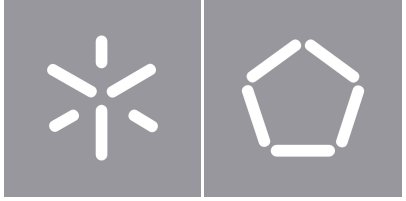
University of Minho
School of Engineering

Inês Laranjeiro Poças Falcão Fernandes

Proposal to improve Risk Management in New Product Development projects in an automotive company

October 2023



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Proposal to improve Risk Management in New Product Development projects in an automotive company

Master's Dissertation
Master's in Industrial Engineering and Management

Dissertation supervised by
Professor Doctor Anabela Pereira Tereso
Doctor João Manuel Peixoto Faria

October 2023

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Acknowledgements

Dedico às minhas duas estrelinhas mais brilhantes, à Mizé e à "bobó" Lurdes, que estarão certamente de coração cheio com esta conquista.

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Foi reunindo um pedacinho de cada um que consegui levar este objetivo até ao fim.
O meu mais sincero obrigada!

Statement of Integrity

I hereby declare having conducted this academic work with integrity.

I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

University of Minho, Guimarães, october 2023

Inês Laranjeiro Poças Falcão Fernandes

Abstract

Proposal to improve Risk Management in New Product Development projects in an automotive company

Risk Management is an indispensable area within Project Management across all industries, and plays a fundamental role in the automotive sector, ensuring a competitive position in today's dynamic and constantly evolving environment.

The research presented in this thesis is the result of an individual project developed in a corporate context as part of the master's program in Engineering and Industrial Management. The work was carried out at Bosch Car Multimedia Portugal, with the main objective of analyzing and identifying areas for improvement in Risk Management practices in the company's New Product Development projects. As a result of the study, several measures were proposed to improve and optimize the Risk Management process for projects involving the development of products for Bosch's clients.

The research strategy employed was a case study, incorporating various techniques and procedures to gather the necessary information for both theoretical foundation and analysis of the current situation in the company and the project at hand. The research aimed to foster a culture of Risk Management within the project team, considering their needs, limitations, and expectations. As Risk Management is crucial for the success of any project, it is important to promote Risk Management routines, ensure team's involvement in this work, and implement good practices that make the entire process effective, practical, and facilitated. Following the comparative analysis between the reality observed and theory, a model approach for Risk Management, tailored to the specific project the researcher was involved in, was proposed. Additionally, other suggestions were made to facilitate and enhance the implementation of Risk Management practices within the company, as well as to broaden the overall knowledge of teams on the subject matter. The importance of cooperative and proactive work, the promotion of a risk-aware culture, and continuous investment in process improvement and team dynamics were highlighted.

Keywords: Project Management; Risk Management; New Product Development

Resumo

Proposta de melhoria da Gestão de Risco em projetos de Desenvolvimento de um Produto numa empresa do setor automóvel

A Gestão de Risco é uma área essencial na Gestão de Projetos de qualquer empresa e desempenha um papel fundamental no setor automóvel, assegurando uma posição competitiva num ambiente dinâmico e em constante evolução como o que se observa nos dias de hoje.

A investigação apresentada na presente tese é o resultado de um projeto individual desenvolvido em contexto empresarial, como parte do Mestrado em Engenharia e Gestão Industrial. O trabalho foi realizado na empresa Bosch Car Multimedia Portugal, tendo como objetivo central analisar e identificar áreas de melhoria nas práticas de gestão de risco nos projetos de desenvolvimento de novos produtos da empresa. Como resultado do estudo, foram propostas diversas medidas com vista a aprimorar e otimizar o processo de Gestão de Risco para projetos de desenvolvimento de produtos para clientes da Bosch.

A estratégia de investigação utilizada foi o estudo de caso, no qual foram incorporados diversas técnicas e procedimentos com o objetivo de adquirir o máximo de informação necessária tanto para a base teórica quanto para a análise da situação atual na empresa e no projeto em causa. A investigação visou fomentar a Gestão de Risco na equipa do projeto, considerando as suas necessidades, limitações e expectativas. Sendo a Gestão de Risco fundamental para o sucesso de qualquer projeto, torna-se relevante promover rotinas de Gestão de Risco, garantir o envolvimento da equipa neste trabalho e implementar boas práticas que tornem todo o processo eficaz e simultaneamente prático e facilitado.

Após a análise comparativa entre a realidade observada e a teoria, foi proposto um modelo para a Gestão de Risco moldado ao projeto em que a investigadora esteve envolvida. Além disso, foram apresentadas outras sugestões com o objetivo de facilitar e aprimorar a implementação das práticas de Gestão de Risco na empresa, bem como ampliar o conhecimento geral das equipas sobre o tema em questão. Destacou-se a importância do trabalho cooperativo e proativo, a promoção de uma cultura de consciencialização em relação aos riscos e o investimento contínuo em melhorias no processo e dinâmica dentro das equipas.

Palavras-chave: Gestão de Projetos; Gestão de Risco; Desenvolvimento de Novos Produtos

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Abbreviations and Acronyms

AE Automotive Electronics.

APM Association for Project Management.

BBE Energy and Building Technology.

BBG Costumer Goods.

BBI Industrial Technology.

BBM Mobility Solutions.

BG Bosch Group.

BrgP Bosch Braga.

CEO Chief Executive Officer.

EMV Estimated Monetary Value.

HW Hardware.

IPMA International Project Management Association.

MECH Mechanics.

NPD New Product Development.

PDP Product Development Process.

PLC Project Life Cycle.

PM Project Management.

Pm Project Manager.

PMBOK® Guide A Guide to the Project Management Body of Knowledge.

PMI Project Management Institute.

PMO Project Management Officer.

QGC Quality Gate Customer.

R&D Research & Development.

RBS Risk Breakdown Structure.

RI Risk Indicator.

RM Risk Management.

RMP Risk Management Plan.

SOP Start of Production.

sPM Sub-Project Manager.

SuperOPL Super Open Points List.

SW Software.

Chapter 1

Introduction

This chapter begins with the background and motivation for this master's dissertation in section 1.1. Subsequently, the research objectives and the overall methodology employed to achieve them are outlined in section 1.2 and section 1.3, respectively. Finally, a brief overview of the document's structure is provided in section 1.4.

1.1 Background and motivation

"Innovation distinguishes between a leader and a follower." - Steve Jobs.

Globalization and increasing competitiveness are introducing new challenges that organizations must overcome by being innovative and introducing new ideas and projects. This urgency for change has forced companies to rethink and reorganize their structures, projects, and systems to survive in this competitive climate and gain an advantage over others (Kerzner, 2018).

In the automotive industry, the challenges of staying competitive are intensified by the fast evolution of Industry 4.0 technologies and the need to keep up with the demands of the global market. As such, it is critical for organizations to manage their projects and risks effectively to achieve their strategic goals and maintain a competitive edge (Lin et al., 2018). Efficient Project Management (PM) practices can enable organizations to identify New Product Development opportunities, allocate resources efficiently, and execute on innovative ideas to bring new products to market. Moreover, Project Management (PM) can help companies streamline their operations, optimize their processes, and improve their products' quality, which is essential for meeting customer demands and expectations. At the same time, managing risks associated with PM is also essential to ensure that the projects are delivered on time, within budget, and with the desired quality. Therefore, Project Management and Risk Management are two critical aspects of the automotive industry, and companies that can manage them effectively will be better positioned to

succeed in this dynamic and rapidly evolving industry (G. Fernandes et al., 2013).

"If your organization is not good at project management, you're putting too much at risk in terms of ultimately delivering on strategy" - Mark A. Langley, PMI President and CEO.

As project-oriented management becomes increasingly prevalent in the business environment, the need to manage projects effectively and efficiently for them to succeed and contribute effectively to the organization has emerged. This is where Project Management (PM) has gained representation and importance, being regarded as a powerful organizational response to complex management challenges.

There are several studies and researches that were conducted in the past years that clearly prove the importance and the advantages that come with Project Management. PMI (2018) published a premiere global survey of professionals who provide project, program, or portfolio management services within global organizations, that found that organizations with mature PM practices completed 71% of projects on time and within budget, compared to only 50% for organizations with immature practices. Furthermore, another survey by PMI (2019) states that organizations with high PM maturity had higher customer satisfaction ratings, higher productivity, and higher profitability than organizations with low PM maturity.

Risk Management (RM), as an integral part of PM, is crucial and plays a vital role in every project's success. For RM to be more effective, it should be ingrained in the organization's culture, philosophy, practices, and business processes rather than being treated as a separate task. When this is accomplished, all members of the organization actively participate in managing project risks. Taking a strategic approach to project Risk Management also acknowledges the importance of implementing advanced RM practices across all stages of the decision-making process (Rodrigues et al., 2018).

