities **(Institute Project Management, 2019)**

E. Response plan implementation:

A common method for implementing preventative response plans is incorporating them into the portfolio, program, or project management plan. While some planning techniques can track and differentiate tasks originating from response plans, others do not distinguish risk response tasks from general project tasks. Ensuring proper integration helps maintain visibility and effectiveness in risk management.(Institute **Project Management, 2019)**

F. Monitor risk:

a. **Risk audits**: Risk audits evaluate the effectiveness of the risk management process, ensuring that risks are properly identified and addressed. The project manager is responsible for scheduling audits at appropriate intervals, as outlined in the risk

management plan. These audits can be conducted within routine project review meetings, dedicated risk review sessions, or as separate evaluations. To maximize their impact, the format and objectives of risk audits should be clearly defined before execution.**(Project Management Institute, 2017)**

b. **Risk register:** A risk register is essential for tracking identified risks and their management methods. It should be regularly updated to reflect changes and ensure ongoing monitoring. As risk owners are assigned, they are recorded in the register, facilitating accountability. Over time, as the project progresses, risks decrease, allowing contingency funds to be reallocated to other budget areas. Completed risks must be documented under risk closure, while new emerging risks should be incorporated to maintain project stability **(Lester, 2017).**

c. **Risk reassessment:** Risk reassessment ensures continued project stability by identifying new risks, evaluating existing threats, reviewing risk management processes, and closing resolved risks. These activities help maintain an adaptive and proactive approach, ensuring risks are effectively controlled **(Institute Project Management, 2019).**

2.3. Divergence between Traditional Risk Management and Agile Risk Management:

Based on **(Cardona, 2021)** he divided the differences between ARM and TRM into five key differences has been showed on the following table :

Table 8: Key differences between ARM and TRM.

Key deference's	Traditional risk management	Agile risk management
Process Formality and Structure	Characterized by formalized processes with comprehensive documentation and predefined procedures.	Emphasizes flexibility, with less reliance on extensive documentation and more on adaptive processes that evolve with the project.
Risk Identification and Timing	Risks are typically identified and assessed during the initial phases of the project, with mitigation strategies planned upfront.	Risk identification is continuous, occurring throughout the project lifecycle, allowing for real-time responses to emerging risks.
Tool Utilization and Accessibility	Often employs standardized tools and platforms for risk management, which may be underutilized due to accessibility challenges or complexity.	May use more lightweight or integrated tools, but the emphasis is on tools that support collaboration and are easily accessible to all team members.
Responsibility and Ownership	Risk management responsibilities are usually assigned to specific roles or departments, leading to a centralized approach	Promotes shared responsibility among team members, fostering a collective approach to identifying and mitigating risks
Communication and Collaboration	Communication about risks may be periodic and follow formal reporting structures.	Encourages continuous communication through regular meetings (e.g., daily stand-ups), facilitating immediate discussion and resolution of risks

Source: (Cardona, 2021).

Furthermore, **(Velazquez, 2021)** he distinguishes the contrasts of the TRM and ARM into five main aspects as the following table will demonstrate it:

Table 9: the main contrasts of TRM & ARM.

	TRM	ARM
Risk Identification	Primarily conducted upfront; assumes requirements remain static.	Integrated into iterative workflows; continuously adapts to emerging risks.
Planning approach	Relies on detailed, upfront plans spanning the entire project timeline.	Shorter planning horizon with flexible, adaptive cycles.
Risk evaluation	Periodic reviews; may lag behind fast paced environments.	Continuous evaluation during development, embedded into team processes.
Risk handling	Limited flexibility due to strict timelines; risks often addressed reactively.	Proactive handling through prioritized backlogs and adaptive responses.
Challenges	Struggles to adapt to dynamic, fast-paced environments.	Provides frequent opportunities to evaluate and address risks effectively.

Source: Illustrated by the authors.

Section Three: Agile Risk Management: A Dynamic Approach to Uncertainty in Projects

This following section will demonstrate what is Agile Risk Management, then will pass by the process and the principles of the new approach, to conclude by the transition from a complicated rigid traditional risk management process to a new flexible adaptable reactive approach such Agile Risk Management.

3.1. What is Agile Risk Management and its significance?

3.1.1. What is Agile Risk Management?

From **(Moran, 2014)** perspective he defined based on the IT field, but we can project that approach on construction/infrastructure projects and he mentioned that Agile Risk Management is a proactive and iterative approach to identifying, analyzing, and responding to risks within Agile software development frameworks. This strategy, which is based on the principles of the Agile Manifesto, allows teams to continuously manage uncertainty by including risk-related activities into the pattern of Agile delivery through iterations, daily stand-ups, and retrospectives. It emphasizes early risk detection, shared accountability,

transparency, and adaptability over rigid documentation and formal gating processes found in traditional risk management systems.

Furthermore, there is a study that's talk about the effect of the explicit integration of the Agile's methods on risk management which conclude the positive impact. And that impact had a favorable such as improved quality, increased risk visibility, enhanced team efficiency, reduced costs, and faster time-to-market **(Vieira et al., 2020).**

Finally, **(Sikweya & Njue, 2021)** they defined the ARM as Agile Risk Management (ARM) is an iterative and collaborative framework for managing project risks, grounded in the principles of the Agile Manifesto. Emerging initially from software development and later adopted in fields such as construction, ARM promotes continuous risk identification, discussion, and resolution through regular team interactions, such as iteration-based stand-up meetings. Unlike traditional risk management approaches, which often assign responsibilities to isolated parties and rely on extensive but underutilized documentation, Agile Risk Management encourages shared accountability, lean documentation practices, and rapid responsiveness to emerging risks. This model ensures higher risk visibility and fosters informed decision-making by integrating risk management into each phase of the project lifecycle, ultimately enhancing team communication and reducing the time between risk detection and mitigation.

3.1.2. What is the significance of ARM:

The importance of agile risk management is underscored by several key benefits:

- **Enhanced Responsiveness**: By minimizing the time between when a risk is detected and when corrective actions are implemented, agile risk management ensures a faster response to emerging threats.
- **Improved Visibility and Communication:** The regular, iteration-based meetings keep risk information visible and facilitate ongoing discussions, which support informed decision-making across the organization.
- **Shared Ownership**: Bringing all relevant parties together fosters a collaborative environment where responsibilities for risk management are collectively understood and acted upon.
- **Continuous Documentation:** Unlike traditional methods that may suffer from poor maintenance of risk information, agile risk management mandates documentation and

risk reporting every iteration, ensuring that risk registers remain current and effective.**(Sikweya & Njue, 2021)**

3.2. Agile Risk Management Process and principles:

3.2.1. ARM Process:

(Moran, 2014) provided a comprehensive process ARM that will be demonstrated and explained sequentially:

Figure 13: Agile Risk Management process overview.

Source: (Moran, 2014).

A. Project context and risk environment:

from the description of the first phase of the process we conclude some points that we could demonstrate them to:

a. Contextual Alignment of Risk and Objectives:

- This phase takes place at the initial stage of the project and is situated inside the organization's enterprise risk management framework.
- It includes defining the project's objectives and determining out how much risk the organization is prepared to take on in order to achieve them.
- While the project's context establishes whether it necessitates exemptions from standard controls or limits because of excessive risk, project objectives serve as the basis for risk identification.
- To guarantee alignment with company goals, decisions about the project's risk level are carefully considered and approved when needed.

b. Project-Specific Risk Context:

- The framework of the project may permit more risk for creative endeavors or, if judged excessively hazardous, impose restrictions by redefining the project scope.
- At this point, risks need to be noted and deliberately handled without adding needless bureaucracy
- This guarantees that projects that are suggested are not compromising the organization's financial or reputational status and are in alignment with its risk tolerance.

c. Understanding IT Project Risk Drivers:

- Using a consistent scale (e.g., five-to-seven points), basic risk drivers for IT projects should be evaluated at the enterprise, divisional, business unit, or program level.
- All participants should be able to understand risk assessments when they are presented in business terms.
- A grading system that emphasizes the possible advantages of technological uncertainty should recognize that risk can bring both opportunities and challenges.

d. Risk Driver Maps:

- Enterprise risk attitudes are graphically represented by a risk driver map:

Figure 14: Risk driver map based on prototypical risk determinants.

Source: Illustrated by the authors.

- Red zone (Upper threshold): Hazards that need immediate attention because of a high degree of uncertainty.
- Green zone (lower threshold): Minimal risk that needs little attention.
- Risks in the yellow zone (intermediate threshold) demand constant observation and, if necessary, response.

➢ By identifying acceptable and unacceptable risk levels, the risk driver map assists in coordinating project risk appetite with business risk standards.

e. Personal Risk Attitudes and Team Dynamics:

➢ The project manager assesses team members' personal attitudes towards risk to ensure alignment with project risk appetite**.**

➢ To get the team to agree on what risks are acceptable and unacceptable, differences in risk tolerance must be clarified.

➢ Disparities between project risk thresholds and individual attitudes can also be highlighted via risk driver maps.

f. Framework Integration:

➢ To enhance risk assessment for future efforts, the enterprise risk driver map incorporates lessons acquired from prior projects.

➢ It ensures uniformity in risk management procedures across organizational levels by coordinating project risk appetite with more comprehensive corporate frameworks, such ISO 31000.

B. Risk scoping:

we've extracted these points and will be showed as demonstrated below:

a. Assessment of Project-Specific Drivers:

➢ The impact of particular risk drivers on the project is assessed using the enterprise risk driver map.

➢ To create a common awareness of risks, discussions should include the project sponsor, team members, and other important stakeholders.

➢ It is advised that this conversation take place in a facilitated workshop**.**

b. Evaluation of Preconditions for Project Approval:

- Cautious consideration of whom is handling the project and whether criteria need to be fulfilled before approval are encouraged.
- While it is important to keep an eye on the remaining risk factors, they might not be sufficient grounds for project termination.

c. Boundary Risk Assessment and Implications:

- How a project is managed will change if the risk map shows that it is located within the enterprise limits of unacceptable risk.
- Depending on the degree of risk, particular instruments and methods that align with risk-driven methodologies ought to be chosen and implemented.

d. Risk-Driven Tools and Techniques:

In accordance with risk-driven approaches, as outlined by **(Fairbanks, 2010),**which support the idea that technique selection and implementation should be driven by risk and proportionate with the risk of failure (or success), it might become required to select suitable instruments. For instance, it could be essential to make a larger investment in test-driven development throughout the project if creating an application that needs to achieve high performance utilizing a new algorithm.

C. Risk tailoring:

a. Project-Specific Amendments to Agile Methodology:

- Adapting the selected agile methodology in light of the risks discovered during the risk scoping phase is the main objective of the following step in the agile risk management process.
- Thus, until now the particular agile methodology has not been discussed in detail; however, it is now necessary to take the methodology's details into account.

b. Role of the Agile Chart:

- According to the chapter on "Agile Software Development," he mentioned **(Moran, 2014)** that an agile chart is a useful tool for communicating ideas and enhancing comprehension of the cyclical nature of tasks.

- It makes clear the frequency and timing of activities, which affects the integration of risk management (e.g., identifying whether planning is incremental or iterative and the scheduling of risk assessment activities).

c. Annotated Agile Charts:

- Practitioners often annotate agile charts with artifacts from their methodology (e.g., product vision, iteration backlog).
- Adding risk artifacts (e.g., project risk driver map) to agile charts can enhance communication and visibility of risk management practices.

d. Placement of Risk Management Activities:

The level of information provided determines where risk management activities should be conducted.

- Risk analysis should take place at the iteration level instead of the incremental level if there is inadequate information.
- To provide clarity and alignment, teams must decide explicitly where to position these activities.

e. Agile Techniques as Risk Management Tools:

- Risk management tools include methods such as refactoring, continuous integration, and prototyping.
- The degree of information needed, as well as the intended frequency and intensity of these actions, determine how they are deployed.

D. Risk management:

a. Identification, Evaluation, and Management of Risks:

- The agile risk model's subsequent phase is devoted to project-level risk identification, assessment, and management.
- To conform to agile principles, some agile adaptations are added to traditional risk management methodologies.
- The main objective is to improve knowledge of risk and return in order to facilitate decision-making in the context of the project.

Table 10: Risk management process.

Input	Activity	Output(s)
Project risk driver map	Identification of risks commensurate with the available level of information	Risk list
Risk list and risk pyramid	Analysis and prioritization of risks in terms of likelihood and impact	Risk list
Risk list and backlog	Management of risks in terms of response strategies and tasks	Risk list, updated backlog (including risk tagging) and risk-modified Kanban board
Backlog and risk list	Monitor and track risk-related activities; observe possible changes in underlying risk exposure components	Risk Burndown

Source: (Moran, 2014).

b. Agile Perspective on Risk:

- Because they are worried about project tolerances (such time and budget), traditional project managers frequently see risk negatively.
- On the other hand, agile project managers see uncertainty as both a threat and an opportunity, rejecting the plan-driven paradigm.
- It has been observed that agile literature emphasizes the drawbacks of risk, especially when it comes to needs and technological concerns.

c. Risk List as a Central Tool:

- To support risk-related operations, it is advised to maintain a risk list, which should have the characteristics listed in Table:

Table 11:Core attributes of risk lists tailored for application within Agile methodologies.

Attribute	Purpose in Agile Context
Identifier (optional)	Simple label for tracking risks across sprints or tasks.
Description	Clear articulation of the risk to support team understanding.
Classification (optional)	Categorizes the risk (e.g., technical, organizational, external).
Likelihood	Estimated chance of the risk occurring within a timeframe.
Impact	Anticipated effect on project delivery or sprint objectives.
Score	Prioritization value (Likelihood × Impact).
Strategy	Chosen method for managing the risk (avoid, mitigate, accept).
Measure	Specific action or task to address the risk.
Residual Likelihood	Likelihood remaining after mitigation efforts.
Residual Impact	Remaining impact after implementing measures.
Residual Score	Updated risk score post-mitigation (for monitoring).

- Individual risk owners are not included in the risk list for two reasons:
  - Any member of the project team, not just one person, can assign tasks that are on the backlog.
  - Some risk mitigation strategies (such using agile approaches) are shared responsibilities rather than belonging to a single owner.
- The team should always be able to see the risk list, for example, next to burndown charts, so that anyone can add new risks as they emerge.

d. Periodic Review and Monitoring:

- Throughout the project, the risk list needs to be reviewed, analyzed, and consolidated on a frequent basis.
- The ongoing process of risk management necessitates the revalidation of fundamental presumptions, like risk appetite.