This thesis aims to contribute to the development of effective Risk Management strategies for automotive companies. By analyzing the existing literature, conducting a case study, and considering the PMBOK® *Guide* framework, this thesis aims to identify the key challenges and opportunities of RM in the context of Industry 4.0, obtaining insights and recommendations that can ensure the development of effective strategies in this domain for the project under analysis.

1.2 Objectives

The objective of this thesis was to propose recommendations for improving Risk Management (RM) in New Product Development (NPD) projects within the context of an automotive company.

The study aims to identify the challenges and opportunities of RM processes in the project under analysis

and provide insights and recommendations that can assist in developing effective strategies for managing risks. By achieving these objectives, this study intends to contribute to the enhancement of RM practices in NPD projects.

To achieve this overall objective, the following specific objectives have been identified:

i. Understand Risk Management processes and practices, particularly in the context of NPD projects in automotive companies.

ii. Evaluate the current status of RM in the project, including an assessment of team dynamics related to RM.

iii. Identify the challenges and opportunities of RM processes in the project.

iv. Provide insights and recommendations that can assist in developing effective strategies for managing risks in the project.

To summarize, the study aims to accomplish a structured framework that provides practical insights and actionable recommendations to improve Risk Management in NPD projects within the context of an automotive company.

1.3 Global Research Methodology

To accomplish the objectives outlined in section 1.2, the research approach utilized in this thesis was based on the **case study** methodology.

Referring to Meyer (2001, p. 330), *"Case studies are tailor-made for exploring new processes or behaviors or ones that are little understood"*. Moreover, this *"approach is particularly useful for responding to how and why questions about a contemporary set of events"*, which justifies its application in the search for answers to the overarching question that has prompted this study: *'How can Risk Management practices be improved?'*. This methodology enabled the researcher to gain a comprehensive understanding of the current state of Risk Management practices in New Product Development projects within the context of an automotive industry. It is important to highlight that the study involved the integration of the researcher into the project team of an ongoing NPD project for a specific customer of the company and an exploration of existing RM practices and processes.

In addition to the case study methodology, a **multi-method qualitative research** approach was employed, including interviews, questionnaires, document analysis, and observation during the researcher's

working hours. These methods were used to collect data and insights from various stakeholders, including the project team members and the overall Project Manager (Pm), about the challenges and opportunities related to RM.

The processing of the data collected from these sources was done in a manner that ensured the confidentiality and anonymity of all the employees. The proposed framework for improving this domain was developed based on the findings and insights obtained from the research. Further information on the Research Methodology employed in this study, including approaches, techniques, strategies, and tools that were used, can be found in chapter 3.

1.4 Structure of the Thesis

The document is broken down into six chapters: *Introduction, Literature Review, Research Methodology, Case Study, Proposal of Improvements*, and *Conclusions*.

The Introduction (chapter 1) of this master thesis serves to provide a comprehensive overview of the work. Firstly, it presents the Background and Motivation through a brief description of the concepts and topics under study. Moreover, it identifies the Objectives of the study and outlines the Research Methodology employed to achieve them. Finally, it presents the Structure of the Thesis.

Chapter 2 of this thesis is dedicated to a comprehensive Literature Review on Project Management (PM), New Product Development (NPD) process, and Risk Management (RM). Initially, the chapter provides a general contextualization of PM, including a brief overview of the A Guide to the Project Management Body of Knowledge (PMBOK® *Guide*). Then it goes further to the NPD process, focusing on the stages and activities involved in bringing new products to market, and exploring its relation to PM. Finally, the chapter explores the Risk Management knowledge area, exploring its standard process and phases.

Chapter 3 is dedicated to describing the Research Methodology employed in this investigation. This chapter provides a detailed explanation of the research design and approach, including the research philosophy, research strategy, time horizons, research methods, and also techniques and procedures used to collect and analyze data.

Chapter 4 presents a detailed Case Study analysis. It begins by providing an overview of the Bosch Group (BG), and then proceeds to conduct an analysis of the RM and Pm standards inside the company. The chapter also presents the pilot project where the work was focused, as a comprehensive AS-IS analysis of its RM practices, dynamics, and routines.

Building on the findings of the Case Study presented in chapter 4, chapter 5 proposes a set of practical recommendations for enhancing Risk Management in NPD projects.

Finally, chapter 6 presents the Conclusions of the study, summarizing the key findings, implications, contributions of the research, and also proposals for future work in this matter.

Chapter 2

Literature Review

Prior to the case study presentation, a theoretical revision of the most relevant concepts will be performed, throughout this chapter, in order to promote a better understanding of the theme. Therefore, some articles, books, and other published documents were selected and studied with the purpose of clarifying and getting deeper into the scope in which this project was inserted.

This chapter is structured in three key areas. Concepts of Project Management will be discussed in section 2.1. In section 2.2 the process of New Product Development will be explored, and section 2.3 will delve into the domain of Risk Management.

2.1 Project Management

The Project Management (PM) knowledge plays an important role in this research. Nowadays, it is essential for organizations to be able to react quickly to customer needs as well as globally experienced competitiveness. In response, a sharp increase in the movement toward project-based organizations has emerged (Fath et al., 2020). Project Management has thus continued to grow and develop, being continuously applied to new fields of study, industries, and even countries.

In this section, a brief historical context will be firstly given in subsection 2.1.1 to introduce the matter. Then, some key concepts related to the theme will be explained. In subsection 2.1.2 the definitions of project will be explored, followed by the definition or concept of Project Management in subsection 2.1.3. Following, details about the PMBOK® *Guide* will be provided in subsection 2.1.4. In subsection 2.1.5, the Project Life Cycle and it's process groups will be explored. Lastly, the knowledge areas, principles and performance domains of PM will be presented in subsection 2.1.6, subsection 2.1.7 and subsection 2.1.8, respectively.

2.1.1 Historical Evolution

Project Management existence has been proven since ancient times, wherefore it is not a recent development. Hundreds of years before Christ, architects proved to have the knowledge and the necessary principles to achieve a result with a certain level of quality, by using mathematics, for example, to plan and build (Kwak, 2005). As listed by Seymour and Hussein (2014), there are several successful projects offered by history that prove the long-standing existence and importance of PM practices, such as the Pyramids of Giza, the Olympic Games, the Great Wall of China, the Taj Mahal, among others.

It was only around the twentieth century that Project Management arose from the need to better monitor and analyze projects, a need that has been growing in recent years. However, it's not clear among authors when Project Management actually started.

According to Chiu (2010), Henri Fayol and Henry Gantt were both really important personalities regarding the PM development in the early 1900s. Fayol was the father of the five primary management functions, that he defined as: *1) Planning; 2) Organizing; 3) Commanding; 4) Coordinating;* and *5) Controlling.* Regarding Gantt, he was the creator of important techniques in this matter, more related to project planning and control, such as the famous tool called *Gantt Chart*.

Even with these developments, and as supported by Kwak (2005), Project Management was still going through its embryonic phase until the Second World War, which is considered the true lever for the growth of this domain. Both *Manhattan* and *Apollo* projects occurred at this time. The first one was a research and development program that lead to the production of the first nuclear weapons, which was an extremely complex project that involved thousands of people and a high volume of resources. *Manhattan* Project ended up successfully tested in July 1945, one month before the bomb was dropped in Hiroshima. In relation to the *Apollo* Project, this was another important historical event based on the ambitious plan to land a man on the moon. This project was successful in November 1968 (Seymour & Hussein, 2014).

In the years following these projects, the interest in PM and the need to share knowledge in this subject became increasingly evident since its importance was clearly proven. Further, the PM techniques became more widely adopted in industries, and the concept of Project Management became more formalized worldwide. As a result, several professional Project Management Associations started to emerge. Currently, the most prominent ones are the following:

i. International Project Management Association (IPMA), founded in 1965.

ii. Project Management Institute (PMI), founded in 1969.

iii. Association for Project Management (APM), founded in 1972.

These associations were created with the aim to promote PM as a discipline and professional area, supporting the development and recognition of this domain. Furthermore, they intend to promote the best practices and standards in the field by providing a multiplicity of techniques, tools and procedures associated with Project Management. Having this into account, the first formal Project Management *Bodies of Knowledge* started to emerge, promoted by these institutions. The appearance of these standard guidelines has led to improved PM practices, that increased project success rates. By adopting a standardized approach, organizations are able to better manage their projects, reduce risks, and improve their overall performance (Crawford, 2006). In Figure 2.1 it is possible to observe the countries where these standards have emerged over the years, which highlights that PM and its standardization has been growing as a worldwide concern.