- Risks should be identified at the beginning of each iteration and continuously monitored in all projects, with the exception of those that are extremely low risk. Incremental-level risk management could be adequate for low-risk initiatives.

e. Prioritization of Risk Measures:

- Proactive measures can be regularly prioritized and are intended to minimize inherent hazards to residual risks.
- Reactive measures, which result from the accept strategy, depend on hazards being triggered and, once realized, prioritized according to their urgency.
- To enable efficient planning, contingent priority entails determining how quickly actions must be taken after a risk materializes.

f. Non-Task Risk Activities:

- Non-task activities, including using agile methods (like pair programming), have an impact on estimating procedures.
- Potential overhead expenses must be taken into consideration when choosing risk mitigation strategies, and task estimates have to be adjusted appropriately.
- For instance, using pair programming to reduce the risk of GUI implementation adds overhead that needs to be distributed among tasks according to their size.

a. Risk identification:

i. Relevant and Irrelevant Uncertainties:

- Not all project-related uncertainty is relevant.
- For example, when a horse race is used as a metaphor, the outcome is unpredictable and only becomes risky when a wager is made.
- Similarly, uncertainties that do not affect project objectives can be overlooked.

ii. Distinguishing Risks from Non-Risks:

- The distinction between risks and non-risks, especially between causes and effects, can be confusing. While a risk adds uncertainty that could affect the work's conclusion (effect), a cause drives a task.

iii. Avoiding Misguided Risk Management:

- This misconception is especially harmful because it often confuses risk management initiatives, resulting in actions which fail to adequately reduce the underlying risks.

iv. Techniques for Risk Identification:

- What/Why technique: Instead of always phrasing the question negatively (e.g., "What could go wrong?"), this strategy emphasizes the value of remaining neutral and open by asking, "What could happen?" Both positive and negative risks are acknowledged in this approach. The "Why" question that follows enables the identification of dangers that need to be addressed right now. This method works particularly well in brainstorming sessions, especially when participants are unfamiliar with the risk identification procedure.

- Risk statement: This method promotes the creation of "*As a result of definite cause, uncertain event may occur, which would lead to effect on objective(s)*"**(Hillson, 2009)**. Although it takes some practice to fully comprehend, this strategy may be effective.

v. Workshop-Based Identification:

- 'Paper round' approach: a two-stage workshop as be illustrated:

Figure 15: Paper round technique.

Source: illustrated by the authors based on (Moran, 2014).

- First stage: Write "what" titles on separate pages, review for duplicates, and clarify misunderstandings.

- Second stage: Circulate pages for team members to add potential "whys," which are then collected to create a risk list using the risk statement technique.

b. Risk analysis and prioritization:

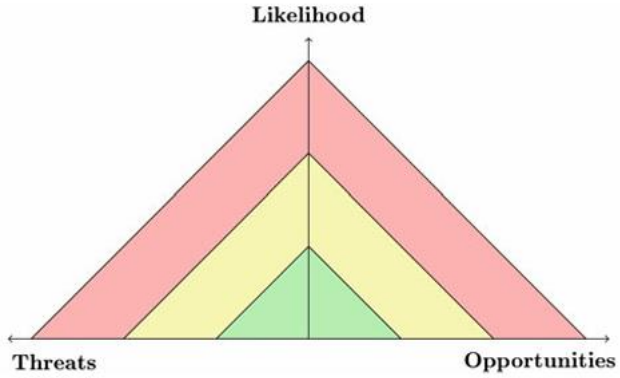
i. Evaluation and Prioritization of Risks:

- Risks need to be assessed and ranked when they have been identified.
- Risk assessment entails evaluating impact and likelihood, with impact being measured in terms of project objectives, which may be prioritized in and of themselves.

ii. Representation of Risks: Traditional and Improved Approaches:

- Positive risks may be obscured by the standard risk map, which displays absolute exposure but mixes threats and opportunities in the same area.
- To illustrate the idea of positive risk, opportunities and threats ought to be shown independently.
- In the following Figure, the conventional orientation is reversed, with the horizontal axis representing impact (positive or negative) and the vertical axis representing likelihood.

Figure 16: Risk pyramid of opportunities and threats.



Source: (Moran, 2014)

iii. Reducing Risk Assessments to Comparable Bases:

- Although it is frequently applied, risk exposure the numerical product of components might not be suitable for ordinal risk components.

- As an alternative, risk scores which are comparable to tale points are suggested.
- The bands of the risk pyramid are used to assign scores:
  - Green (inner pyramid): 1 point
  - Yellow (middle pyramid): 2 points
  - Red (outer pyramid): 4 points

iv. Approaches to Risk Prioritization:

- Despite their low likelihood, risks related to high-value objects are frequently given higher priority.
- The suggested order of priorities strikes a balance between value and risk:
  - High value and high risk: Addressed first.
  - High value and low risk: Addressed next.
  - Low value and low risk: Considered last.
  - Low value and high risk: Avoided entirely.

v. Linking Risk and Business Value:

- It is not recommended to prioritize risks alone by decreasing exposure because this would disrupt the essential link between risk and reward.
- It is advised to use a T-shirt sizing system (e.g., XS, S, M, L, XL), with priority determined by the color areas of the risk pyramid and connected to company value.

vi. Balancing Risk and Reward:

- The relationship between risk and reward must be maintained for risk prioritization to be effective.
- Risk prioritization should always be connected to larger project goals and value considerations rather than being done in isolation.

c. Risk treatment:

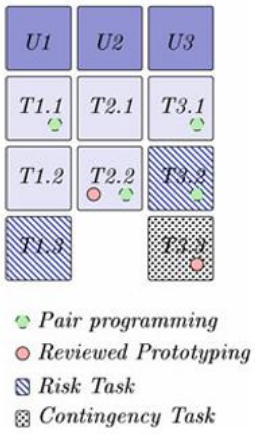
i. Risk Response Strategies:

- Risk tasking: Formulate risk tasks, link them to items on the risk list, and place them on the iteration backlog.
- Risk Tailoring/Tagging: Apply agile techniques to specific tasks or integrate them into the project methodology.
- Contingency Planning:
  - Set up tasks for potential approved risks.
  - In the event of a risk, contingency tasks remain on the backlog and move up in priority.

ii. Practical Applications:

- Risk methods such as pair programming, prototyping, or contingency planning are used to customize user stories (e.g., U1, U2, U3) and their tasks. And the Figure below illustrate the three methods:

Figure 17: Risk treatment methods.



Source:(Moran, 2014).

- Risk assessments should determine whether a less risky method can provide the same value.

iii. Risk Walling and Transparency:

- All risk-related artifacts, such as risk lists and modified Kanban boards, should be visible and accessible.
- Promotes clear communication and understanding of risk management activities.

iv. Selection of Agile Techniques:

- Intensity-Based Responses: Conducted less frequently but requiring greater effort.
- Frequency-Based Responses: Conducted regularly within daily cycles.
- Automation and Flexibility:
  - Automated processes can occur multiple times daily with minimal programmer involvement.
  - Techniques like prototyping vary in frequency and intensity based on project needs

v. Common Agile Strategies for Risk Management:

- Iteration planning with varied teams, daily builds, pair programming, continuous integration, refactoring, customer demonstrations, and retrospectives.
- To handle operational uncertainty, more robust approaches are recommended, such as Quality Function Deployment or Business Process Modeling.

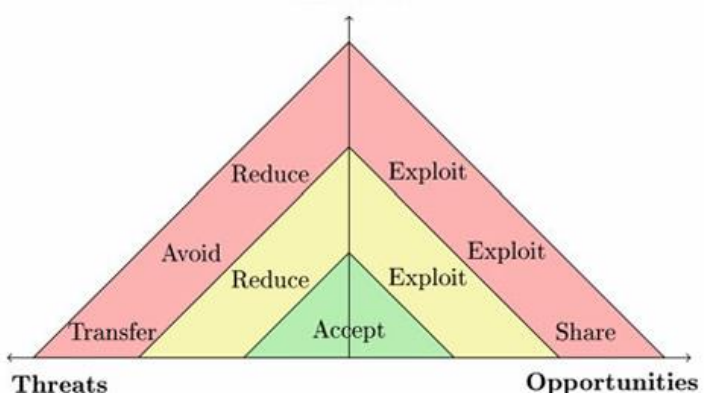
vi. Placement in Risk Pyramid:

- Table 12 and Figure 19 depict the natural agile placement of risk response strategies within the risk pyramid.

Table 12: Risk response strategy**.**

Strategy	Agile Interpretation
Accept	No active mitigation; contingency tasks may be scheduled with low priority if needed.
Exploit	Actions are taken to leverage the opportunity by increasing its likelihood or benefit.
Share	The risk is distributed among partners to share both potential benefits and impacts.
Transfer	Responsibility is outsourced (e.g., through insurance or external providers).
Reduce	Steps are taken to minimize the probability or impact of the risk, often via explicit tasks.
Avoid	Activities linked to the risk are eliminated from the plan to prevent occurrence.

Figure 18: The placement of the risk response strategies within the risk



Source:(Moran, 2014)

- The risk pyramid serves as a starting point for selecting appropriate strategies based on risk exposure.

vii. Linking Risk Measures to Activities:

- Risk measures should be considered as part of regular project activities and are essential to iteration tasks.
- Risk management-specific backlogs, like a "risk backlog," are avoided.

viii. Sensitivity to Risk Assessment: Strategies for responding to risks must vary as assessments do. Task outsourcing could result in additional risks.

d. Risk monitoring:

i. Overview of Risk Monitoring:

- Similar to burndown charts in agile approaches, the risk burndown chart is an essential tool for monitoring risk reduction.
- Outstanding risk at any point is represented by the cumulative risk score from pending tasks, completed tasks, and residual risks.

ii. Conditions for Risk Reduction:

- Completion of Risk-Related Tasks: Tasks that directly address underlying risks.
- Decisions Affecting Risk Courses: Actions that lower residual risks from inherent risks.

- Application of Agile Techniques: Completing tasks in a particular way in order to lower risks and take use of agile methodologies.
- Cessation of Risk-Inducing Activities: Placing a closure to risky or impractical actions.
- Expiry of Risks: Understanding that risks fade as their origin is rendered irrelevant.

iii. Iteration Residual Risk:

- This risk, which falls between zero and the total residual hazards, is the one that cannot be eliminated.
- Serves as a reminder that there is always some degree of risk.
- Components include:
  - Accept Strategy Risks: Contingency plans are relied upon if risks occur.
  - Task Residual Risks: Risks are not completely eliminated by completion.
  - Loss of Control Risks: Residual risk persists from transfer or share actions.

iv. Risk Reduction Process:

- As tasks advance, overall risk decreases until it approaches the residual risk of the iteration.
- Risk assessments may result in upward pressure, increasing current risks.
- Changes in scope could disrupt the risk curve's monotonic fall.

v. Iteration Managed Risk Ratio:

- Defined as: Iteration Managed Risk (I.M.R)

$$\text{I.M.R Ratio} = \left(1 - \frac{\text{Iteration Residual Risk}}{\textit{Total Iteration Risk (incl.Iteration Residual Risk)}}\right) \times 100$$

  - Indicates the percentage of controllable risk that is left in the iteration.
  - Begins high and falls as hazards are controlled, eventually reaching zero.
  - A ratio of zero indicates that there is still systemic risk that cannot be removed.

3.2.2. ARM principles:

Throughout the discussion, several principles that support the agile risk management process will be referenced for convenience. These principles are harmoniously integrated with core values such as openness, respect, and courage, which are fundamental to most agile methodologies. Additionally, they embody key features such as effective communication and collaboration, which are central to the principles articulated in the Agile Manifesto.

- **Transparency:** Every team member should be able to consistently see all risk-related activities and artifacts. This can be accomplished by placing these components in a central project area, like an information radiator, or next to other agile tracking and reporting tools, including burndown charts and Kanban boards. It should be possible for team members to add to or annotate these artifacts as needed. Known as "risk walling," this technique makes sure that anyone outside the project can enter the project area and rapidly assess the present risk scenario without needing clarification or disturbing other team members.

- **Balance:** The purpose of risk management is to minimize risk exposure while delivering the same amount of value by achieving the perfect equilibrium between risk and reward. It is essential to make it apparent which user stories present the most significant risks and to maintain clarity about how each team member's work affects risk reduction. These contributions may be in the form of reducing potential threats or capitalizing on opportunities to improve project results.

- **Flow:** IT projects as for this process always have risks, but in order to ensure that the project moves forward smoothly and without any disruption, it is essential to have a solid awareness of these risks and effective measures to mitigate them. Teams can avoid disruptions from reactive replanning or crisis management operations by proactively creating contingency plans that allow them to react effectively when accepted risks materialize.**(Moran, 2014).**

3.3. The transition from the Traditional Risk management to ARM:

There is multiple researcher that mentioned the transition from TRM to ARM for its positive and rapid risk mitigation and some of them:

The shift from traditional to Agile risk management moves from static planning to dynamic mitigation. Traditional methods use predictive models, while Agile integrates risk management into daily workflows like sprints. And highlights Agile's adaptability but suggests hybrid models, such as risk-modified Kanban boards, to balance flexibility with structured oversight. This transition requires both methodological and cultural shifts to manage uncertainties effectively while maintaining agility **(Alan Moran, 2016).**

Then **(Petrillo, 2024)** thinks about the shift to Agile risk management, transforms how projects handle uncertainty, moving from static, upfront methods to dynamic, iterative workflows. Agile incorporates risk mitigation into activities like daily stand-ups and sprint retrospectives, fostering collaboration and adaptability. Success depends on integrating risk discussions into Agile practices, empowering teams, and using hybrid. Aligning Agile's flexibility with structured oversight ensures organizations effectively manage volatility without sacrificing rigor.

And **(Haye, 2024)** encourager's the transition for its numerous benefits that enhance organizational performance and resilience. By proactively addressing potential threats, organizations can anticipate risks, implement timely mitigation measures, and prepare contingency plans, thereby reducing the likelihood and impact of crises on operations, reputation, and financial performance. Real-time data and insights further support improved decision-making by enabling leaders to assess risks, evaluate options, and allocate resources effectively. Additionally, Agile practices empower teams to respond quickly and flexibly to emerging risks or opportunities, moving away from rigid protocols and fostering greater organizational agility. Transparent communication strengthens stakeholder trust by ensuring investors, customers, employees, and regulators that risks are managed effectively and the organization is well-equipped to address potential challenges. Together, these aspects demonstrate how Agile risk management aligns adaptability with accountability to navigate uncertainties successfully.

By the ending of this chapter will form some theoretical base on the three previous mentioned topics APM, Risk management and the core topic which is Agile Risk Management, these theoretical bases will be implemented on the next chapter. To conduct a conceptual framework and then the methodological frame of our study.

CHAPTER II: Conceptual and Methodological framework of the research

The following chapter will address our conceptual framework and its elements that we will conduct our research base on the, then the methodological framework from the research methodology through tools of data collection. Finaly, will bring up a brief presentation about the hosting firm and the actual project that we conduct our study on it.

Section One: Conceptual framework

In the first chapter, we explored the theoretical foundation of the two key variables in our study: Agile Project Management as the first variable and Project Risk Management as the second, examining their intersection within Agile methodologies. The subsequent sub-section will focus on the conceptual framework that serves as the basis for our analysis.

This section is structured around the contribution of Agile Project Management (APM) principles to enhancing risk management practices. We outlined six of the twelve Agile Manifesto principles as foundational elements of Agile project execution. Additionally, we chose to work with the risk management process proposed by PMI (2019), which is based on ISO 31000:2018.

Before we start our conceptual framework, we first need to define a various key notion that related to our research such:

A. Project:

a large number of authors had defined the project; we choose some of the definitions such:

(Steinegger, 2019) he defined project as several fundamentally characterized attributes such:

- Uniqueness: Every project is unique and has risks that could cause it to fail.
- Change-oriented: The overall objective of a project is to enhance or modify an already existing system.
- Time and cost constraints: It operates within defined timeframes and budgetary limitations.
- Customer-centric: It is initiated and executed in response to specific customer needs or requirements.

For **(Project Management Institute, 2017)***" A project is a temporary endeavor undertaken to create a unique product, service, or result."*

B. Risk management:

Risk Management (RM), sometimes termed "uncertainty management," is a structured process used by organizations to minimize unforeseen events and maximize profitability. Scholars often equate RM with uncertainty management due to the unpredictable nature of risk itself. By systematically assessing and addressing potential threats, businesses enhance resilience and ensure strategic success **(Rahman, 2018).**

For **(*AS ISO 31000:2018 Risk Management - Guidelines*, 2018)** risk management is "*coordinated activities to direct and control an organization with regard to risk*".

Our internship takes place in a construction firm that specializes in various types of projects. We are assigned to the public works branch, which is overseeing construction of an infrastructure project. This assignment leads us to divide our previously mentioned objective into specific areas of focus.

1.1. Agile Project Management Principles:

The past chapter we noted that APM had 12 principles and to the condition and nature of our study we will discuss several principles that can be related to the construction of an infrastructure project: based on **(Fowler & Highsmith, 2001)**

1.1.1. Principle 1:

Prioritizing Customer Satisfaction Through Early and Continuous Delivery of Valuable Software. In agile development, functional software delivery takes precedence over extensive documentation. While requirements and architecture are valuable, customers ultimately prioritize working software that meets business needs in each cycle. Traditional project management equates plan adherence with success, yet modern project volatility requires continuous reassessment of customer expectations. Meeting predefined plans does not always ensure project success, making adaptability and incremental value delivery essential in maintaining business relevance.

1.1.2. Principle 3:

Deliver working software frequently, from a couple of weeks to a couple of months, with a preference for the shorter timescale. Incremental development characterized by multiple deliveries of evolving functionality has long been advocated, yet remains underutilized despite its necessity in agile projects. Agile methodologies emphasize

reducing delivery cycle time, ensuring frequent internal iterations that allow teams to assess progress and adapt efficiently.

Importantly, delivery does not equate to release. Business stakeholders may have valid reasons for delaying production deployment, yet rapid internal deliveries remain crucial for continuous evaluation and improvement. Even in projects where releasable functionality takes months or years, maintaining a steady rhythm of internal iterations fosters agility, learning, and refinement, ensuring the final product aligns with evolving business needs.

1.1.3. Principle 6:

Face-to-face conversation is the best form of communication. Agile methodologies challenge the notion that extensive documentation alone ensures project success. The core issue is not lack of documentation, but rather effective understanding among team members. While written records provide structure, they are often insufficient for transferring tacit knowledge, which is best communicated through direct collaboration and shared experiences. Agile approaches emphasize frequent interaction and adaptive learning over rigid documentation processes. The real distinction lies not in rejecting documentation, but in optimizing the blend of written records and active dialogue to enhance team comprehension and project efficiency.

1.1.4. Principle 7:

Working software is the primary measure of progress. Many project teams encounter delays late in the development cycle, despite completing requirements, design, and coding on time. However, testing and integration often take longer than anticipated, leading to unforeseen setbacks. Agile methodologies emphasize iterative development, ensuring clear milestones that provide measurable progress and deeper risk awareness. These checkpoints allow teams to identify issues early, adjust strategies proactively, and prevent last-minute surprises, making iterative cycles a crucial approach for project success.

1.1.5. Principle 11:

The best architectures, requirements and designs emerge from self-organizing teams. The best architectures, requirements, and designs emerge through iterative development rather than rigid early planning. Adjustments come in response to real-

world shortcomings, reinforcing the need for adaptability in design. Predicting exact usage patterns in advance is often unrealistic, making flexibility essential for success.

In complex systems, self-organizing teams foster innovation and creativity. When interactions are high and strict rules are minimal, emergent properties drive effective solutions. By embracing continuous refinement, teams ensure their work remains relevant, adaptable, and aligned with evolving needs.

1.1.6. Principle 12:

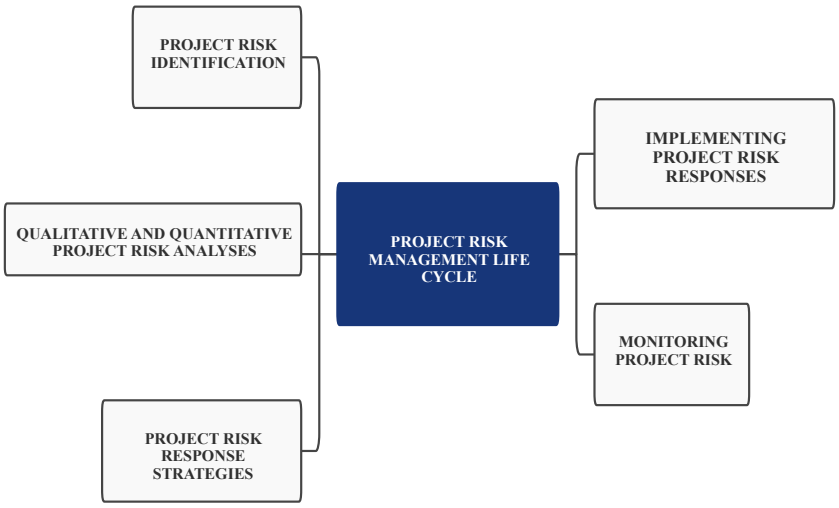
Regular reflection on how to become more effective (inspect & adapt). Agile methods are not rigid frameworks to be followed blindly; instead, they evolve based on project-specific needs. While teams may start with a predefined agile process, continuous refinement and adaptation are necessary for success. Agile teams must reflect, modify, and enhance their practices to fit their unique circumstances, fostering efficiency and responsiveness.

Real-world agile implementations demonstrate this adaptability. Teams working on Adaptive Software Development and Extreme Programming have modified methodologies immediately to align with their workflows. This approach emphasizes trust in people, valuing individual expertise and group collaboration. By empowering teams to monitor and improve their processes, agile ensures that methodologies remain relevant, effective, and tailored to project requirement

1.2. Project Risk management Practices:

As we have saw in the first chapter the section that mentioned the risk management process and we bring the foundation of the majority of risk management process which is the guideline ISO 31000:2018. We have found a process of PRM that explicitly uses the guideline that we observed and divided the process in 5 essential steps as the following:

Figure 19: Project risk management life cycle**.**



Source: The schema illustrated by the authors.

As the Figure illustrate the steps defined as the following**:(Institute Project Management, 2019).**

1.2.1. Project Risk Identification:

The methodical process of identifying potential uncertainties that could affect project outcomes is known as project risk identification. Based on contextual and operational inputs, this identification guarantees thorough risk assessment at every stage of the project's lifecycle.

A. Operational Inputs:

Operational risks arise directly from project activities and include the following elements:

- **Project Scope Statement:** Risks associated with product specifications, agreed-upon delivery methods, and project expectations.
- **Project Life Cycle:** Each lifecycle phase introduces unique risks, regardless of the selected approach.
- **Work Breakdown Structure (WBS), Activity List, or Backlog:** Risks emerge from the decomposition of project tasks and the challenges encountered during execution.
- **Estimates:** Risks related to time, cost, effort, and resource estimations, where accuracy determines the acceptable risk level.
- **Dependencies and Work Sequencing:** Risks stemming from task interdependencies, critical path changes, and external dependencies influencing project execution.

- **Procurement Plans:** Outsourcing certain project components may serve as risk transfer strategies but can simultaneously introduce new risks.
- **Change Requests**: Every project modification may either mitigate existing risks or generate new uncertainties.
- **Historical Data:** Past project experiences help identify systemic risks and enable automated risk management approaches.

B. Contextual Inputs:

Contextual risks originate from external factors, strategic influences, and organizational dynamics shaping the project environment:

- **Stakeholder Analysis:** While stakeholders contribute valuable opportunities, mismanagement may introduce project risks that require mitigation.
- **Business Case:** The profitability and return on investment (ROI) factor carry a certain level of uncertainty. Ensuring long-term benefits post-project completion is an integral part of risk identification.
- **Program or Portfolio Governance Success Factors**: Changing governance priorities may shift the project's importance within a portfolio, influencing risk levels.
- **Enterprise Environmental Factors**: Organizational structure, strategic direction, business dynamics, and regulatory changes can act as external risk triggers impacting project execution.

1.2.2. Qualitative & Quantitative Project Risk analyses :

The evaluation of project risks involves assessing both impact severity on project objectives and probability of occurrence. The primary goal of these analyses is to determine whether the impact can be managed within the project's budget constraints and within the accountability scope of the project manager.

- **Containable Risks**: Risks deemed manageable within project limitations are addressed through the Project Risk Management Plan and related strategies.
- **Escalated Risks**: If a risk impact exceeds project boundaries, it is escalated to the appropriate governance level for further intervention.

Project-level risks are handled when their effects remain within budgetary and managerial limits, ensuring direct mitigation within the scope of project execution. Conversely, risks that threaten the organization's ability to achieve or sustain expected

benefits are escalated to governance structures, where broader strategic decisions can be made.

1.2.3. Project Risk Response Strategies:

Project risk response strategies encompass a range of potential actions aimed at mitigating risks that may affect project execution. These strategies are guided by the risk management plan, budgeted accordingly, and financed through the project's contingency reserve.

Integration with Project Baselines:

- Risk responses may involve the introduction of additional activities or work packages to update project baselines.
- In some cases, certain activities may be removed from baselines to eliminate risk factors.

Escalation Within Program and Portfolio Management:

- Projects managed within a program or portfolio may require risk escalation to higher governance levels.
- Escalation enhances the efficiency and effectiveness of addressing risks that impact the broader program or portfolio.
- Risks exceeding contingency reserve allocations necessitate higher-level intervention for appropriate funding and resolution

1.2.4. Implementing Project Risk Response:

The execution of risk responses within a project follows the guidelines established in the risk management plan, utilizing allocated contingency reserves and integrating necessary adjustments into the project baselines. These activities become an integral component of the project scope and are managed through standard project execution processes.

Unlike conventional project modifications, the implementation of a risk response plan does not require initiation through a formal change management procedure. Since risk responses are pre-approved as part of the overall project management plan, they do not necessitate additional change control processes and are executed as planned interventions to mitigate identified risks

1.2.5. Monitoring Project Risk:

A. Tracking Identified Risks:

- Assess the status of previously identified risks to ensure continued awareness.
- Verify whether any known risks have not occurred or are likely to materialize.

B. Monitoring Risk Response Actions:

- Evaluate the effectiveness of implemented risk response measures.
- Ensure that all mitigation strategies align with the project risk management plan**.**

C. Updating Project Documentation:

- Revise project plans, registers, and controlling documents based on risk status updates.
- Integrate new data from performance reports to refine risk assessments.

D. Performance Analysis and Trend Identification:

- Review performance reports to detect new risks or ineffective response strategies.
- Identify emerging risk trends that may require further mitigation efforts.

E. Implementation of Risk Responses:

- Apply responses according to quantitative parameters (time, cost, scope, and specifications).
- Conduct qualitative assessments to evaluate the efficiency and effectiveness of risk treatments for realized risks. (Institute Project Management, 2019).

1.3. The mapping matrix:

The following mapping matrix will demonstrate how these principles interact with risk management process that been proposed by PMI 2019, this mapping matrix will be illustrated in the following table:

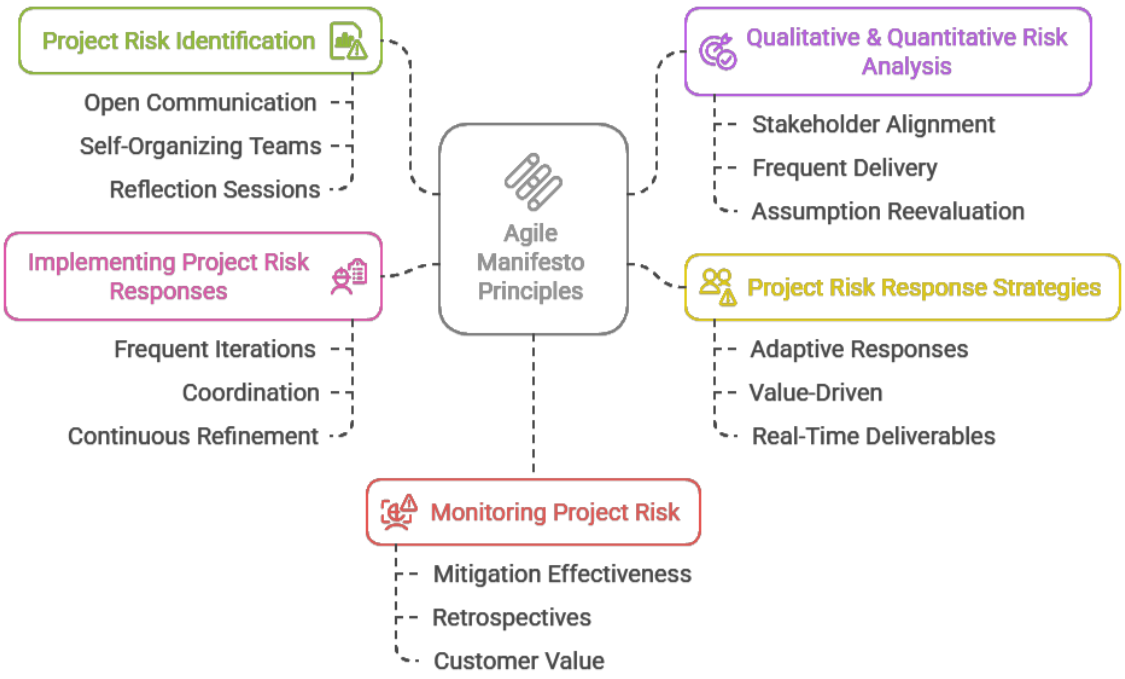
Table 13: The contribution of Agile manifesto principles on Risk management practices.

PMI Risk Management Process	Agile Manifesto Principle	Contribution
1. Project Risk Identification.	**Principle 6**	Encourages open communication, enabling early detection of risks through transparent team interactions.
	Principle 11	Self-organizing teams are more likely to spot emerging risks proactively.
	Principle 12	Reflection sessions help in uncovering latent or evolving risks.
2. Qualitative & Quantitative Risk Analysis.	**Principle 1**	Emphasizes stakeholder alignment, which supports prioritization of risks based on impact to value delivery.
	Principle 3	Frequent delivery provides more data points and insights for better risk evaluation.
	Principle 12	Reflection helps reevaluate assumptions used in risk quantification.
3. Project Risk Response Strategies.	**Principle 11**	Self-organizing teams devise adaptive and context-specific risk responses.
	Principle 1	Risk responses are designed to safeguard the most valuable outcomes (value-driven).
	Principle 7	Emphasizes action over planning; risk strategies can be tracked via real-time deliverables.
4. Implementing Project Risk Responses.	**Principle 3**	Frequent iterations make it easier to implement and test risk responses incrementally.
	Principle 6	Enhances coordination among implementers to apply risk strategies promptly.
	Principle 12	Teams continuously refine implementation based on feedback and learning.
5. Monitoring Project Risk.	**Principle 7**	Working outputs act as proof of mitigation effectiveness and early detection of new issues.
	Principle 12	Retrospectives support active risk monitoring and course corrections.
	Principle 1	Monitoring is aligned with ensuring continued customer value and satisfaction.