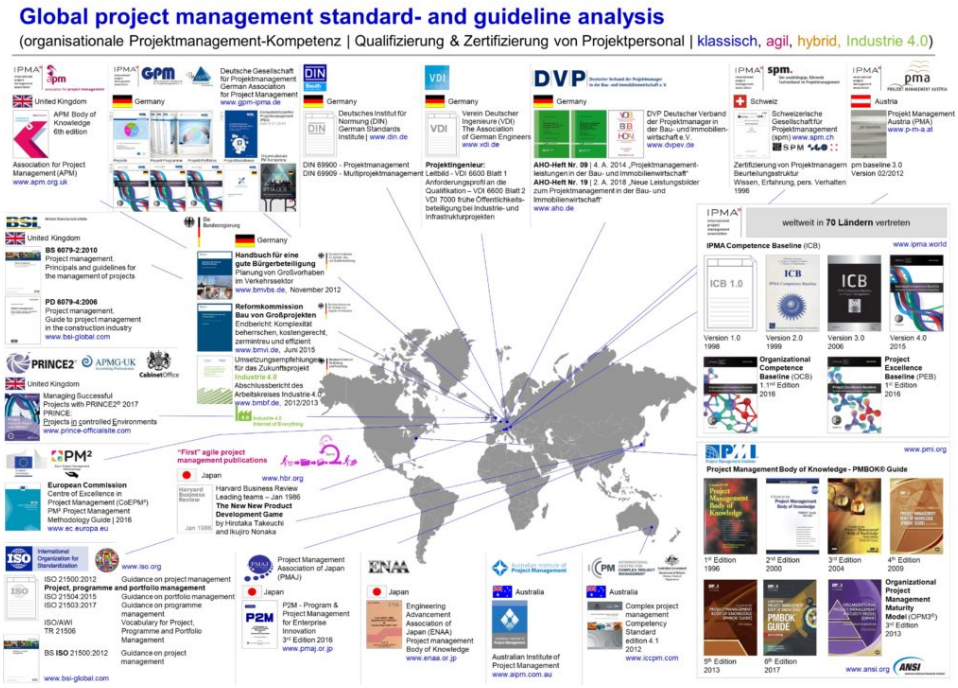

Figure 2.1: Standards of PM origin worldwide
GPM-IPMA (2022)

After all this progress in the field over so many years, Project Management is currently seen as *"a distinct profession with degree programs, certifications, and excellent career opportunities"*, since it is a vital function in every organization nowadays (Schwalbe, 2015, p. 2). Overall, it is clear that this domain has undergone significant evolution, development, and improvement, driven by many factors as advances in technology, changes in business practices, and a greater emphasis on values such as collaboration, flexibility, and continuous improvement. This progress has enabled Pms to work more efficiently, deliver

high-quality projects faster, and drive business value for their organizations, providing results that keep proving the huge importance of this area of knowledge.

In this work, all the concepts learned, standards considered, and practices followed had as main basis the PMBOK® *Guide*, A Guide to the Project Management Body of Knowledge, published by PMI. This choice is mainly related to the fact that the company uses this guide as a reference in its Project Management (PM) activities, but also due to the relevance of this *body of knowledge*.

2.1.2 Project Definition

In order to fully understand the PM domain, it is important to know the concrete definition of project. According to PMI (2021), a project is defined as *"A temporary endeavor undertaken to create a unique product, service, or result"*. It is temporary because it has a beginning and an end defined in time, and therefore a predetermined scope and resources. And it is unique in the sense that it is mainly characterized by no routine, but a specific set of operations designed to fulfill a single goal. However, there are several more definitions, focused on different aspects, that can be found in the literature. Some of these are the following:

i. *"A project is an organizational unit that solves a unique and complex task"* (Munk-Madsen, 2005).

ii. *"Project refers to a value creation undertaking based on a specific, which is completed in a given or agreed time frame and under constraints, including resources and external circumstances"* (Project Management Association Japan (PMAJ), 2005).

iii. *"Project is a unique process consisting of a set of coordinated and controlled activities with start and end dates, undertaken to achieve an objective conforming to specific requirements, including constraints of time, cost, and resources"* (International Organization for Standardization, 2017).

Considering all these definitions, there are some characteristics of the project concept that stand out. In order to go deeper into the project properties, here is a compilation of the characteristics listed by PMI (2017):

i. TEMPORARY: Every project has a beginning and end.

ii. RARITY: Each project has its own characteristics, as well as its own expected outcome.

iii. PROGRESSIVE: As the project is developed, its scope and details become more and more clear.

iv. COMPLEXITY: A project can have a lot of complexity associated with the diversity of goals, its size, the novelty difficulties, and/or the environment evolution.

v. CONSTRAINT: Each project has limitations.

vi. RISK: All projects are under uncertainties and changes.

vii. MULTIDISCIPLINARY: A project involves several areas/organizations, that require integration.

2.1.3 Project Management Concept

Regarding the Project Management concept, it can be defined as a structured process by which an individual or group vision can be successfully converted into reality. PM is also commonly presented as the application of knowledge, methods, skills, tools, competencies, and techniques to achieve the project goals (PMI, 2021). According to the International Project Management Association (IPMA) (2017), effective PM has benefits for the organization and stakeholders, providing a greater likelihood of meeting the project requirements and ensuring efficient use of resources. *"The processes and methods of project management provide the structure, focus, flexibility and control to help guide significant project investments to outstanding results, on time and within budget"*, as stated by Van Wyngaard (2012, p. 4).

Accordingly, projects must be organized and managed in a certain way, that a project is performed and delivered within specific constraints, also called key project variables. There are several distinct interpretations about the dimensions of these constraints, however, generally, three are the most considered when referring to project management, which are **time**, **budget**, and **scope**. This set is commonly known as the *project management triangle*, also known as the *iron triangle* or the *triple constraint*, and offers a visual representation of these variables, as shown in Figure 2.2.

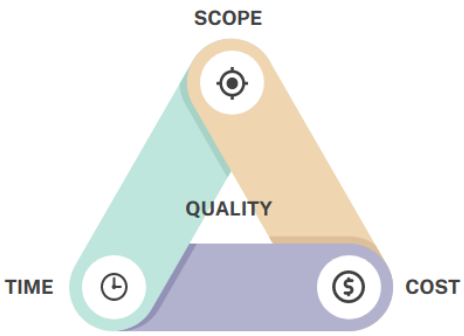

Figure 2.2: Project Management Triangle
Adapted from Van Wyngaard (2012)

The variable time pertains to the length of the project, including deadlines and milestones. To effectively handle this constraint, it is crucial to implement efficient scheduling and time management strategies. The budget aspect, on the other hand, concerns the monetary resources assigned to the project. This domain requires effective cost management to prevent exceeding the budget and guarantee profitability. Finally, scope refers mostly to the project's targets, objectives, and deliverables, defining the inclusions and exclusions of the project. All these domains will influence the results of the project, compromising its quality (Dobson, 2004).

This representation is, however, really primitive, and does not truly represent all the constraints of a project. Another, and more complete form to illustrate this reality is shown in Figure 2.3, which represents six different constraints of a project that directly affects the satisfaction of the customer regarding the project's success. This representation is commonly denominated as *constraints diamond* (Miguel, 2019).

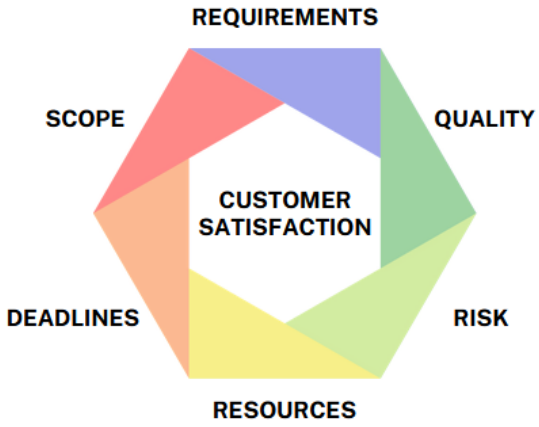

Figure 2.3: Constraint Diamond in PM
Adapted from Miguel (2019)

2.1.4 PMBOK® Guide

A Guide to the Project Management Body of Knowledge is *"an internationally recognized standard which provides the fundamentals of project management as they apply to a wide range of projects"* and also *"a group of processes and knowledge fields which are generally accepted as greatest practice within the project management discipline"* (Jamali & Oveisi, 2016, p. 142).

As already mentioned, this guide belongs to the Project Management Institute (PMI), and its first edition was published in 1996. Since this date, the PMI has been improving and evolving its methods and techniques, so, in the meanwhile, six more editions have been published: PMBOK® *Guide* 2nd edition

[2000]; PMBOK® *Guide* 3rd edition [2004]; PMBOK® *Guide* 4th edition [2009]; PMBOK® *Guide* 5th edition [2013]; PMBOK® *Guide* 6th edition [2017]; and PMBOK® *Guide* 7th edition [2021]. The cover of the most recent version is shown in Figure 2.4.

This guide holds high relevance and recognition for several reasons. Its comprehensive nature, standardization, best practices, flexibility, and continuous improvement make it a valuable resource and important tool for Project Managers, professionals, and organizations seeking to achieve success in their projects.