Source: The table illustrated by the authors.

To conclude, we conducted a schema that demonstrate our conceptual framework as will be defined below:

Figure 20: Illustration of the conceptual framework.



Source: Illustrated by the authors.

Section Two: Methodological Framework

The following section will discuss the methodological framework of the study, framework, approach and tools that been used for data collection and analyze it.

2.1.Methodological framework:

The methodological framework serves as the cornerstone of any rigorous research study. It provides the structured approach necessary to ensure the validity and reliability of the research process while guiding the systematic collection and analysis of data. This framework outlines the logical progression of scientific inquiry, from defining objectives to implementing tools and techniques customized to the study's needs.

2.1.1. The Epistemological approach for the research:

For **(Alharahsheh & Pius, 2020)**, Epistemology refers to how researchers perceive and acquire knowledge, shaping their approach to understanding reality. It influences how a

researcher distinguishes between right and wrong and interprets the surrounding world. Since different research paradigms have varying epistemological and ontological assumptions, they shape distinct approaches to reality and knowledge. These assumptions guide the selection of methodologies and methods, ensuring alignment between theoretical perspectives and research practices.

Opting the right research methodology is crucial for maintaining the rigor and validity of a dissertation. However, the process can be challenging due to the complexity of the subject and the variety of available methodologies. Researchers must precisely assess their objectives, the nature of their data, and the suitability of qualitative, quantitative, or mixed-method approaches to ensure a solid foundation for their study.

Selecting a research methodology is more than just a technical decision it reflects the researcher's curiosity and drive to explore, explain, or solve a particular issue. Three key elements shape this choice:

- Philosophical framework, which defines how the researcher views knowledge and inquiry.
- Research objective, which clarifies what the study aims to achieve.
- Technical aspects, which determine the methods used to collect and analyze data.

Together, these factors ensure the methodology aligns with the study's purpose while maintaining depth and rigor **(MOHAMMED AZIZI Yasmine, 2021).**

Reflecting on epistemology is fundamental for any serious researcher, as it ensures the scientific legitimacy and consistency of the research. According to **(Boukaira & Daamouch, 2021),** epistemological positioning guides the researcher in producing valid knowledge by defining the research object, the adopted strategy, the choice of methods, the logical frameworks applied, and the theoretical constructs mobilized.

This research adopts a constructivist epistemological stance alongside an interpretivist paradigm, both of which complement its qualitative and exploratory nature. Constructivism asserts that knowledge is socially constructed through interaction, context, and interpretation rather than objectively discovered **(Lincoln & Guba, 1985)**. In alignment with this, the interpretivist paradigm focuses on understanding individuals' experiences, prioritizing meaning-making over hypothesis testing or universal laws **(Creswell & Poth, 2018).**

This epistemological position is particularly relevant to our dissertation, as it seeks to explore how Agile Project Management principles can enhance risk management practices in infrastructure projects, particularly in settings where Agile is not yet formally implemented. To achieve this, the study employs semi-structured interviews, thematic coding, and a single case study design, ensuring depth, contextual insight, and practitioner perspectives are fully considered. This methodological alignment reinforces internal consistency between the research's conceptual foundation and analytical approach, validating its rigor and relevance in examining Agile's potential contributions to infrastructure risk management.

2.1.2. Selection of the research field:

This dissertation explores the intersection of Agile Project Management and Risk Management within the field of infrastructure project management, focusing on Cosider's Project M29, an underground metro expansion in Algeria. The research addresses the pressing need to refine risk anticipation, response, and control in large-scale infrastructure projects, which often encounter delays, cost overruns, and unexpected challenges. While Agile methodologies are established within development, their adaptability and responsiveness to change are expanding presence in non-IT sectors. By examining how Agile principles can reinforce risk management practices in such projects, this study seeks to bridge a gap in existing literature and offer practical insights for public works professionals.

2.2.Research methods:

Conducting scientific research effectively requires a structured methodology that aligns with the selected variables. This ensures the reliability, validity, and consistency of the study, helping maintain accuracy in data collection and analysis. A well-defined approach strengthens the credibility of the research and allows others to build on its findings.

To answer our research question, we've opted the qualitative methodological approach. Qualitative methods are widely used in various fields such as psychology, sociology, anthropology, education sciences, public health, marketing, and research in the humanities and social sciences. These methods focus on understanding human behavior, experiences, and social phenomena through non-numerical data, such as interviews, observations, and textual analysis **(Creswell & Creswell, 2018)**.

Qualitative research focuses on meaning and process, rather than numerical measurement. It seeks to provide a detailed understanding of a phenomenon from the perspective of those experiencing it, emphasizing context over generalization. This approach is particularly

useful for exploratory studies, where deep insights into specific cases enable researchers to capture rich, nuanced responses that quantitative methods might overlook .**(Alharahsheh & Pius, 2020).**

This research follows an inductive qualitative approach to explore how Agile Project Management (APM) principles can enhance risk management practices, particularly in contexts where Agile methodologies are not yet implemented. Instead of starting with a hypothesis, the study initiates with field data collection through semi-structured interviews, deriving analytical insights from observed patterns and stakeholder perspectives. This bottom-up process is effective for identifying new relationships between concepts and practices, especially in infrastructure projects where Agile integration remains underdeveloped.

Inductive reasoning, as described by **(Saunders et al., 2019),** supports theory development from empirical data, making it well-suited for examining complex social phenomena. Furthermore, this approach aligns with qualitative research paradigms, where meaning and understanding emerge from participants lived experiences **(Creswell & Poth, 2018)**. firstly, analyzing field data and then mapping findings to theoretical concepts, such as the Agile Manifesto and risk management standards.

2.2.1. Documentary analysis:

In qualitative research, investigators often collect documents as valuable sources of data. These can be public records, providing insights into societal trends and institutional perspectives. Alternatively, private documents, offer deeper reflections on individual experiences and emotions. Analyzing these sources helps researchers develop a nuanced understanding of the studied phenomenon while ensuring the credibility of their findings **(Creswell & Creswell, 2018)**.

For our dissertation, we explored various academic resources, including ResearchGate, Google Scholar, and ScienceDirect, to deepen our research. We also used the library of the National Higher School of Management (E.N.S.M) to refine our theoretical framework. Additionally, we reviewed several internal documents on risk management such context analyses and risk categorization and classification , which helped strengthen our analysis.

2.2.2. Observation:

Observation is a fundamental method in social research, allowing researchers to systematically study behaviors and interactions. It becomes scientifically valid when carefully planned, recorded, and assessed for reliability. Depending on the research approach, the observer may actively engage with participants or remain detached, using either structured tools or a more flexible approach. Observations can take place in controlled environments or natural settings, offering valuable insights into social dynamics **(Islam et al., 2022).**

For **(Denzin & Lincoln, 2011)** they distinguished three types of observation as the following:

- **Participatory Observation**: The researcher actively engages in the participants activities to understand their experiences firsthand.
- **Non-Participatory Observation**: The researcher remains an outsider, observing behaviors without direct involvement.
- **Structured Observation:** The researcher follows a predefined framework, systematically recording behaviors using an observation grid.

This research incorporates non-participant observation as a data collection method to deepen contextual understanding of Cosider's Project M29. Observation allows the researcher to document real-time project behaviors and practices, particularly those related to risk management activities and team coordination. This method supports the interpretivist paradigm by capturing empirical, context-sensitive insights that may not be explicitly stated. Observation will focus on practical aspects such as team communication, responsiveness to uncertainty, and informal adaptive behaviors. All observations are conducted ethically, with participant awareness and consent.

2.2.3. Interview:

Qualitative interviews allow researchers to gather rich, detailed insights from participants through various formats, including face-to-face conversations, telephone interviews, and focus groups. These interviews rely on open-ended, unstructured questions, designed to prompt individuals to share their views freely. By fostering natural conversations, researchers can uncover deep, sophisticated understanding of the studied phenomenon **(Creswell & Creswell, 2018).**

We've adopted interviews as a method for collecting data. Interviews help researchers explore participants' views, experiences, and motivations, offering deeper insight into individual perspectives and the factors shaping them. This method provides rich, detailed narratives, allowing for a more comprehensive understanding of social contexts.

This study employs semi-structured interviews to collect detailed and rich data, ensuring flexibility in question formulation while gaining insights into participants work practices. Individual interviews with interested parties were conducted to assess the contribution of the Agile principles on risk management practices of the interviewers. Through targeted questions, the research explores current risk management practices, perceived relevance of Agile principles, and opportunities for improvement and change, contributing to a comprehensive understanding of their experiences.

A. Interview guide:

A structured interview guide outlining key themes and sub-themes to be explored, designed to facilitate probing and follow-up questions in response to the interviewee's answers **(Patton, 2015).** See the **Appendix A.**

B. Introduction and presentation of the interview:

At the beginning of the interview process, introductions helped establish familiarity and create a welcoming environment. Participants shared their expectations and objectives, setting a foundation for meaningful discussions and ensuring the conversation aligned with their interests and goals.

C. Interview objective:

The objective of this interview is to gather qualitative insights from key stakeholders managing Project M29 at Cosider, with a focus on risk management practices. It aims to assess current approaches, identify challenges, and explore how Agile Project Management (APM) principles could enhance adaptability and efficiency.

D. Interviewees profiles:

Table that shows the interviewees:

Table 14: The Interviewees profiles.

The interviewee	Profile	Date	Time
1	HSE Manager	4/5/2025	30 min
2	Quality Control Engineer	4/5/2025	40 min
3	Quality Control Engineer	4/5/2025	20 min
4	Quality Management Manager	5/5/2025	40 min
5	Internal security Manager	5/5/2025	50 min
6	Quality Control Engineer	7/5/2025	30 min
7	Process & Operations Manager	7/5/2025	30 min
8	Head of department Quality Management, OHS, and Environment.	8/5/2025	40 min

Source: Elaborated by the authors.

We opt these specific profiles for its direct relation with the notion of risk management process or indirect that may affect the process, from the initiation to the monitoring step. The decision of opting the Quality field is related to the nature of the treatment of the risk inside the firm.

E. Questions:

The provided question had been classified on three themes for facilitating their treatment, and organized as the following:

Part 1: Current Risk Management Practices:(2nd to 6th question)

The questions in this section were drawn from**:(Institute Project Management, 2019).**

These standards define the five key stages of risk management (identification, analysis, response, implementation, and monitoring) and stress the importance of stakeholder involvement, communication, and lifecycle integration.

These sources informed our questions on:

- How risks are currently identified and assessed
- What tools or techniques are used
- How risk response and monitoring is practiced at Cosider

These questions aim to establish a baseline understanding of current RM practices to later assess where Agile could add value.

Part 2: Awareness and Relevance of Agile Principle:(7th to 11th question)

This section of the guide is based on the Agile Manifesto (2001) and the:

And based on the following references:**(Fowler & Highsmith, 2001; Conforto et al., 2016; Project Management Institute & Agile Alliance, 2017)**, These sources emphasize:

- Iterative planning
- Frequent delivery
- Team autonomy
- Collaboration and adaptability

all of which are valuable traits for effective risk response and management.

The questions explore the interviewees awareness of Agile methods and perceptions of their potential to improve areas like communication, responsiveness, and team involvement in risk control.

Finaly, these questions bridge theory and practice by assessing openness to Agile mindset in a non-Agile infrastructure setting.

Part 3: Opportunities for Improvement and Integration (12th to 15th question):

The final section of the interview incorporates questions that aims to collect practical recommendations and insights on how Agile principles could realistically be adapted into Cosider's RM systems.**(Hillson, 2009; Kerzner, 2017) .**

2.2.4. NVivo software:

NVIVO software was chosen for processing interview results in this qualitative study, offering a structured and efficient approach to data collection, organization, and analysis. Its advanced features, such as coding, categorization, search functions, and visualization tools, provide a strong methodological framework for identifying trends, patterns, and relationships within qualitative data. This systematic approach enhances the reliability and validity of the study's findings, ensuring a thorough and insightful analysis.

Section 3: Presentation of the Host Organization:

This section provides the information necessary to understand the framework of the study as well as the methodology adopted. The key aspects of the company in which the empirical study was conducted are presented before outlining the research approach and tools.

3.1.Presentation of COSIDER Group:

Despite the fierce competition in the Algerian construction market following the opening of the country to international construction groups, COSIDER Group stands out for its diversity of activities in the construction and public works sector, its status as a state-owned enterprise, and its leading position in the market, with 10 subsidiaries whose capital is 100% state-owned.

3.1.1. Company History:

As a semi-public company, COSIDER was created on January 1, 1979, by the “Société Nationale de Sidérurgie” (S.N.S) and the Danish group Christiani and Nielsen.

In 1982, COSIDER became a wholly-owned subsidiary of S.N.S following the latter's purchase of the Danish partner's shares.

As part of the organic restructuring of public enterprises decided by the Algerian authorities, Cosider was transformed in 1984 into a national company under the supervision of the Ministry of Heavy Industry

Thanks to the implementation of laws and economic reforms, including those relating to the autonomy of public enterprises in 1988, COSIDER was transformed into a joint-stock company in October 1989.

Cosider has created and exploited various opportunities that have enabled it to develop and expand its field of intervention to other activities beyond the construction and public works sector. Unlike its competitors on the local market, favored by its stability and entrepreneurial spirit, Cosider has committed to diversifying its business and client portfolios over the course of a decade.

Continuous evaluation, through internal growth, has made Cosider the largest Algerian construction group. Today, Cosider Groupe SPA, with a share capital of 17,800,000,000 DA, is organized into a group of companies holding 100% of the capital of ten (10) subsidiaries.

The Group ranks first in construction in Algeria and eleventh in Africa (according to Jeune Afrique).

This performance is the result of a keen sense of organization and rigor; it is also the result of a strong corporate culture that has brought together the best talents to build teams of highly motivated employees

3.1.2. Missions and activities:

COSIDER's activities are organized around 10 subsidiaries that handle:

- Pipelines: hydrocarbon transportation (oil pipelines, gas pipelines);
- Highway infrastructure, railway laying, airfields, maritime works, major engineering structures;
- Hydraulic dams, major transfers, water supply, sanitation and treatment:
- Housing: large housing complexes, promotional programs;
- Industrial construction and offices;
- Social infrastructure: hotels, hospitals, universities, sports complexes;
- Production and operation of aggregate quarries:
- Maintenance of public works machinery;
- Renovation of public works machinery components:
- Formwork manufacturing: for construction, metal framework, boiler making:
- Financing of promotional programs, housing sales:

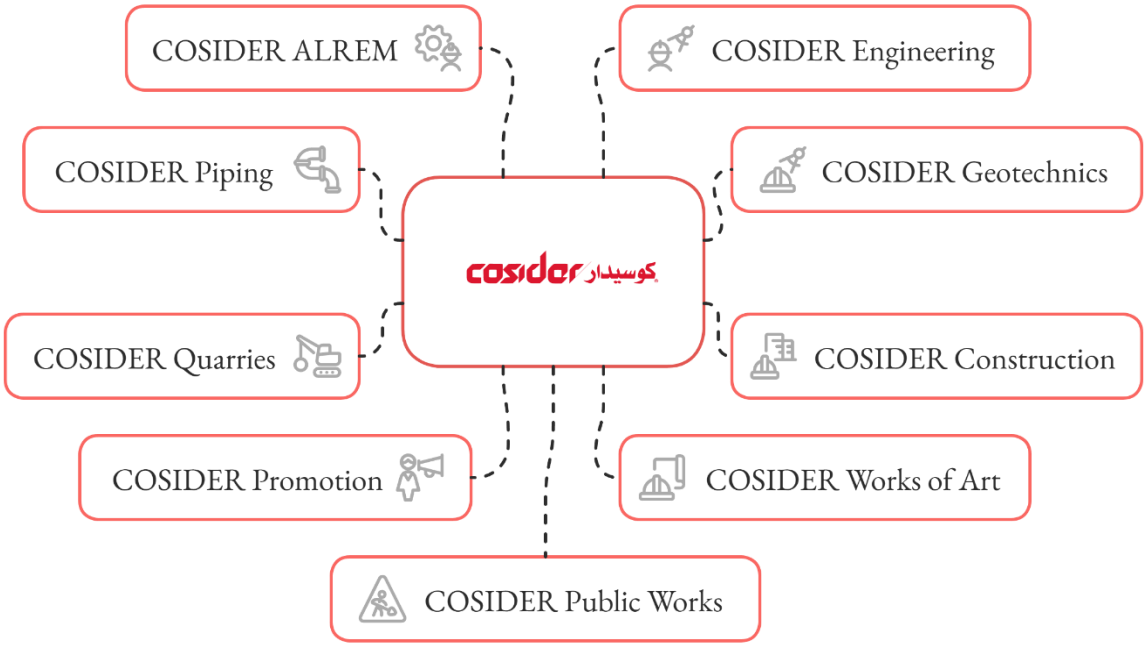
3.1.3. Significant achievements:

COSIDER has diversified its activities and gained experience by embarking on several projects.

- The largest number of dams built to date from all types of earth (compacted, arched concrete, etc.).
- The greatest track record in laying pipelines of all diameters for the transport of hydrocarbons.
- The largest number of road, rail, and hydraulic tunnels.
- The longest list of international-class airfield runways.
- The completion of major industrial civil engineering projects and engineering structures.
- One of the largest, if not the largest, construction capacity (formwork, tunnels).

All of this contributes to making COSIDER a powerful, diversified group, solidly integrated around its ten subsidiaries. These subsidiaries appear in the figure below:

Figure 21: Organizational chart representing the COSIDER group's sectors.



Source: organization intern document.

3.2.Presentation of the COSIDER Travaux Publics subsidiary:

Figure 22: Logo of the hosting organization.

Source: internal document provided by the organization.

COSIDER Travaux Publics, the undisputed leader in construction on the Algerian market thanks to the scale and quality of its projects, is a major works construction company with over forty (40) years of experience in mastering the construction of major public infrastructure projects. It now has to its credit a significant number of projects completed with recognized success, which it aims to maintain

Considered a joint-stock company, it now holds its title as the largest subsidiary of the COSIDER group with a share capital exceeding 4 billion DA. Its head office is located in Algiers, Cité Clément-Mohammedia-Algiers.

To strengthen its position, it is now relying on a sustainable development strategy by implementing a major recruitment program. To improve the professionalism of its employees, it is considering providing them with a career plan.

COSIDER TP intends to further elevate its leadership in the construction sector and contribute, alongside its clients, to further equipping the country with basic infrastructure, with the aim of investing in new niches requiring high technology for the sustainability and growth of its business.

As such, the search for new criteria and the improvement of existing performance criteria has always been a major concern, making it considered highly competitive nationally and far beyond, rivaling large-scale and world-renowned foreign companies in all areas, following the experience already acquired through partnerships.

The perfect match between the objectives and the means implemented has enabled the company to achieve criteria of excellence, judging by the results achieved, with an average growth of approximately 30%. This growth is linked to investments in of land, rail, maritime, airport, and underground infrastructure and transportation, but also through its ability to orient itself, organize itself, and adapt to the environments and quality/cost requirements of customers in the market

COSIDER TP obtained its quality certification in 2006 according to the international ISO standard. It maintains an up-to-date Integrated Management System (IMS), currently certified ISO 9001 version 2015, ISO 14001 version 2015, and OHSAS 18001 version 2007. Through this quality management certification, it aims to guarantee the reliability of its processes, ensure optimal safety for its employees given the quality of its activities and services, protect the environment, prevent personal injury and damage to the health of the company's workers, and improve the effectiveness of its Integrated Management System to make it an essential tool for progress.

COSIDER TP is organized into four (04) divisions, as follows:

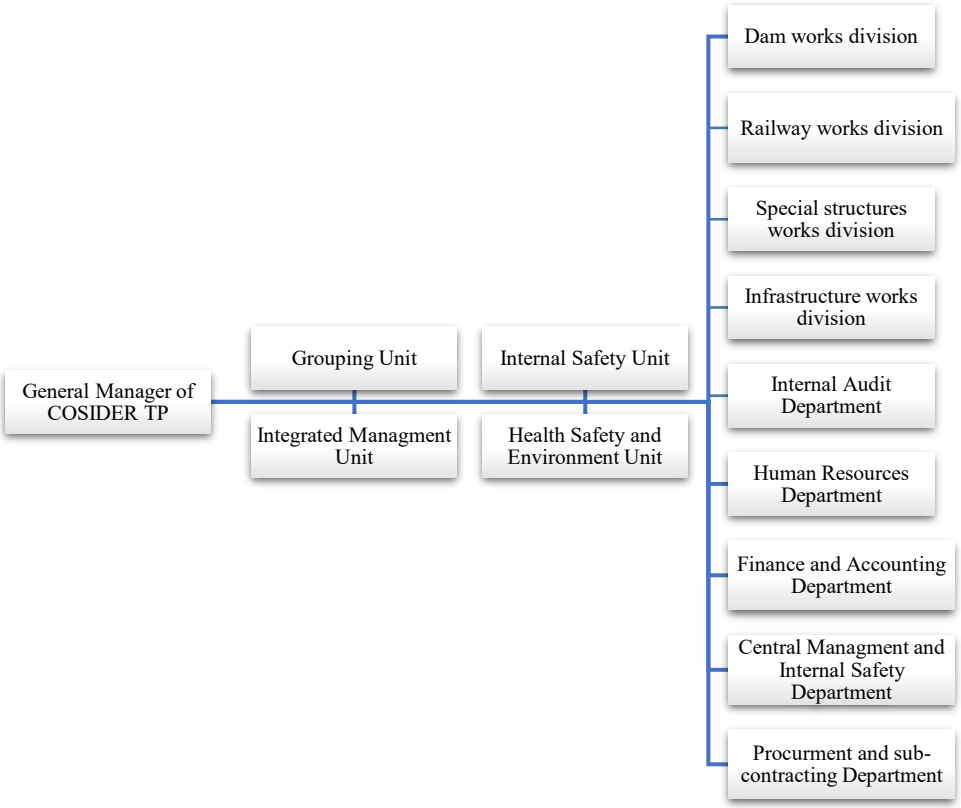
- **Infrastructure Works Division (DTI)**: responsible for the construction of roads, highways, railways, airfield runways, and engineering structures;
- **Special Works Division (DTOS):** responsible for the construction of underground and maritime structures;

- **Dam Works Division (DTB):** responsible for the construction of major hydraulic structures (dams and transfers);
- **Railway Works Division (DTF):** responsible for the preparation and execution of railway construction site work.

In addition to these divisions, there are two departments:

- Central Equipment Directorate (DCM) located in M'sila, which ensures the provision of construction equipment;
- Procurement and Subcontracting Department, which handles major procurement, and the establishment and monitoring of subcontracting relationships.

Figure 23: Organization chart of the COSIDER Travaux Publics subsidiary.



Source: Internal company document.

Among the various projects that COSIDER TP has to its credit, we are interested in the Special Works Division (DTOS), which is responsible for the construction of underground and maritime structures. There are several major projects currently underway, including the Algiers metro extension project: **"PROJECT: Algiers Metro, Line 1-Lot 2 Extension C1: Ain Naadja-Baraki"**, which will be the subject of our case study.

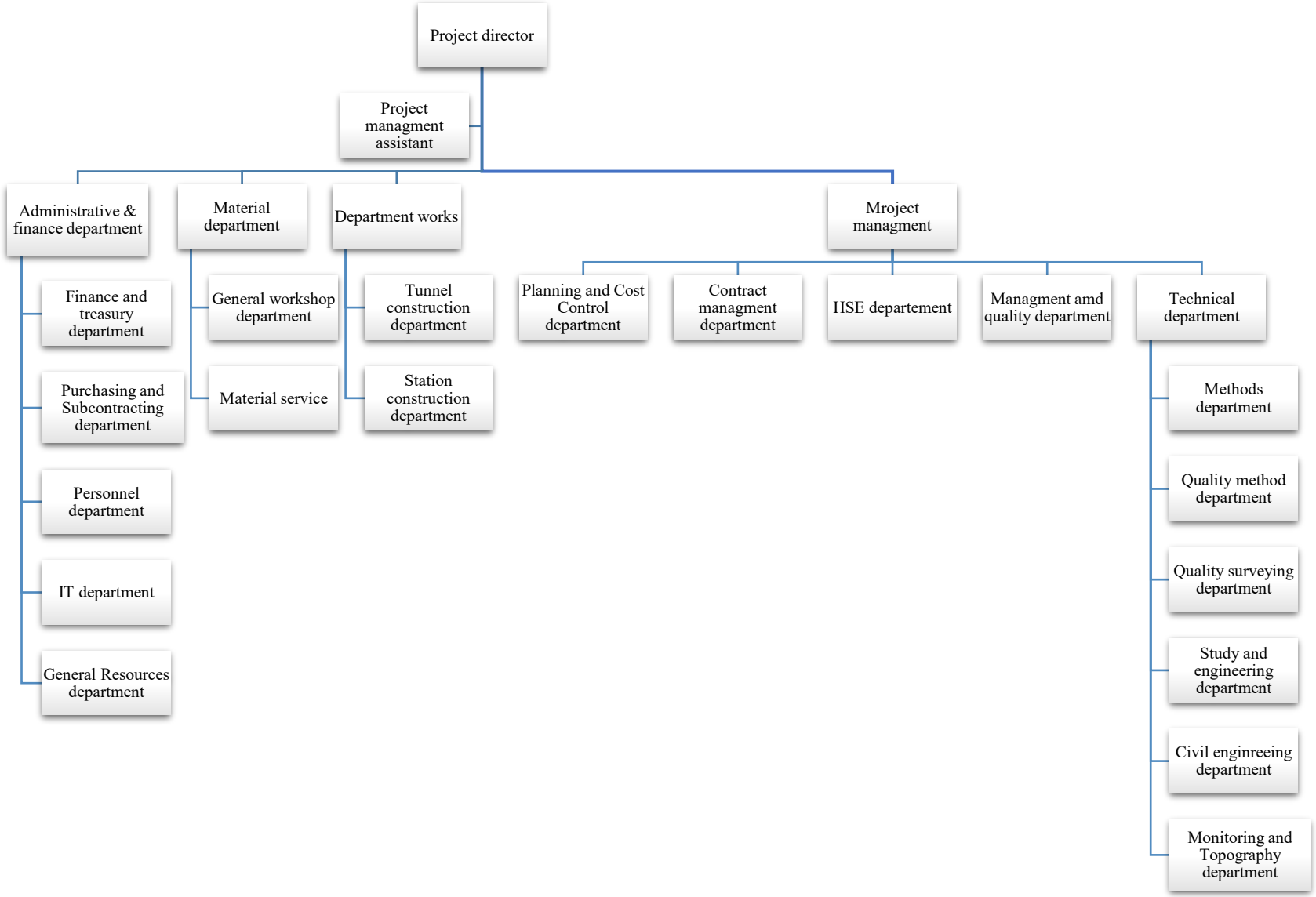
3.3.Presentation of the host organization “M29-COSIDER TP Project Management”:

In what follows, we will present the management of the M29 project, the main objectives of the project, those of the General Management through this project, as well as the various stakeholders involved.

3.3.1. Presentation of the project management:

After giving a brief presentation of the COSIDER Group and its public works subsidiary COSIDER TP, we will focus on one of its ongoing projects which is presented as the project for the extension of the Algiers metro, AIN NAADJA BARAKI section. Which will be presented under the initials “M29”. The M29 Project management team is part of the parent company COSIDER TP and is directly linked to the Special Works Division (DTOS). It is responsible for carrying out the work on the extension of line 1 lot 2 extension CI: AIN NAADJA BARAKI The project management team is structured as shown in the following:

Figure 24:Organizational Chart of COSIDER M29 Division.



Source: Internal Source company document.

The project is defined by the 6 km extension. It mainly consists of 6 stations and 8 sections and a viaduct connecting the Mohamed Boudiaf station to the Mohamed Belarbi station, which crosses the SNTF railway line, National Road No. 38 and Oued El Harrach at height. It includes two multimodal stations on the viaduct as follows:

A. Stations:

- Mohamed Boudiaf Station.
- Ain Naadja Gare Station.
- Future Pare Urbain Station, (This extension provides access to the center of Baraki and also allows a connection with the train at the Gué de Constantine Railway Station and the future intermodal station of this municipality.)
- Mohamed-Belarbi Station
- Jardin Station.
- Station city 2004.

The choice of station placement reflects the high population concentration (high population density areas) of the chosen places and cities. The objective of the latter is to streamline urban traffic for the development of transport in an overpopulated region of the capital.