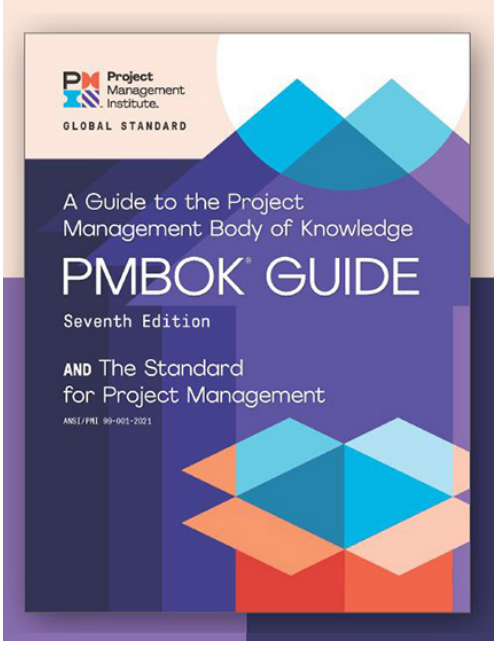

Figure 2.4: PMBOK® *Guide*, 7th Edition
PMI (2021)

The new and updated version that appeared in 2021, emphasizes a change-oriented Project Management (PM), introducing a new paradigm, different than the process-based approach that was presented in the previous edition. The PMBOK® *Guide* 6th edition (PMI, 2017) presents a well-defined Project Life Cycle, consisting of five phases that include a total of forty-nine processes. This approach will be further explained in this section. The 7th edition of the PMBOK® *Guide* (PMI, 2021), is a significant update and revision from the previous edition. This one is based in an integrated value delivery system, consisting of eight *Performance Domains* that are *"interactive, interrelated and independent, working in unison to achieve the project objectives"* (Amaro & Domingues, 2023, p. 1878). Furthermore, this edition defines twelve *Project Management Principles*.

In summary, the PMBOK® *Guide* 7th edition represents a significant shift in PM thinking, moving towards more outcome-focused approaches and recognizing the importance of adapting PM approaches to meet specific project needs (Amaro & Domingues, 2023).

2.1.5 Project Life Cycle

The PMI (2017) has defined a standard Project Life Cycle (PLC), which includes a series of processes that a project goes through from its inception to its completion. Each process group involves a specific set of activities that are performed by the project team, stakeholders, and other relevant parties to ensure that the project is successfully completed within the three previously explained constraints.

The five process groups inherent to the PLC are listed and explained below.

i. INITIATING: Processes to obtain approval to start a new project or phase.

ii. PLANNING: Processes to define the scope, refine objectives and develop the action plan to achieve project goals.

iii. EXECUTING: Processes to complete the project management plan and meet the established requirements.

iv. MONITORING AND CONTROLLING: Processes required for tracking progress, reviewing performance, and identifying necessary changes.

v. CLOSING: Processes to formally consider the project or phase as concluded.

It is important to highlight that *groups of processes are not project phases*. The process groups interact with each other throughout the various PLC phases, and it is also possible for all these kinds of processes to occur within a single phase. Moreover, the processes can happen repeatedly or interact, depending on the project needs (PMI, 2017). These interactions are shown in a more visible form below (Figure 2.5).

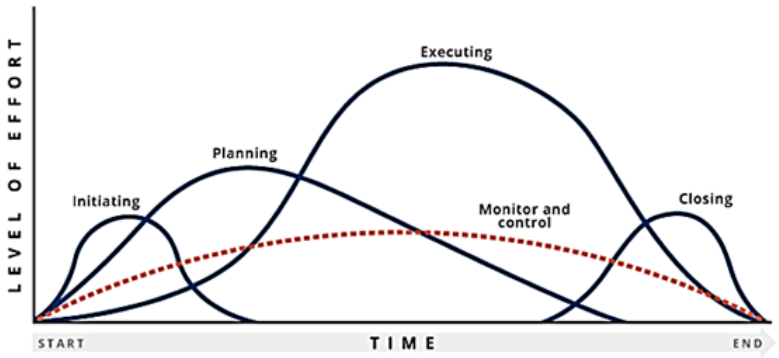

Figure 2.5: Process Group Interactions within a Project or Phase (Benzuly, 2019)

2.1.6 Knowledge Areas

Still regarding the information published by the PMI (2017), PM has ten knowledge areas where the previously explained process groups are integrated. These areas are shown below in Figure 2.6.

As stated by Miguel (2019), all knowledge areas are used, in the majority of projects, the majority of the time. In order to better understand the focus points and the context of each area, a brief presentation of each one is then performed, referencing PMI (2017), Miguel (2019) and Schwalbe (2015).

Figure 2.6: The Knowledge Areas in PM
Adapted from Miguel (2019)

i. INTEGRATION MANAGEMENT: Coordinates and manages all aspects of the project. It's an overarching function that is related to all the other knowledge areas.

ii. SCOPE MANAGEMENT: Defines and manages the project's scope, including requirements gathering, scope planning, as well as schedule development and control, aiming to guarantee that the project includes all the necessary work.

iii. SCHEDULE MANAGEMENT: Deals with the management of project schedules, sequencing activities, and focusing on meeting deadlines.

iv. COST MANAGEMENT: Focuses on managing the costs, guaranteeing that the project remains within the approved budget.

v. QUALITY MANAGEMENT: Ensures that the deliverables of the project meet the quality standards

and the requirements that are defined.

vi. COMMUNICATION MANAGEMENT: Deals with project communication, including stakeholder communication planning, information distribution, and performance reporting.

vii. RISK MANAGEMENT: Includes identifying, analyzing, and responding to risks in the project.

viii. RESOURCES MANAGEMENT: It is about the processes to identify, acquire, and manage the resources needed for the successful completion of the project.

ix. PROCUREMENT MANAGEMENT: Deals with managing the processes necessary to purchase or acquire products or services needed from outside the team, including procurement planning, vendor selection, contract management, and contract closure.

x. STAKEHOLDERS MANAGEMENT: Focus on identifying, analyzing, and managing the engagement of the stakeholders, regarding their expectations and their impact on the project.

It is crucial that Pms have knowledge and skills in all of the ten knowledge areas, since each one plays a critical role in the Project Management process, from initiating and planning the project to executing, monitoring, and controlling, and lastly, closing the project. These areas provide a structured framework for PM that can be adapted to various types of different projects, industries, and organizations, making them an imperative component of any successful approach (Schwalbe, 2015).

2.1.7 Project Management Principles

As mentioned before, the PMI (2021) introduced twelve *Project Management Principles*. These principles are applicable to all projects, regardless of their amplitude or organization.

i. STEWARDSHIP: *"Be a diligent, respectful, and caring steward"*. Stewardship encompasses the values of integrity, care, trustworthiness and compliance.

ii. TEAM: *"Create a collaborative project team environment"*. Individuals who work collaboratively and wield diverse skills, knowledge, and experience.

iii. STAKEHOLDERS: *"Effectively engage with stakeholders"*. Proactively advance in value delivery and customer satisfaction.

iv. VALUE: *"Focus on value"*. Considered the ultimate indicator of the project's success.

v. SYSTEMS THINKING: *"Recognize, evaluate, and respond to system interactions"*. Being responsive to the dynamic and interdependent domains to positively affect project performance.

vi. LEADERSHIP: *"Demonstrate leadership behaviors"*. Support individual and team needs, demonstrating behaviors in areas of honesty, integrity and ethical conduct.

vii. TAILORING: *"Tailor based on context"*. Iterative and continuous process to deal with the uniqueness of each project.

viii. QUALITY: *"Build quality into processes and deliverables"*. Align the needs, requirements and acceptance requirements set forth by stakeholders.

ix. COMPLEXITY: *"Navigate complexity"*. Stay vigilant to reduce the amount or impact of complexity, that is the result of human behavior, uncertainty, ambiguity and system interactions.

x. RISK: *"Optimize risk responses"*. Continually evaluate risk exposure to maximize the positive impacts and minimize the negative ones.

xi. ADAPTABILITY AND RESILIENCY: *"Embrace adaptability and resiliency"*. Promote change accommodation, setbacks recovery, and advances in the work.

xii. CHANGE: *"Enable change to achieve the envisioned future state"*. Prepare and embrace the impact of the transition from the current to the intended future state created by project outcomes.

These principles provide an effective structure PM, and can be used to guide decision-making and actions throughout the Project Life Cycle.

2.1.8 Performance Domains

The PM *Performance Domains* emerged in the 7th edition of PMBOK® *Guide* as an alternative to the *Knowledge Areas*. This reflects the shift from a process-based standard to a systems view, as the domains represent a PM system of interactive, interrelated, and interdependent management capabilities that act in unison to achieve outcomes. Accordingly, a *Performance Domain* can be defined as a *"a group of related activities that are critical for the effective delivery of project outcomes"* (PMI, 2021, p. 102). Next, a brief explanation of each domain is presented.

i. STAKEHOLDER: addresses activities and functions associated with stakeholders.

ii. TEAM: addresses activities and functions associated with the responsibility for producing project deliverables and outcomes.

iii. DEVELOPMENT APPROACH AND LIFE CYCLE: addresses activities and functions associated with the development approach, cadence, and life cycle phases of the project.

iv. PLANNING: addresses activities and functions associated with all organization and coordination necessary for achieving project deliverables and outcomes.

v. PROJECT WORK: addresses activities and functions associated with establishing processes, managing physical resources, and fostering a learning environment.

vi. DELIVERY: addresses activities associated with delivering the required scope and quality.

vii. MEASUREMENT: addresses activities and functions associated with assessing project performance and maintaining it acceptable.

viii. UNCERTAINTY: addresses activities and functions associated with risk.

"Together the performance domains form a unified whole" (PMI, 2021, p. 102). The twelve PM principles offer direction for how project participants should act as they shape and impact the eight performance domains to achieve the desired results. Although there is a conceptual overlap between the principles and the performance domains, these last offer broad areas of emphasis where the behavior can be demonstrated, while the principles provide direction for behavior (Amaro & Domingues, 2023; PMI, 2021). Figure 2.7 illustrates how the Project Management principles are positioned above the performance domains, and serve as a guide for each domain's operations.

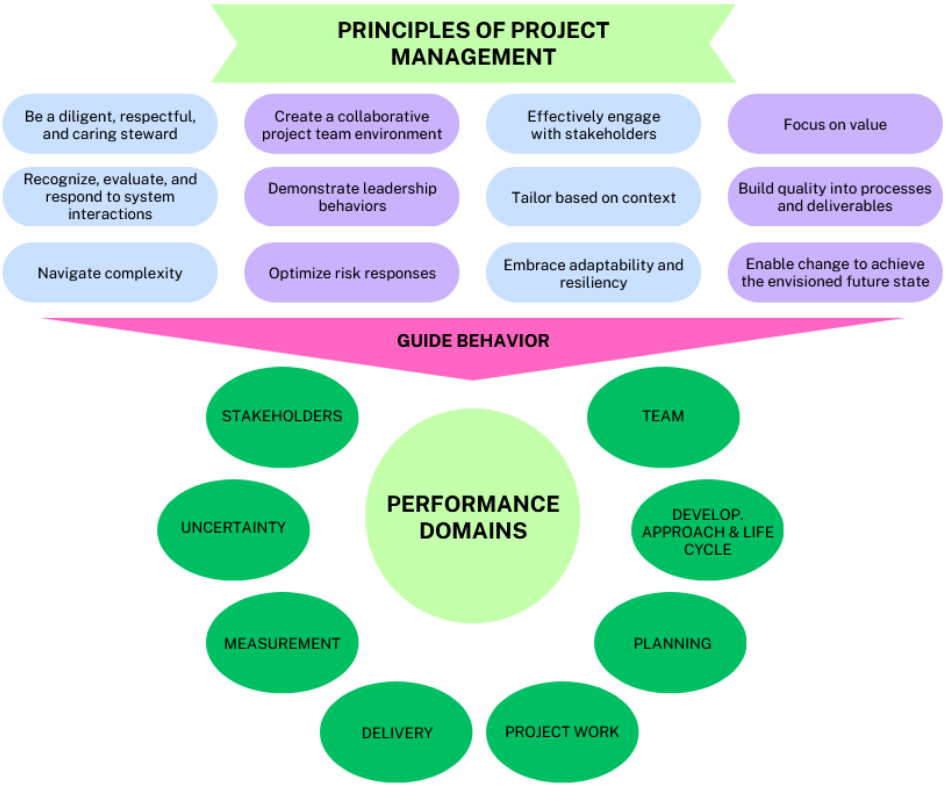

Figure 2.7: Relationship between PM Principles and Performance Domains
Adapted from PMI (2021)

2.2 New Product Development Process

"To remain competitive, a company has to be innovative, giving attention to product cost, product and process quality, flexibility in the product mix and new solutions" (Willaert et al., 1998, p. 88). Therefore, New Product Development (NPD) is an important process that provides future business opportunities for organizations, by creating a sustainable competitive advantage, meeting the needs of their customers, and supporting a strong brand image (Pons, 2008). The area under study in this thesis is the development of consumer products, which has a considerable engineering production content.

A product is considered new when it is introduced to the market for the first time or when it is completely unfamiliar to a company, regardless of the presence of similar products in the market (I. Fernandes et al., 2022).

The New Product Development (NPD) process incorporates several functional areas inside the industries, such as *Engineering*, *Procurement*, and *Marketing*, among others, that must collaborate continuously to achieve the goals of the project. Furthermore, this type of process is very complex and highly risky for a variety of reasons (Costa et al., 2017). The development process can be very time-consuming, requiring a significant investment of resources and time, in order to perform correctly and successfully processes such as market research, prototype design, and conducting extensive testing and quality control. On the other hand, there is always the important need for a deep understanding of customer needs to ensure all the requirements are considered.

In this master's thesis, the NPD considered is for a single customer, and not to present to the general market. Therefore, the process needs to be tailored to meet the needs and requirements of this specific customer. Developing a new product specifically for a single customer can be highly advantageous for companies operating in niche markets, as this approach enables them to provide tailor-made solutions. However, the process can be complex and demanding, requiring substantial resources and expertise. Therefore, it is crucial to undertake this process with meticulous planning and attention to detail to achieve a favorable outcome (Kara & Kaynak, 1997).

2.2.1 Project Management in NPD

The ability to bring innovation to market quickly, efficiently, and first then the competition is becoming increasingly important (Eppinger & Ulrich, 2011). The high risk associated with New Product Development

processes, coupled with today's highly volatile and extremely competitive business atmosphere, calls for an increasing need for the company to react to challenges, especially in terms of quality, price and response time. Consequently, it is crucial to have an efficient plan and management process for introducing new products that can impact competitive environments, as developing a new product within a set time frame and budget requires significant investments and a high level of focus to achieve success. And it is in this scope that Project Management emerges in the development of new products context.

The general NPD process can be grouped into five stages, that start after the generation of the new product idea. These stages are shown in Figure 2.8, together with the PLC phases explained in subsection 2.1.5.

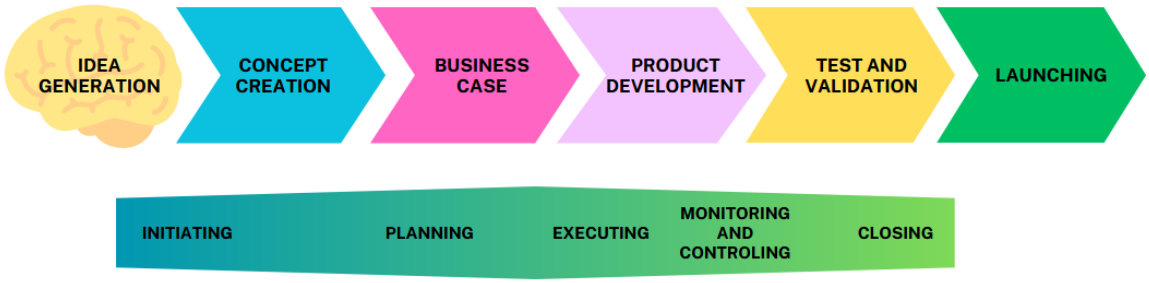

Figure 2.8: New Product Development (NPD) and Project Life Cycle (PLC) phases
Adapted from Smolnik and Bergmann (2020)

i. CONCEPT CREATION: Also known as the preliminary investigation or initial screen. Conducts a preliminary investigation of the project scope.

ii. BUSINESS CASE: Conduct a detailed investigation, both technical and commercial, of the project scope to build the project's business case (includes defining the product and project, justifying the project, and creating the project plan).

iii. PRODUCT DEVELOPMENT: Includes product design and production processes.

iv. TEST AND VALIDATION: Technical and commercial tests are conducted to seek approval of both the concept of the new product.

v. LAUNCHING: The start of commercial operation, including marketing activities, mass distribution, and commercialization.

The Product Development Process (PDP) can be defined as *"the sequence of steps or activities that an enterprise employs to conceive, design and produce a product"* (Eppinger & Ulrich, 2011, p. 30). It is possible to find several reference models for this process, that are considered classics in the literature. According to several authors, the most generic and simple process can be defined by five stages, represented in Figure 2.9.