B. Section:

a. Section D9 - Mine tunnel over 208.85 m from ventilation shaft No. 06 to ventilation shaft No. 07.

b. Section D10 - Ventilation shaft No. 07 and mine tunnels

- Subsection D10.1 Mine tunnel over 124.932 m going towards ventilation shaft No. 07.
- Subsection D10.2 Air extraction structure: ventilation shaft No. 07.
- Subsection D10.3 - Mine tunnel over 625.90 m between ventilation shaft No. 07
- and Mohamed Boudiaf station

c. Section D11 - Mohamed Boudiaf station over 146.50 m

d. Section D12 - Frame tunnel and special structure

- Subsection D12.1 Mine tunnel over 434.251 m
- Subsection D12.2 - Open-pit tunnel over 99.817 m
- Subsection D12.3-Special structure with ramp between walls over 63 m

e. Section D13-El-Harrach viaduct and AIN NAADJA Gare station

- Subsection D13.1-El-Harrach viaduct over 1537.50 m
- Subsection D13.2-AIN NAADJA Gare station over 115 m
- Subsection D13.3-Future Urban Park station over 115 m

f. Section D14-Transition structures and frame tunnel

- Subsection D14.1 Reinforced embankments over a length of 64.25 m
- Subsection D14.2-Ramp between walls over a length of 180 m
- Subsection D14.3-Open-cut tunnel over a length of 59 m

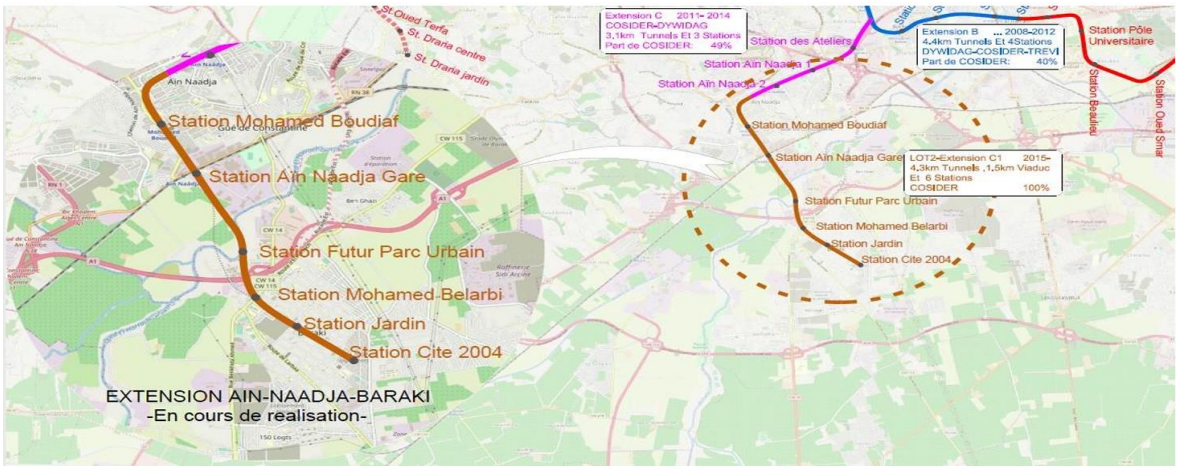
g. Section D15-Ventilation shaft no. 08 and mine tunnels

- Subsection D15.1-Air extraction structure ventilation shaft No. 08 with an
- average depth of 12 m
- Subsection D15.2 Open-cast tunnel over a length of 82.3 m
- Subsection D15.3-Mined tunnel over a length of 175 m
- Subsection D15.4-Open-cast tunnel over a length of 92.27

h. Section D16-Mohamed Belarbi station over 127.2 m.

The tunnels are made by digging the attack shafts and branches (PV6 and PV7), using the Austrian N.A.T.M. (New Austrian Tunnelling Method).

Figure 25: Route of the C1 extension of the Algiers metro: Ain Naadja – Baraki.



Source: Internal company document

3.3.2. Number of employees and management rate:

Table 15: Number of employees and management rate.

Category	Number	Management rate
Executive	137	14.74 %
Supervisory	531	57.15 %
Execution	261	28.09 %

Source: Internal company document.

3.3.3. M29 objectives:

The project has various objectives such as:

- Meet travel needs in the capital: The project will streamline densely populated regions and thus allow people in the region to benefit from an additional transport service;
- Comply with the development plan for the capital, ALGIERS;
- Create an efficient connection with the existing public transport network (tram and road transport);
- Minimize the impact on the environment, particularly on geographical conditions;
- Solve the problem of urban traffic congestion and the balanced development of the urban areas concerned.

3.3.4. COSIDER TP's objectives through the implementation of the M29 project:

The implementation of this project to extend Line 1 of the Algiers metro represents an opportunity for COSIDER Group and COSIDER Travaux Publics in particular to distinguish themselves from local and foreign competition in Algeria.

The main goal is to maintain its brand image as a leading construction company in Algeria by adding to its history a highly strategic achievement for the country, which will allow it to prospect for international tenders with the experience of more than 20 years it will have acquired.

Given the importance of this project, COSIDER, through this latest project, plans to develop its training policy regarding its technical skills.

The scale of the project and the size of the company offer COSIDER the opportunity to take advantage of major raw material acquisitions for the completion of the work. Its main

objective through the completion of this project remains, however, to increase its capital through the profits estimated at 12% that it will achieve

This is already beginning to be confirmed. Since the Oran metro project was publicly entrusted to the company in October 2017, for possible implementation, which will begin in the coming year.

3.3.5. Project Stakeholders:

To carry out the Algiers metro extension project, three participating parties must be designated. These include the project owner, representing the end client of the project, having felt the need, the Ministry of Transport; the delegated project owner, EMA, who takes responsibility for the project; and the project manager, representing the SAETI EUROSTUDIOS DONG MYEONG consortium, which responded to the EMA call for tenders to monitor and oversee the work of the project's contractor, COSIDER Travaux Publics. This section will present all of these stakeholders.

A. The project owner, Ministry of Transport:

The central organization of the Ministry of Transport comprises eight directorates, two of which are specifically responsible for land transport. Its mission is to plan urban transport infrastructure, propose elements of national transport policy, and ensure better implementation of various operations. It develops projects, launches studies and implementation on behalf of the State, and designates companies to sponsor the projects. For this project, the Ministry of Transport has designated the ALGER Metro Company to carry out the extension of the metro line.

B. The delegated project owner "Alger Metro Company (EMA)":

Created in 1984 as the delegated project owner of the Ministry of Transport to carry out the studies, construction, and operation of an underground and surface passenger transport network known as METRO D'ALGER; the EMA is represented as the main client of COSIDER M29

Since its transformation in 1989 into a public economic enterprise, a joint-stock company with a capital of 380,000,000 DA, the EMA has embarked on the development of research and engineering capabilities in transport and the creation of traffic plans through the creation of an Urban Transport Research Office (BETUR), which became a wholly-owned subsidiary of the EMA in 2011.

Its main mission in the project is:

- To fulfill the role of delegated project manager for the Ministry of Transport and to conduct the monitoring operation and make strategic decisions related to project launches:
- Defining the project study framework and setting programs:
- Establishing the organizational principles of the operation and defining the roles of the various operators;
- To ensure monitoring of regulations related in particular to the safety plan.

C. The project manager "SAETI-EUROSTUDIOS-DONG MYEONG":

The EMA, to ensure the proper completion of the work and its compliance with international standards, launched a national and international call for tenders. A foreign-Algerian consortium (SAETI EUROSTUDIOS DONG MYEONG), consisting of an Algerian, Spanish, and Korean company, responded to the call and subsequently set up offices within several construction sites and the general management for better control and proximity.

- DONG MYEONG: South Korean design office:
- SAETI: one of the few design and engineering firms specializing in infrastructure studies and land use planning;
- EUROSTUDIOS: Spanish engineering firm ensuring technological monitoring, proposing solutions for achieving productivity gains, reducing deadlines and costs

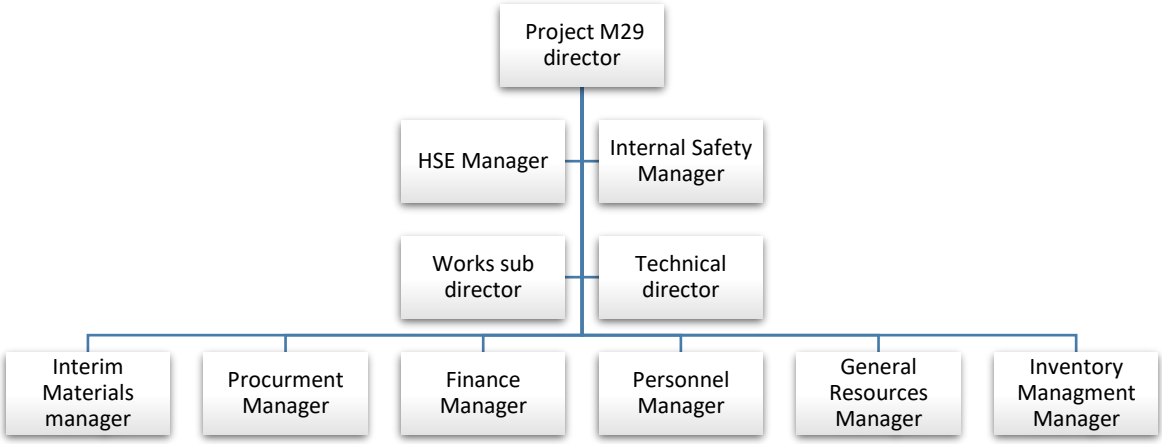
The group called project management has the objectives of monitoring non-compliance, defining the work, accepting the work, signing attachments, and HSE control. The main objective is to manage the scheduling, planning, and coordination of various tasks. The agreement with COSIDER M29 is therefore mandatory.

The importance of this project and its weight in the Algerian economy reflect the mobilization of a large number of human, material, and financial resources for COSIDER TP. The organization it will put in place should be highly efficient in the control of this project, the need for success of which is very high.

3.3.6. Structural Organization of the M29 Project:

The structural organization of Cosider TP Project M29, illustrated by the organizational chart, allows us to identify the different organizational structures as well as the hierarchical dependency relationships within the organization.

Figure 26: Project M29 organigramme.



Source: Internal company document.

The M29 project is under the responsibility of a project director who will lead a team of four assistant directors responsible for the following departments: HSE, internal security, works, and the technical component, and will oversee six sections: equipment, procurement, finance, personnel, general resources, and finally, inventory management.

This chapter outlined the qualitative methodology used to explore how Agile Project Management (APM) principles can improve risk management practices at Cosider's Project M29. Based on an interpretivist approach, data was collected through interviews and analyzed with NVivo. A conceptual framework was developed, linking selected Agile principles to the five stages of the PMI Risk Management Standard (2019). This framework will serve as the basis for comparing theoretical insights with field results in the next chapter.

CHAPTER III: Results and Discussion

This chapter presents and discusses the key findings derived from the qualitative analysis of eight semi-structured interviews conducted with employees involved in Cosider's Project M29, the Algiers Metro expansion. The objective is to assess how Agile Project Management (APM) principles could contribute to improving existing risk management practices in a large infrastructure project. The results are structured around three core themes that emerged from the coding and analysis of the data using NVivo 15:

- Current risk management practices;
- Perception and understanding of Agile principles;
- The potential contribution of Agile to risk management.

These findings are interpreted in light of the conceptual framework developed in Chapter II, particularly the mapping matrix linking selected Agile principles of Agile manifesto (2001) to PMI's risk management process (2019).

Section One: Presentation of results

The results will be presented and analyzed sequentially by theme, as will be presented below:

1.1.Theme One: Current risk management practices;

We extracted and analyzed the eight interviews with predefined interviewees as been discussed in the previous chapter and **(Appendix B)** demonstrate what we got as an interview response; the following table will illustrate what we've we found after the analyzing the interviews:

Table 16: Synthesis of Findings from Interviews of the **first theme**.

Interviewee	Main Practice Observed	Risk Identification	Tools Used	Frequency	Collaboration Level
INTR 1	Multidisciplinary risk planning	Matrix, Categorization	VRP, ISO 45001	Annual	High (within teams)
INTR 2	Continuous reevaluation	Context analysis	Informal	Daily	Low (HSE dependent)
INTR 3	Site-based observation	Visual identification	Situational	Real-time	Medium (HSE & QC)
INTR 4	Documented analysis	Structured methodology	5M, Action plans	Mixed	High (All departments)
INTR 5	Multi-source detection	Feedback, interviews	Internal Security Plan	Event-driven	High (stakeholders)
INTR 6	Centralized tracking	Context tables	Analysis table	Weekly/Monthly	Medium
INTR 7	Digital planning tools	Monitoring platforms	Reports, Logs	Weekly	Medium
INTR 8	Structured procedure	Thermal matrix	Planning documents	Continuous	High (users' input)

Source: Illustrated by the authors.

Analytical Commentary on Risk Management Practices:

a. **Diversity in Practices:** The responses show a wide variation in how risk is identified and addressed. While some teams follow formal methodologies (INTR 1, 4, 8), others rely on informal or reactive practices (INTR 2, 3). This reflects a lack of standardization, which may hinder knowledge transfer and scaling of effective practices across project teams.

b. **Use of Tools:** A significant number reference structured tools like context analysis, thermal matrices, and action plans. However, VRP and ISO 45001 appear central in formalized contexts (INTR 1, 4, 8), while others indicate ad hoc or observational approaches.

c. **Frequency of Risk Review**: There is inconsistency in how often risks are reviewed from real-time observation (INTR 3) to annual reassessment (INTR 1), indicating varying degrees of maturity and agility in risk practices.

d. **Collaboration and Communication:** Stronger risk practices appear linked to interdepartmental collaboration (INTR 4, 5, 8), which helps diversify input and promote shared responsibility in risk assessment.

e. **Gap in Agility:** Although some interviewees mention continuous monitoring and adaptive updates, none explicitly link their practice to Agile principles like iterative cycles, team empowerment, or customer responsiveness. This confirms the absence of Agile integration in current risk management and thus supports the objective of your dissertation: exploring how Agile could enhance or reshape these practices.

Furthermore, we opt the Word Cloud that been offered by NVivo for visualization for more deepen understanding. The following word cloud represents the first theme:

Figure 27: Word Cloud of the interviews of the **first theme**.

Source: Illustrated by the authors by utilizing NVivo Software.

The word cloud highlights certain words that been repeated by the interviewers such as “Risks”, “project”, “identify”, “action”, “context”, “process”, “follow”, “management”, “evaluation”. This word cloud paints a clear picture of how risk management is approached at Cosider structured, methodical, and deeply process-driven. The notability of “risks” confirms that identifying potential issues is at the core of operations, while words like “identify”, “evaluation” and “action” reflect a logical progression from detection to resolution. The inclusion of “project” and “context” suggests a reliance on established tools such as risk matrices and context analysis, shaping how teams navigate uncertainties. This highlights the strong emphasis on formal processes and documentation within the current risk management system. While this structured approach ensures consistency, the absence of dynamic or collaborative elements such as feedback, learning, and teamwork suggests limited agility in addressing evolving risks.

1.2.Theme Two: Perception and understanding of Agile principles;

The **Third Appendix** will elaborate the final results of the interviews concerning the second theme. And for the findings the table below explains it:

Table 17: Synthesis of Findings from Interviews of the **second theme.**

Interviewee	Awareness of Agile	Planning & Iterations	Communication Practices	Autonomy & Decision-Making	Risk Responsiveness
INTR 1	Unfamiliar with term, applies principles intuitively	Regular reviews	Multichannel (verbal, written, digital)	High autonomy	Strong adaptive responses
INTR 2	Agile term unknown, intuitive practices used	Monthly reports, daily briefings	Cross-functional coordination	Encourages team autonomy	Enhances coordination
INTR 3	Not familiar with term, recognizes principles	Annual planning	Emphasizes team communication	Supports self-management	Problem-solving in real-time
INTR 4	Agile spirit acknowledged without formal knowledge	Weekly/monthly cycles, site journal	High feedback frequency	Strong departmental autonomy	Rapid response, team-based
INTR 5	Aware of Agile as a methodology	Advised for well-known risks only	Emphasizes collaboration	Autonomy required for surprise risks	Agile suitable for high uncertainty
INTR 6	Agile term new, practice familiar	Weekly reflection with planning teams	Close coordination improves reactivity	Decentralized responsibility	Fast identification & resolution
INTR 7	Unaware of Agile, accepts planning flexibility	Modifiable planning cycles	Structured meetings + ad-hoc reviews	Mixed autonomy	One-off risk assessment
INTR 8	Flexibility strongly valued	Weekly/monthly planning	Stakeholder-involved meetings	Encourages local decision-making	Improves risk handling in complexity

Source: Illustrated by the authors.

Analytical Commentary on Agile Practices:

a. **Agile by Practice, Not by Name:** While most participants do not explicitly refer to their approach as "Agile," many cores Agile principles such as adaptability, team empowerment, and iterative planning are embedded in their daily routines.

b. **Planning and Iteration:** Weekly and monthly planning cycles are common across interviews. Respondents recognize the importance of frequent updates and flexible planning to address emerging risks and project delays (INTR 4, 6, 8).

c. **Communication as a Pillar:** Every interviewee emphasized the central role of communication in project success. This aligns with Agile's emphasis on face-to-face interactions, transparency, and collaboration. Briefings, email exchanges, and site meetings help maintain visibility and responsiveness in risk management (INTR 1, 2, 4, 6).

d. **Decentralized Decision-Making:** Many participants described a structure where team leads and project staff have the autonomy to make decisions without waiting for centralized approval (INTR 1, 4, 5, 8). This reflects Agile's focus on empowered teams and rapid decision-making, essential for managing dynamic risks in large infrastructure projects.

e. **Practical Alignment with Agile Principles:** Although formal Agile terminology is unfamiliar, interviewees demonstrate alignment with six key Agile principles including customer collaboration, responsiveness to change, self-organizing teams, frequent delivery, direct communication, and simplicity.

f. **Implication for the Study:** These findings reinforce the relevance and feasibility of introducing Agile Project Management (APM) principles to enhance risk management at Cosider. The presence of informal Agile behaviors suggests that structured Agile integration could build upon existing practices, leading to more efficient and adaptable risk strategies.

Lately, we visualized the interview responses for more responses and the findings we're:

Figure 28: Word Cloud of the interviews of the **second theme**.

Source: Visualization by NVivo.

The word visualization that been provided, highlight a various word that been frequently repeated such: Risks, project, helps, manage, autonomy, department, communication, team, decision, meetings. This word cloud highlights a shift toward human-centric and collaborative practices in risk management discussions. The prominence of terms like “autonomy”, “team”, “communication”, and “decision” aligns with Agile values, emphasizing team empowerment, rapid decision-making, and iterative communication. Additionally, the presence of “helps” and “manage” alongside “risks” suggests that interviewees already recognize Agile-inspired behaviors in their workflows, even if they are not formally structured under an Agile framework. This reinforces the idea that Agile methodologies could be seamlessly integrated. This reinforces the relevance and applicability of Agile Project Management (APM) principles within the current operational framework. Despite the absence of formal adoption, interviewees acknowledge how Agile-inspired practices enhance coordination, improve responsiveness, and support more effective risk management.

1.3.Theme Three: The potential contribution of Agile to risk management;

Appendix D will demonstrate the responses that we collected by the interviews and the result after analyzing it were as following:

Table 18: Synthesis of Findings from Interviews of the **third theme.**

Interviewee	Identified Issues	Suggested Improvements	Openness to Change	Agile Compatibility
INTR 1	Perceived HSE resistance; lack of empowerment	Empowering non-supervisory staff	Favors new approaches	Supports integration into CMI
INTR 2	Miscoordination across departments	Internal/external awareness; access systems	Supports continuous improvement	Positive about flexibility
INTR 3	Adequate supervision, but needs better knowledge sharing	Awareness and inter-team communication	Open to new approaches	Values communication culture
INTR 4	Managers' inability to detect risks; rigid structures	More collaboration; autonomy; daily evaluation	Strong support for Agile	Wants integration into project management culture
INTR 5	Risk of burnout; loyalty gaps	Specialization; transparent collaboration	Positive toward dynamic models	Acknowledges training needs
INTR 6	No major issues but room for training improvement	Enhance quality control and collaboration	Very open to innovation	Agile considered compatible
INTR 7	Problems external to company; response delays	Immediate reporting; training in tools	Welcomes innovation	Supports tool-based visibility
INTR 8	Lack of formalization; weak anticipation	Understanding project context; data-based insights	Supports agile practices	Stresses cultural change

Source: Illustrated by the authors.

Analytical Commentary on Agile Integration in Risk Management:

a. **Willingness for Change & Innovation:** Interviewees demonstrated openness to new risk management approaches, acknowledging the need for evolving practices. This creates a

favorable environment for introducing Agile Project Management principles as part of ongoing improvement (INTR 1, 2, 4, 5, 8).

b. **Collaboration and Communication:** A lack of coordination and information sharing was cited as a challenge, potentially hindering risk detection and mitigation (INTR 2, 3, 8). Agile promotes cross-functional collaboration, transparency, and iterative learning, which could address these shortcomings.

c. **Structural and Cultural Barriers:** Some participants noted rigid hierarchies and independent departmental structures (INTR 1, 4, 8). Agile emphasizes team empowerment and decentralization, providing a framework to reduce silos and encourage shared responsibility.

d. **Training and Capability Gaps:** Several respondents (INTR 5, 6, 7) identified upskilling needs, particularly in technical and risk-related tools. Agile principles such as continuous learning and team retrospectives could support skill development and institutional improvement.

e. **Strategic Integration:** A few participants proposed directly linking Agile practices with integrated systems and central decision-making bodies (e.g., CMI) (INTR 1, 4). This suggests potential scalability and alignment if Agile were to be formally adopted within the organization.

f. **Implication for the Study:** Findings indicate that while existing risk management practices have structure, there is a strong readiness for more adaptive, collaborative, and iterative approaches. This reinforces the relevance of Agile methodologies in enhancing risk management efficiency and flexibility.

Furthermore, we using the word cloud as supporting our conducted result and for the last theme we treated the cloud will be:

Figure 29: Word Cloud of the interviews of the **third theme**.

Source: Illustrated by the authors using NVivo.

This word cloud represents most common word between the interviewers concerning the last theme, and it put it in focus words like: Risk, management, better, collaboration, introduction, company, people, problems, practices, continuous. This word cloud reflects a forward-thinking perspective on risk management and organizational practices. The notability of “better”, “collaboration”, “introduction”, and “practices” suggests a willingness to embrace change and formally integrate Agile-inspired improvements. Additionally, the presence of “people” and “problems” indicates an awareness of operational challenges and the human dynamics involved in change resistance. This highlights the importance of addressing both technical and cultural barriers when implementing new methodologies. The term “continuous” aligns with Agile’s commitment to ongoing refinement and adaptability, reinforcing the value of iterative improvement in making risk management more effective and responsive. These findings provide strong validation for our study objectives. The frequency of terms related to change, agility, and improvement suggests a clear organizational readiness for adopting a more dynamic and flexible risk management approach. This embracement aligns well with Agile methodologies, reinforcing the feasibility of integrating iterative, collaborative, and adaptive strategies into current risk management practices.

Section Two: Discussion

This section examines the relationship between the proposed conceptual framework particularly the mapping matrix and insights obtained through field interviews conducted at Cosider’s Project M29. By integrating real-world perceptions, practices, and expressed needs, this analysis seeks to validate, refine, or challenge the initial theoretical assumptions regarding the contribution of Agile Project Management (APM) principles to risk management enhancement.

Validating the Conceptual Framework Through Field Evidence

The mapping matrix initially developed within our conceptual framework proposed that six key Agile Project Management principles (Principles 1, 3, 6, 7, 11, 12) could significantly improve five core risk management practices as defined in the PMI 2019 Risk Standard:

- Risk identification
- Qualitative and quantitative risk analysis
- Risk response strategy development
- Implementation of responses
- Ongoing risk monitoring

Findings from the field interviews strongly corroborate the relevance of these principles:

- **Principle 1: Customer Satisfaction Through Early and Continuous Delivery** Interviewees consistently highlighted the importance of frequent stakeholder communication and iterative planning to mitigate unforeseen risks. Regular update meetings and informal review cycles demonstrated a proactive approach to monitoring risks and adjusting strategies accordingly.
- **Principle 3: Deliver Working Software Frequently (Short Iterations)** Although the term "iteration" was not explicitly used, weekly and monthly reassessments, as described by several participants, reflect an underlying agile mindset. This approach fosters responsiveness in risk identification and facilitates rapid mitigation.
- **Principle 6: Close, Daily Cooperation Between Business People and Developers** Respondents emphasized the role of daily briefings and cross-functional collaboration in improving risk awareness. Such interactions help dismantle organizational silos, thereby strengthening both risk identification and qualitative analysis.
- **Principle 7: Working Software as the Primary Measure of Progress** Teams consistently rely on visible progress monitoring, tangible deliverables, and real-time feedback to anchor their risk assessments in observable outcomes. This approach enhances the basis for risk response strategies.
- **Principle 11: Regular Reflection on How to Become More Effective** Participants acknowledged that informal retrospective analyses of incidents and delays are frequently undertaken. These learning loops align closely with risk monitoring and continuous improvement processes.

- **Principle 12: Self-Organizing Teams Tend to Produce the Best Results** Multiple interviewees cited autonomy and delegated decision-making as key enablers of rapid risk responses. This decentralized decision-making framework accelerates response implementation, reducing bureaucratic delays.

Thus, the mapping matrix is strongly validated by empirical data, confirming that key Agile principles despite not being formally structured already resonate with existing informal practices. A more deliberate and systematic integration of these principles could address current structural gaps while reinforcing organically emerging behaviors.

Enhancing Agile Principles for Strengthened Risk Management

The analysis indicates that Cosider teams inherently apply Agile-compatible behaviors in their risk-related workflows, albeit in a fragmented or intuitive manner. This suggests a favorable organizational maturity level for Agile adoption.

Agile principles contribute to risk management improvement in the following ways:

- **Accelerated risk response** due to decentralized decision-making (Principle 12)
- **Enhanced visibility and issue anticipation** through continuous feedback mechanisms (Principles 3 and 6)
- **Improved communication and collaboration**, reducing gaps in information handoffs (Principle 6)
- **Continuous learning**, refining and updating risk registers and matrices (Principle 11)

What emerges as particularly compelling is the field-based affirmation that these behaviors do more than complement traditional risk management practices they transform the approach to uncertainty into an adaptive, iterative model.

Identifying Gaps and Opportunities for Agile Integration

Despite these encouraging alignments, several key gaps both structural and cultural were identified:

- **Lack of formal iteration planning and retrospectives** Although short-cycle reviews exist, they lack structure and documentation. Introducing lightweight Agile ceremonies, such as sprint reviews or retrospectives, could strengthen monitoring and learning loops.

- **Uneven empowerment across departments** While some teams operate autonomously, others remain reliant on top-down decision-making. Training programs on self-organized team dynamics and role alignment could enhance agility in risk responses.
- **Limited integration of customer and stakeholder feedback in risk processes** While internal collaboration is strong, external stakeholder engagement remains underutilized. Systematic application of Principle 1 would ensure that risk management decisions better reflect real-world constraints.
- **Absence of a formalized Agile framework** the lack of a cohesive structure limits the effectiveness of current risk management efforts. Developing a tailored Agile Risk Management system would provide governance while leveraging the existing cultural fit.

In summary, the Agile principles outlined in the mapping matrix do not necessitate radical organizational change. Instead, they require a structured alignment of existing informal practices into a cohesive risk governance framework. Cosider already embodies an “Agile spirit” the next step is to formalize and systematize this agility into a sustainable model.

This chapter synthesized the empirical findings of our qualitative research, aligning them with the conceptual framework established in Chapter 2. Through the analysis of eight semi-structured interviews structured under three thematic axes, a strong congruence emerged between APM principles and existing risk management practices within Cosider’s Project M29. The mapping matrix proved instrumental in validating the informal adoption of Agile principles such as continuous communication, collaborative decision-making, and incremental planning despite the absence of a formal Agile framework.

The discussion underscored Agile’s role in strengthening risk identification, response planning, and mitigation strategies while highlighting key areas for improvement, including strategic alignment and formalized Agile training. These insights reinforce the potential of Agile risk management in infrastructure projects such as metro expansion, laying the groundwork for a structured implementation roadmap.

CONCLUSION

This dissertation set out to explore how Agile Project Management (APM) principles could contribute to improving risk management practices within infrastructure projects, using Cosider's Metro Expansion Project M29 as a case study. Faced with complex and evolving risks, public works and infrastructure projects often suffer from rigid planning and slow adaptability. Our research responded to this issue by proposing a more flexible, responsive approach grounded in Agile principles.

Through a detailed literature review, we established that traditional risk management frameworks though structured sometimes fall short in addressing emergent risks in dynamic environments. Agile Project Management, rooted in adaptability, continuous feedback, and iterative planning, offers a potential alternative or complement to these conventional methods. We selected six principles from the Agile Manifesto that align best with infrastructure realities, such as continuous communication, team empowerment, customer collaboration, and iterative progress tracking.

A conceptual framework was developed by mapping these six Agile principles to the five key phases of the PMI (2019) Risk Management Standard. This matrix formed the backbone of our theoretical proposition, guiding our fieldwork and analysis.

To test and validate the conceptual framework, a qualitative methodology was adopted. Eight semi-structured interviews were conducted with key stakeholders from Cosider, followed by thematic analysis using NVivo. The findings confirmed that while Agile is not explicitly applied at Cosider, many of its practices such as collaborative decision-making, flexible communication, and iterative planning are already informally integrated.

By comparing our interview results to the mapping matrix, we validated the relevance of Agile principles in improving risk identification, response planning, and monitoring. Moreover, we identified gaps in autonomy, formalization, and proactive stakeholder engagement offering clear opportunities for Agile integration.

Ultimately, the study confirms that Agile principles can enhance, and in some aspects, transform, how risk is managed in infrastructure projects. Rather than replacing current practices, Agile complements them by fostering continuous responsiveness, human-centered decision-making, and collective accountability. The outcome is not only more robust risk mitigation but a stronger organizational learning culture and greater project adaptability.

Recommendations:

- **Formalize Agile Awareness**: Cosider should initiate training to formally integrate Agile thinking within project teams.
- **Pilot Agile Risk Modules**: Test the proposed mapping matrix in a pilot project phase to measure feasibility and impact.
- **Foster Collaborative Risk Reviews**: Institutionalize short, frequent review sessions with cross-functional teams to identify and respond to risks.
- **Empower Decision-Makers**: Promote autonomy at the operational level to act quickly on emerging threats, reducing escalation time.
- **Digital Tools**: Invest in simple digital platforms to enhance traceability and visibility of iterative risk responses.

Perspectives and Future Outlook:

Looking forward, this study opens the door for further research and operational experimentation. It would be beneficial for Cosider and similar infrastructure companies to:

- Pilot a formal Agile Risk Management model, using the mapping matrix developed in this research as a baseline.
- Train teams on Agile principles that are most aligned with project-based risk management needs.
- Introduce tools and routines (e.g., stand-up meetings, retrospectives, risk boards) to reinforce agility in practice.
- Explore hybrid frameworks combining conventional and Agile methodologies to suit the complexity and scale of public infrastructure projects.
- Conduct longitudinal studies to evaluate the performance of Agile integration over time and in different project phases.

The conceptual framework proposed in this dissertation serves not only as a research contribution but also as a practical roadmap for organizations aiming to improve their resilience and adaptability through Agile Risk Management.

Limitations and Future Research:

This study focused on a single infrastructure project in Algeria, with a limited sample of interviewees. Future research could expand the scope to multiple projects or conduct longitudinal studies to observe Agile integration over time. Quantitative analysis could also complement qualitative insights to measure the impact of Agile on cost, time, and risk metrics.

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Appendix A: Interview guide.