Figure 2.9: Product Development Process (PDP)
Adapted from Cooper (2008)

According to Rozenfeld et al. (2006), it is believed that the **product design phase** determines around 85% of its life cycle costs. This includes factors such as the basic product and process technologies, materials used, and specifications. Additionally, identifying and resolving design problems early on can lead to a reduction of over 50% in product launch time, as it decreases the need for subsequent changes, reduces production and response times to consumer needs, and ultimately increases competitiveness in the market. This highlights the importance of a good PDP structure.

As stated by I. Fernandes et al. (2022, p. 222), *"the PDP is a divergent process, which varies depending on the context of the organization"*, thus, the process flow diagram must always be previously established and defined within the organization, based on its competencies, knowledge, and resources. However, is also important that the structuring of this process inside the company considers a reference model to support standardization of NPD processes, as they exist to institutionalize the best practices on PDP management.

Citing Costa et al. (2017, p. 1192), *"the adoption of project management standards can improve the product development efficiency"*. Accordingly, the commitment and support of management, regarding the Product Development Process is essential for successful NPD. A standard structure of these processes outlines the various stages of the NPD process, moreover, helps to ensure that all necessary steps are completed in the proper order and that the product is developed according to the desired quality, cost, and time constraints (Sanongpong, 2009). Furthermore, this organized approach will promote the reduction of uncertainty and risk levels during the process and better plan and control of the tasks performed (A. Fernandes et al., 2019).

2.2.2 Stage Gate Model and Milestones in NPD

Robert Gravlin Cooper introduced the Stage Gate process for New Product Development for the first time in the late 1980s, since then the concept has evolved, and nowadays *"(...) firms all over the world implemented Stage Gate processes as blueprints to overcome the chaos that comes along*

with the development of new products" (Smolnik & Bergmann, 2020, p. 42).

Cooper (2008) defines **stages** as *"major phases in the product development process"*, that typically represent a set of activities, with certain goals and deliveries. These stages are intercalated with **gates** which can be defined as *"checkpoints where decisions are made regarding whether or not to proceed to the next stage"*. In other words, the gates will determine if a project should proceed to the subsequent phase, acting like a "filter" based on the completion and success of the previous stage. In each gate, the gatekeepers, responsible for the decision-making, evaluate the project, based on a set of predefined criteria or metrics, and a decision is made on whether to continue, redirect, or terminate the project (Cooper, 2008).

This framework became really popular among companies, as it is useful for managing complex projects. This model ensures not only that the project is on track, but also that the project's viability and alignment with business goals. Even more, the continuous evaluation of the process benefits not only the identification and evaluation of risks but also the efficient resource allocation inside the company (Cooper, 1990, 2008).

In addition to stages and gates, Cooper (2016) also emphasizes the significance of **milestones** in the New Product Development process. Milestones can be defined as *"significant events or achievements"* that occur within each stage, and they provide a way to track progress and ensure everything is moving forward according to plan. These marks are considered one of the most important aspects of project planning, as they are the most visible indicators of its progress. Unlike regular tasks, milestones don't have any duration associated and do not consume any resources, as they represent a specific moment in time, such as the completion of a project phase or the achievement of a particular goal (Cooper, 2008; PMI, 2013).

Regarding the NPD process, illustrated in Figure 2.8, five stages and five gates can be defined, when considering a Stage Gate model, as represented in Figure 2.10.

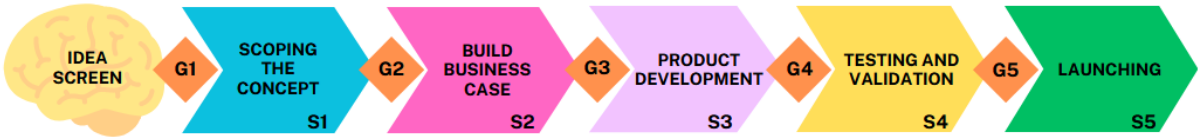

Figure 2.10: Stage Gate model in New Product Development (NPD) processes
Adapted from Cooper (2008)

2.3 Risk Management

This section aims to provide a comprehensive exploration of the Risk Management knowledge area. It begins with an introductory overview of the key concepts and a global process explanation in subsection 2.3.1. Subsequently, each phase of the RM process is exposed in greater detail. The subsection 2.3.2 focuses on Risk Management Planning, subsection 2.3.3 delves into Risk Identification, and subsection 2.3.4 elaborates on both Qualitative and Quantitative Risk Analysis. The Planning and Implementation of risk responses are covered in subsection 2.3.5, and subsection 2.3.6 discusses Risk Monitoring.

2.3.1 Introduction, definitions and processes

The PMI defines **risk** as *"an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives"* (PMI, 2021, p. 122). Risks can come from various sources, including internal factors such as process failures, human errors, and system breakdowns, as well as external factors. These events are an inherent part of any project, moreover, they can have a significant impact on the organization's success or failure. One risk can have one or more causes and one or multiple consequences (Miguel, 2019).

The uncertainty is included by PMI (2021) as one of the eight PM performance domains, also, Risk Management, is considered by PMI (2017) one of the ten PM knowledge areas. These considerations reflect the importance of this subject when referring to Project Management. Risk Management (RM) is an essential component of a successful project, as every project's development and implementation involve a complex and challenging process that carries a high level of uncertainty.

It is important to highlight the distinction between positive risks, also called opportunities, and negative risks, referred to as threats. Therefore, RM consists of *"all the processes that are related to identification, analysis and responsiveness to any uncertainty, which includes maximizing the positive results of opportunities and minimizing the negative results of threats"* (Mirboroon & Razavi, 2020, p. 43). In other words, the main purpose of Risk Management is to minimize the negative impact of risks while maximizing the opportunities that may arise from them.

In addition to the concept of risk, there are several other important definitions that are relevant to this subject. Some of them were highlighted by the PMI, and are cited from (PMI, 2021) below:

i. UNCERTAINTY: *"lack of understanding and awareness of issues, events, paths to follow or solutions to pursue"*. Can be considered a key driver of risk, as it creates the potential for

both positive and negative outcomes.

ii. AMBIGUITY: *"state of being unclear, having difficulty in identifying the cause of events, or having multiple options from which to use"*. This can create uncertainty and increase the likelihood of risk, as it leads to misunderstandings, miscommunications, and misinterpretations of information.

iii. COMPLEXITY: *"characteristic (...) that is difficult to manage due to human behavior, system behavior, and ambiguity"*, also related to having many interconnected or interdependent elements or components that interact in non-linear and unpredictable ways.

iv. VOLATILITY: *"possibility for rapid and unpredictable change"*, referring to the degree of variation or fluctuation in a particular situation or environment.

The 6th and 7th editions of the PMBOK® *Guide* provide a comprehensive and structured approach to RM, that can be applied to identify, analyze, and manage risks throughout the product life cycle. The PMI (2017) defined seven processes inside RM, as represented in Figure 2.11 and described below.

Figure 2.11: Risk Management processes in PM
Adapted from Miguel (2019)

i. PLAN RISK MANAGEMENT: It aims to establish a clear approach, framework, and procedures for managing risks. Also involves defining objectives, outlining the scope of RM activities, and identifying the stakeholders who will be involved in the process. The RMP is developed, which outlines how the activities will be conducted throughout the PLC. This plan is tailored to the specific needs of the project and should be reviewed and updated regularly.

ii. IDENTIFY RISKS: The project team identifies potential risks that could affect the project objectives. This is performed by reviewing project documentation, conducting information-gathering techniques, and engaging expert judgment. All identified risks are documented in the Risk Register, which must be reviewed and updated regularly.

iii. QUALITATIVE RISK ANALYSIS: Involves the assessment of identified risks to determine their likelihood of occurrence and potential impact on project objectives. The risks are then prioritized based on these two factors. The results of this process are documented and communicated to the project stakeholders.

iv. QUANTITATIVE RISK ANALYSIS: A more numeric analysis is performed in order to refine the understanding of each risk and its impact on the project goals. The analyzed data is once more documented and shared with the team.

v. PLAN RISK RESPONSES: Aims to develop effective strategies, not only to mitigate negative risks but also to capitalize on potential opportunities. The output of this phase includes a Risk Response Plan, which outlines the specific actions to be taken to address identified risks and opportunities. The plan must also consider contingency plans to address unforeseen events.

vi. IMPLEMENT RISK RESPONSES: This process involves the real execution of the procedures defined in the previous phase. The output of this process phase includes updated Risk Registers, updated Risk Response Plans, and reports on the status of the identified risks and the effectiveness of the taken actions.

vii. MONITOR RISKS: This process includes tracking the status of the risks, identifying any changes in the risk factors, and assessing the effectiveness of the risk response plans. This monitoring must be continuous in order to ensure that any changes to the risks or the project are addressed in a timely and effective manner.

Figure 2.12 shows a partial view of the risk management processes, with special emphasis on the inputs in the planning domain, as well as the flow between activities. As represented, when planning Risk Management Plan (RMP), several inputs and documents of the project must be taken in account, in order to develop a comprehensive and effective RMP.