INTRODUCTION TO INTERVIEWEE:

Hello, and thank you for participating in this interview. I'm conducting a master's dissertation to explore how Agile Project Management (APM) principles could improve current risk management practices in infrastructure projects specifically through the case of Cosider's Project M29. Your professional insight is essential to this qualitative research. The data will be kept confidential and used strictly for academic purposes.

المدرسة الوطنية العليا للمناجمنت École Nationale Supérieure de Management	**Interview guide**	cosider Travaux Publics كوسيدار
Topic: **"**Assessing How Agile Project Management Could Improve Risk Management practices**"**. **Case study:** Cosider public works, M29 Project.		
Interviewer:	**Date:**	
Time:		
THEME 1: Current Risk Management Practices		
1. Can you briefly describe your role in Project M29 or similar projects at Cosider? **2.** How are risks usually identified and documented in your projects? **3.** Which tools or techniques do you use to analyze and prioritize risks? **4.** How are risk response strategies chosen and applied? **5.** How often are risks monitored and reassessed during the project lifecycle? **6.** To what extent do different teams or departments contribute to risk identification or prevention?		
THEME 2: Perception and Relevance of Agile Principles		
7. Are you familiar with the Agile mindset or any Agile practices? **8.** Do you believe that short, iterative cycles (e.g., weekly or monthly planning) could help in managing project risks more effectively? **9.** Would regular reflection sessions or reviews help improve your risk response process?		

10. Do you think closer communication (e.g., daily check-ins) between teams and stakeholders would improve risk visibility or coordination? **11.** Could giving teams more autonomy and flexibility help in dealing with unexpected risks more efficiently?
THEME 3: Opportunities for Improvement & Change
12. What challenges or gaps have you observed in Cosider's current risk management practices? **13.** In your opinion, which practices (Agile-inspired or not) could improve risk anticipation and reaction? **14.** Would you support introducing new, more dynamic risk approaches (like those inspired by Agile)? Why or why not? **15.** If you had the opportunity to enhance Cosider's risk management system, what key changes would you propose?

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APPENDIX B: Framework Matrix of the **first theme**.

	Interview 1	Interview 2	Interview 3	Interview 4	Interview 5	Interview 6	Interview 7	Interview 8
Theme One	We have a procedure for identifying the risks, we generally use, the VRP evaluation of the occupational risks at the same time we do the significant environmental aspects, we identify the hazards we will evaluate the risks then we prioritize the risks, we make an action plan to eliminate this risk We have a documentary system at the level of Cosider, we have the management unit integrated at the level of Cosider TP, it is it that develops the authentication and evaluation procedures, it disseminates it at the project level for the application, we have opted for the VRP through the risk assessment matrix First of all, we create at the project level a more disciplinary group which contains staff supervising: Responsible he has a team under his responsibility and not supervised: as a safety officer, secondly we divide the project into work units such as: the generator, the circulation air, the central store, the laboratory, then we identify the hazards for all the work units after we do the risk assessment through	we have a whole process of identifying risks, through context analysis. through context analysis There are no strategies to follow, but through the process of analyzing the risks and identifying what we can deal with the risks more effectively This is all the time we have to monitor and re-evaluate each step and phase of the project with the team concerned on a daily basis. It's not our department, it's much more HSE service and service management	We observe the risks on site, The visual side, and in the concrete architecture and civil engineering side, there are more techniques to analyze the risks.There is no standard strategy to be applied, it is according to the riskThrough a quality control engineer and an HSE engineer that they will be on site, it is up to them to identify the current risks.Each element or person who is on site it is supposed to identify and declare the risk that appears	Risks are identified through the development of the project context analysis, inspections and audits (internal/external) in collaboration with all project departments. Risk documentation is carried out through internal documents that track each risk from its identification to its resolution and closures Context analysis is our main tool for analysis. In well-defined steps: Hazard identified Spring Natures Identification of the 5M Processing (correction/corrective action/improvement action/deviation) Follow-up of the actions carried out Fences Risks are monitored through well-defined action plans with an appropriate frequency (daily, weekly, monthly, half-yearly and annually) depending on the	Threat identification is carried out through several pathways:FeedbackThe security data that can be collected from the services concerned by crime and malicious actsQuestionnaires that can be carried out with the populationBooks and Specialized PublicationsManagement tools (Ichikawa, brainstorming... etc.)Their documentation is done through the development of an Internal Security Plan (ISP)In order to analyze and prioritize the risks arising from the identified threats, a qualitative approach and feedback from the sector were usedThrough interviews with the managers of the various critical structures and/or processes and/or the different services of the project, the threat categories were examined through the development of a questionnaire.response strategies are taken after consultation and debate with stakeholders to see the best ways to deal with any eventualitythe safety risks are reassessed from	Risks can be identified when the problem or risk occurrence through awareness-raising and doing the context analysis also through collaboration with interested parties where risks can be identified We have a whole table in the context analysis and risk analysis table, we group all the risks of all the services we put them in a table designated the risk, the degree of risk, the person in charge who must take action to reduce the risk We group all the risks of all the services, we put them in a table to designate the risk, the degree of risk, the person in charge who must take action to reduce the risk We don't have a frequency to follow, we make the weekly and monthly analysis table according to the type of risk then we take action	Really there are no risks, our risk is the poor management of the studyTo avoid having risks, we have follow-up reports each time, update them, we have monthly updates and the sharing of information, so having a tool for planning and visualizing the evolution of the service or our task allows us to manage the risksWe have a server that is accessible to everyone where we put our data, it's a way of managing the risk and monitoring by steps, updated either weekly or monthly and then the correspondence with the stakeholders.Be weekly or monthly, communication also allows to have reduced feedback through the hard timeIt is through a whole process to follow for the analysis of the context helps us to identify the risks of each service	We have a whole procedure called project planning and risk management to identify and document risks. We have a methodology called the thermal matrix, to assess the severity of the risk =(probability*the severity), we use it as a barrier method then we make the action plan after the follow-up, we follow the action plan to deal with the risk. It depends on the objectives sought, for example if I find a risk either I take the risk, either I abandon it, or I share with the parties concerned All the time, we always monitor and reassess the risk We take people's perceptions and people's experiences to deal with the risk

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	the matrix, probability*severity, then we find risks by category, and by class, then we make an action plan to reduce their importance, then we study the possibility of doing simulation exercises for category 1 risks, then we make the hierarchy of risks, major risks, priority 2 risks, Priority 3 and 4 At the level of Cosider we have a probable emergency situation plan will be defined, all the emergency situations that we have the possibility of doing a simulation exercise we do it according to the strategy we also have probable emergency situations We have an annual frequency, each year we have to make a reassessment of the occupational risks, in the event of a situation of serious accident occurring more than 21 days at the project level As he has already mentioned, before the identification of danger a more disciplinary group is created and this process among the requirements of ISO 45001 it's consultation and			actions carried out and the importance of the risks. All departments contribute to the identification of risks through the development of the CONTEXT ANALYSIS document. and the source of the risk Each department brings its specific expertise in the identification, evaluation and management of risks in its area of competence.	time to time each time a site of our project undergoes modificationsThe different project teams make a real contribution to the identification and prevention of risks insofar as we work together and exchange information that is useful for the smooth running of the work	It is through a whole process to follow for the analysis of the context helps us to identify the risks of each service		

	participation of workers in the field of OHS							

APPENDIX C: Framework Matrix of the **second theme.**

	Interview 1	Interview 2	Interview 3	Interview 4	Interview 5	Interview 6	Interview 7	Interview 8
Theme Two	It's new for me HSE we apply it without knowing Yes, indeed, it helps to manage the various risks of projects They have an awareness program for workers and site managers, through the safety meeting and awareness sessions through this exchange we always find new elements, new ideas, risks, we don't know them, we always try to deal with them. Yes, the brainstorming sessions and regular reviews helped to improve the risk response process, there are new risks and unpleasant surprises, we have to adapt Yes, communication is always important within a project, not necessarily verbally, we communicate by email, during meetings, during daily briefings, during management meetings, by phone, by	The term agile is new, we apply it without knowing, we just know how to react to an unforeseen event on any construction site Of course, we make a monthly project work activity report for each department. To know and designated the positive and negative aspects of a project in order to address them. Yes, we do briefings every day with all the departments to talk about the execution of the next phase of the project. Yes of course, closer communication is very important between teams, and knowledge sharing in the work framework to help with improve risk visibility and coordination. Yes, giving my people more autonomy and flexibility through orientation and roadmap always helps to improve visibility and coordination of risks.	Yes, but by applying it without knowing sometimes we are faced with unexpected risk situations we are forced to act without even planning we have to find the solution on the spot through collaboration with the team concerned Yes, there is an annual planning session to be done at the SMI level that contains all the meetings and iterations during the entire project.Yes, it helps It is very important to communicate in a team or in a group to distinguish the riskIt's always important to have autonomy, if we lived in a delicate case we could manage ourselves without waiting for a person to do it	It's new, at the level of our project, the spirit of agile exists and we apply it without knowing It's a real thing, weekly and monthly planning, we work with and following meetings and schedule updates, we work through journals, we can see the evolution of the project and the deviations we experienced and the delay that occurs weekly and monthly so there will be a continuous update. Of course, following reflections and daily follow-ups throughout the department through business procedures or detailed technical specifications, it has a journal and site notebook support we put down the progress of the project and we identify anomalies and unexpected risks at the same time there is the site book between the project owner and project manager	Now I know what it is: Preparing to work "agile method". That is to say, there is a risk of launching an "agile method" before acquiring the best practices to launch an "Agile" or successful agile transformation. For activities for which their dangers and threats are well identified and the analysis and evaluation of their risks are well developed, then it is necessary to work in a long cycle Without the slightest doubt. Also, without the slightest doubt. Yes, a trained, efficient and collaborative team must have the autonomy and flexibility to deal with unexpected risks.	The practice is not new but the term agile is new This is valid for everyone, yes the short cycle is important, the longer we take to act, the more we will reduce the risk and the problem Yes, there is this reflection within our company through meetings with the quality and technical control and planning departments concerning the progress and status of projects, it always helps to improve processes and respond to risks Yes of course the closer communication between the teams always helps to improve the visibility of the risks in the project it's to us to easily identify the risk and solve it at the minute while aiming at the coordination of ideas between the managers concerned	No, it's new, we allow the modification of the planning we will do as we progress Yes, it helps to manage the project more efficiently, but you shouldn't be too short, we have three meetings Fixed: the management meeting with all the departments once a week, the study meeting, the works meeting, Yes, it's clear, even at the moment we have taken a small meeting to present the progress of the studies, everyone will criticize in their own way, each one denounces the positive and negative points that we do and if there are things proposed and modifications. On a daily basis, we can't see the progress and risks of the project, but we'll say punctual and on demand, in addition to our organization, we can have complementary sessions and one-off	Yes, every step forward we have to act in the identification and planning of projects in a flexible way Yes, that's what we're doing at the moment, always we plan weekly and monthly meetings to respond to the risk and the constraint Yes, through the briefings and meetings we do, it helps to improve our risk response process Yes, absolutely, good communication with teams and stakeholders helps improve risk visibility and coordination. Yes, giving my elements a certain autonomy and flexibility to make decisions in complex situations helps to manage unexpected risks more effectively

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	letters always there are several channels of communication. I am autonomous, I have carte blanche to manage my department I give this authority to my team, I give the main lines and I direct you to the road.			the actions are made to the minute by identifying the various defects and delays that we experienced it is certain that the first person in charge must inform about the risks or the deviation noted through feedback and reports, but all departments have autonomy in decision-making Following the close communication every day we have briefing to do with the director and the project managers where we will talk about all the criticisms and failures and delays that we have experienced the exchange of training helps us for the treatment to have visibility and also for the rapid processing and it will be a coordination and the actions carried out will be vast and all the services will be concerned and all stakeholders will participate in the treatment of risks. The director of our project for each department gives a		Yes, in fact throughout the company we bring this responsibility, and each element is responsible for their work but there is always assistance.	sessions. Yes, there are elements to be managed, we try not to circumscribe them in the mode of reflection	

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				certain autonomy of decision-making, each manager will carry out the action in the moment of deviation I have the ability and autonomy to deal with the risk without going through the director without a doubt, decision-making autonomy has a great importance to help and improve the risk in the brief deadline Autonomy in decision-making is not enough, there is always a need for collaboration between teams and information sharing works in parallel, otherwise it has a negative impact on decision-making				

APPENDIX D: Framework Matrix of the **third theme.**

	Interview 1	Interview 2	Interview 3	Interview 4	Interview 5	Interview 6	Interview 7	Interview 8
Theme Three	people at the level of the sites they see the HSE manager as obstacles, he does not respect the PPE of the workers there is always the resistance of the part of the change to good practices In my opinion, the	There is some miscoordination between the different departments Through internal awareness with managers about the working method and external awareness with workers to apply the instructions carefully, continuous	From what I have seen, everything is well supervised, everything is well planned to reduce the risksClose communication between teams,Yes, I will be in favor of introducing new approaches Communication, awareness, instilled the values of our society	Sometimes I find that there are managers who don't know how to detect the risk, they don't have the mentality of identifying the risk knowing that in the analysis of the context that contains the identification of the risks speaks precisely	Risk of burnout, Transparency, loyalty, I am in favor of introducing a new, more dynamic approach to risk management, in a general idea, agility has come in circumstances by people with a well-defined curriculum,	As quality control departments, we don't have these problems. Collaboration, awareness, collegial decision-making Yes, I will be in favor, through the know-how and the continuous collaboration it is a company that is really	The problems we encountered were not at the level of our company, it was a caused by people who dealt outside the company Sharing information, sharing problems, attracting attention as soon as a problem is detected, we react at	There is a problem of lack of formalization between the teams The best way to anticipate is to better understand the project context you also need to have enough data to know how the stakeholders think about being

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	involvement of non-supervisory staff: laborer, scrap metal worker, form worker, they are given more authority and power to report risks Yes, I am in favor of the introduction of new approaches to risk management, I am going to integrate it with the integrated management unit to have a direct link with the CMI	risk improvements. Yes, I will be in favor of introducing new risk management approaches, it is always for continuous improvement. It's about having more flexibility, and having access to the systems to see what's going on outside	and the sharing of know-how with people who have not seen the situation	the responsibility of the project manager and his collaborators. Collaboration with the daily weekly meetings they will be able to idea to the continuous project evaluation, autonomy of decision-making I totally agree to insert this agile practice in the realization of cava project to help better identify and react in time and will bring us more benefits normally the HSE quality and service department will be independent of the project I have to depend on the CMI because I watch over quality and the project on progress and HSE watch over safety and not progress	training, but it must be taken into consideration. Adopts the principle of specialization, and collaboration with groups	very flexible and really open to practices. What would be good is to have improvements in the level of training in the quality control dimension	the minute. Yes, I will be in favor of the introduction of new approaches if it can improve the project, we open the door to any approach, all of which is innovation in management It would be good to have training in the technical, software, computer side allows us to see what is being done elsewhere, what is being done in the mode, having new methods allows us to improve our work and reduce the time it takes to achieve and have better visibility	effective in better resolving the risks Yes, I will be in favor of the introduction of new risk management approaches, and if there are new techniques and approaches I must support the identification of risks. The key change is the work culture and how people anticipate the perception of the company's problems.