It's important to highlight that the RMP is going to suffer updates throughout the PLC, to ensure that it remains relevant and effective. As suggested by the representation in Figure 2.11, this RM framework is both iterative and cyclical, since it involves a continuous cycle of identifying risks, analyzing them, developing

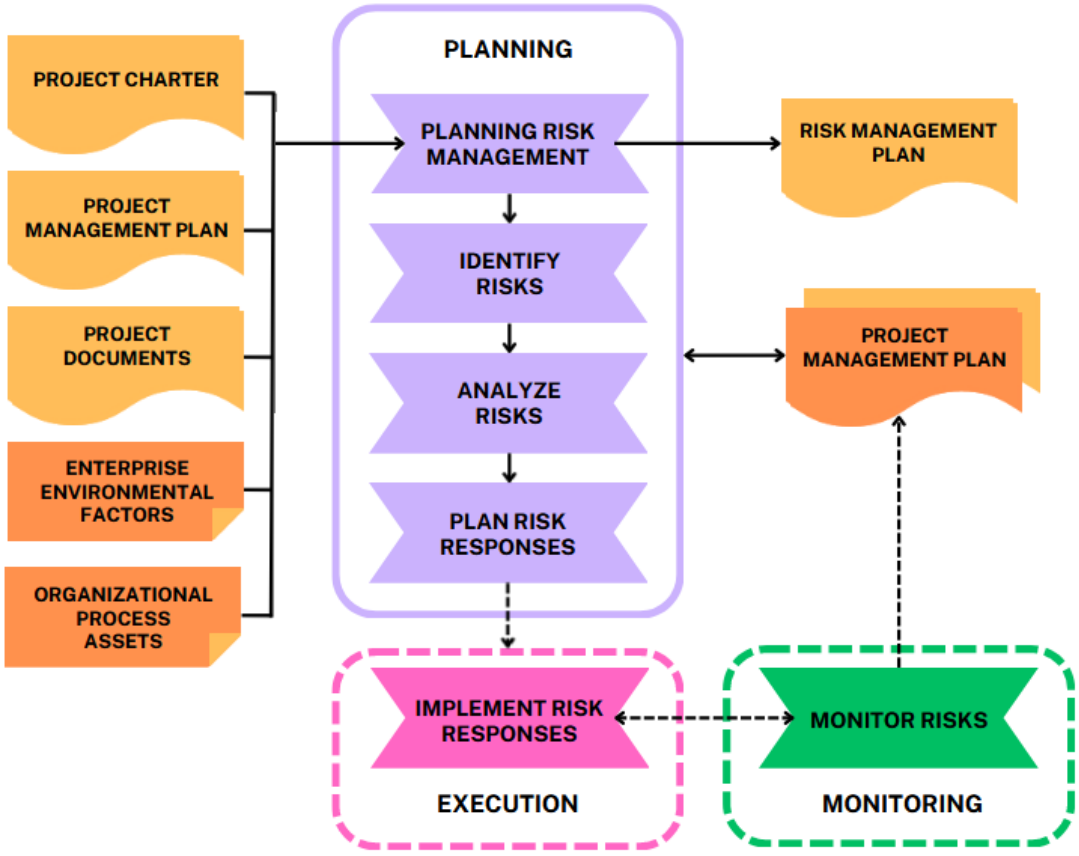

Figure 2.12: Partial flowchart of the Risk Management processes in a project
Adapted from Miguel (2019) and PMI (2021)

and implementing response plans, and monitoring risks throughout the PLC. Plus, each iteration of the cycle involves improving the previous one. An iterative and cyclical approach to RM allows project teams to continuously improve their practices, adapt to changes in the project environment, and take advantage of new opportunities that may arise (PMI, 2017; Miguel, 2019). Likewise, the PMI (2021) acknowledges that the increasing complexity of projects requires a flexible and adaptive approach that promotes continuous learning and improvement. Therefore, the iterative and incremental approach to RM is also suggested in this recent edition of the PMBOK® *Guide*. Moreover, it emphasizes the importance of continuous learning and improvement through feedback and evaluation, assuring continuous stakeholder engagement. Citing PMI (2021, p. 127), *"establishing a frequent rhythm or cadence of review and feedback sessions from a broad selection of stakeholders is helpful for navigating project risk and being proactive with risk responses"*.

2.3.2 Risk Management Planning

A comprehensive RMP should include several aspects in order to ensure that the RM process is well-defined, consistent, and effective. According to Miguel (2019) and Keshk et al. (2018), the Risk Management Plan (RMP) building should sum up the following topics:

i. METHODOLOGY AND STRATEGY: Define meetings, tools and approaches to use with the team.

ii. ROLES AND RESPONSIBILITIES: Determine core team for RM, establish who leads and/or supports the various risk-related activities.

iii. BUDGETING: Determine the estimated budget to cope with risks.

iv. SCHEDULING AND TIMING: Definition of when and how often the RM processes will be carried out throughout the PLC, as well as the establishment of the activities to be included in the project schedule.

v. SCORING: Create standards and a working knowledge of these standard mechanisms to ensure quality in risk assessment.

vi. CATEGORIZATION: Define a Risk Breakdown Structure (RBS), which is a segmentation method to categorize risks and facilitate their identification.

vii. FORMATS AND TEMPLATES: Define the format for representing and visualizing risks to make the prioritization process more efficient among the team. For example, the Butterfly Risk Matrix. Other documents and tools that are going to be standards for risk documenting must be described.

viii. TRACING: Refers to the process of tracking and monitoring risks throughout the PLC. Gather the documentation of all the terms of risk, useful for perpetrators of the project and all beneficiaries from it, contains explaining of future needs of the implementation processes and also learned lessons.

2.3.3 Risks Identification

The next activity of RM, that is the risk identification, counts with the collaboration of all the team members and the Pm. It is important to encourage teams to adopt a risk-oriented mindset so they are able to identify potential risks in their daily work. By developing a risk-aware culture, teams can proactively identify and deal with risks before they escalate into larger problems that could impact the project.

During the process of identifying risks, it is crucial to take into account three different viewpoints when undertaking a project: the **Past**, **Present**, and **Future** perspectives. Examining past projects can provide

valuable insights into potential problems that should be avoided and opportunities that can be capitalized on based on prior knowledge. The Present perspective demands particular attention as it relates to the current state of the project. During this process, and according to the PMI (2017), several sources of information should be analyzed. Thus, it is important to conduct a thorough review of several documents, such as the project charter, the project management plan, and others, to ensure an accurate understanding of the project's scope, objectives, requirements, and constraints. This process requires a systematic approach to identifying risks. Finally, the Future perspective calls for creative thinking to envision potential scenarios that could arise and somehow affect the project. These perspectives are represented in Figure 2.13.

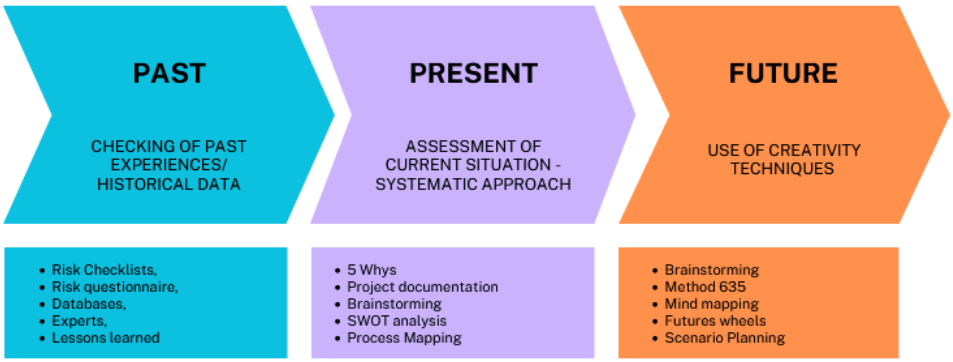

Figure 2.13: Risk Identification perspectives and tools
Adapted from Miguel (2019)

As pointed in Figure 2.13, there are various tools and techniques that can be used to support risk identification. Below are some popular tools commonly used in this field, each briefly described to provide an overview of its purpose and procedure:

i. BRAINSTORMING: a creative technique that involves generating ideas and risks in a group setting.

ii. CHECKLISTS: a structured approach based on creating lists based on available historical information and accumulated knowledge through the implementation of previous projects and other sources of information.

iii. DELPHI TECHNIQUE: involves seeking the input of subject matter experts to reach a consensus on a particular issue or topic.

iv. SWOT ANALYSIS: involves conducting a comprehensive analysis of internal and external factors that could impact the success of the project or organization, categorizing them into strengths, weaknesses, opportunities, and threats.

Documenting all identified risks in the project's **Risk List** is essential to ensure that no risks are overlooked during the PLC. This tool should serve as a central repository of all identified risks, including details such as the nature of the risk, its potential impact on the project, the likelihood of occurrence, and any mitigation measures that have been taken or planned. By maintaining a comprehensive Risk List, the team can stay informed about all potential risks and take proactive measures to manage them effectively. Regularly reviewing and updating the Project's Risk List is also important, to ensure that the team stays on top of any changes in the risk landscape and can adjust their strategies as needed (PMI, 2013).

2.3.4 Qualitative and Quantitative Analysis

After identifying risks, risk analysis and assessment should be performed. Both quantitative and qualitative risk analysis methods have their advantages and disadvantages. Quantitative analysis is typically more precise and objective, but also time-consuming and expensive to implement. Qualitative analysis is quicker and less costly but may be subject to bias and therefore not provide an accurate assessment of the potential risks.

The core procedure for conducting a qualitative risk analysis is illustrated in Figure 2.14.

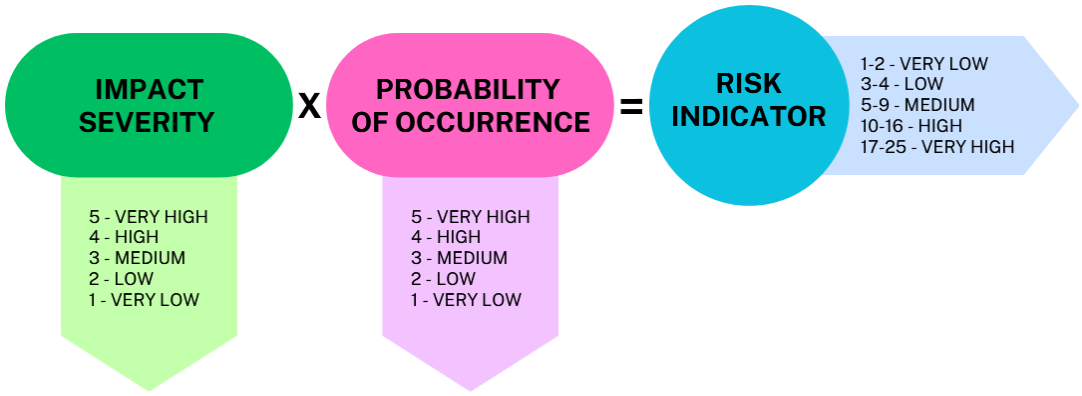

Figure 2.14: Qualitative Risk Analysis - RI calculation
Adapted from Keshk et al. (2018)

Impact severity is a measure of the potential consequences or impact of a risk, which can range from very low to very high values, as suggested in Figure 2.14. It is important to note that this impact rating should be considered high for both highly negative impact threats and highly positive impact opportunities within the project. On the other hand, the **probability of occurrence** measures the likelihood of a risk event occurring. This probability may be expressed as a percentage, normally associated to a qualitative rating value.

By combining these two ratings, the Risk Indicator (RI) can be calculated to provide a measure of the level of risk associated with a particular event or situation. This indicator is a useful tool for assessing and prioritizing risks in a project because even though it is not a very precise or absolute measure, it can be used to compare and rank different risks. As such, threats and opportunities with a higher RI should receive greater attention and resources in RM planning and decision-making (Keshk et al., 2018). However, it is important to note that the RI should not be the only factor considered in prioritizing risks and developing RM strategies.

As mentioned in subsection 2.3.2, it is recommended to organize previously assessed risks in an intuitively appealing and effective manner for better RM (PMI, 2021). Visual tools, including risk matrices such as the Butterfly Risk Matrix or other graphical representations, can be utilized to help project teams understand the level of risk associated with each identified risk and prioritize their response strategies accordingly (Keshk et al., 2018). The **Butterfly Risk Matrix**, for instance, typically involves a two-dimensional grid that indicates the likelihood of a risk occurring on one axis and the severity of its impact on the other axis. The importance of a risk pinned on this Matrix depends on the quadrant it falls into, which is usually distinguished by colors ranging from green to red.

Ideally, both Qualitative and Quantitative risk Analyses would be performed for all the risks in the Risk List, as this would provide the most comprehensive understanding of the risks and enable better decision-making when it comes to RM. However, in large projects, performing a Quantitative Analysis for every identified risk can be time-consuming and resource-intensive, as their Risk Lists can become very lengthy, making it challenging to perform a Quantitative Analysis for every identified risk. Therefore, it may be useful to start by prioritizing the risks and then focus only on the most significant ones to carry out the Quantitative Analysis. This approach can help ensure that at least the most critical risks are fully and properly understood and managed as the Quantitative assessment can provide a more accurate and precise evaluation of the potential impact and likelihood of a risk (Barghi, 2020).

Quantitative risk analysis uses techniques such as sensitivity analysis, decision trees, and simulation to quantify possible project outcomes and also their probabilities, providing support for a more secure decision for the project, given a situation of uncertainty (Miguel, 2019).

The Estimated Monetary Value (EMV), as an example, is a statistic concept commonly used in RM to refer to the expected financial outcome of a risk event. This value is calculated using the following formula:

- $EMV = Probability\ of\ the\ Risk\ X\ Monetary\ Value\ of\ Risk\ Event$

When calculating EMV, the probability of a risk event is typically expressed as a percentage, while the

monetary value is expressed in euros. For example, if the expected cost increase for a project due to a risk event is 7,000 euros, with a likelihood of 10%, the EMV would be 700 euros. This calculation is performed for each scenario associated with the risk, and the totalEMV for the risk is the sum of all these individual values.

2.3.5 Risk Responses Planning and Implementation

The choice of the response strategy depends on a variety of factors, including the nature and severity of the risk, the potential impact on the organization's objectives, the available resources, and also the organization's and project's risk tolerance (PMI, 2018). There are different strategies that Pms can use to respond to risks, depending on whether the risks are threats or opportunities. The four strategies for threats are avoid, mitigate, transfer, and accept, while the four strategies for opportunities are exploit, enhance, share, and accept. These strategies are summarized by the scheme in Figure 2.15.

Figure 2.15: Possible strategies for threats and opportunities
Adapted from Miguel (2019)

The avoidance strategy for threats involves taking actions to eliminate the risk, which may involve changing the project scope, schedule, or budget. The mitigate strategy involves taking actions to reduce the probability or impact of the risk, such as implementing controls or contingency plans. The transfer strategy involves shifting the risk to a third party, such as through insurance or outsourcing. Lastly, the accept

strategy involves accepting the risk and focusing on other aspects of the project.

On the other hand, regarding opportunities, the exploit strategy involves taking actions to maximize the potential benefit of the opportunity, such as by investing more resources. The enhance strategy involves taking actions to increase the likelihood or impact of the opportunity, such as by improving the project plan or increasing stakeholder engagement. The share strategy involves collaborating with other parties to share the benefits of the opportunity, such as through partnerships or joint ventures. Finally, the accept strategy involves accepting the opportunity and focusing on other aspects of the project (Miguel, 2019; Barghi, 2020).

Once a response strategy has been selected, it is important to develop a plan to implement that strategy effectively, determining the measures to follow and carry out. Responses are defined through the development of measures to increase opportunities and reduce threats.

Optimum RM is characterized by the balance of costs of the avoidance measures and the possible damages, as suggested in Figure 2.16.

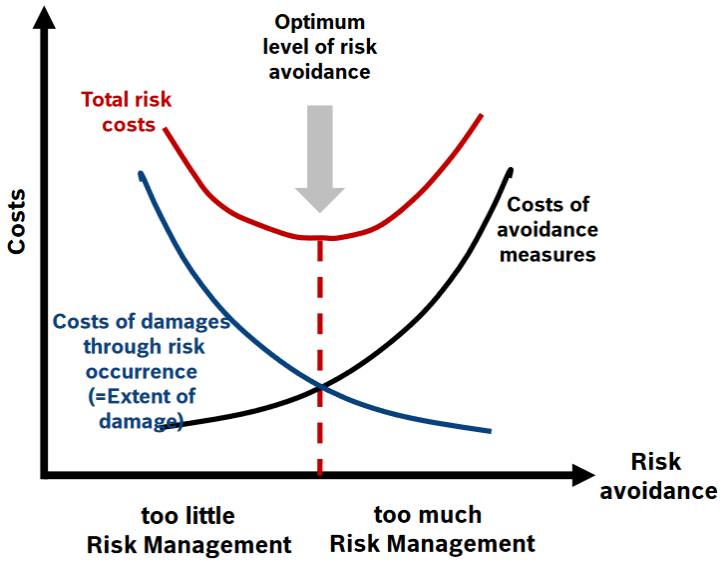

Figure 2.16: Optimum level of Risk Management
Bosch (2023b)

Avoiding or eliminating a risk may be effective in preventing potential damages but it can also be really costly. For instance, it may be decided not to invest in a high-risk opportunity to prevent losses, but then miss out on potential profits. On the other hand, accepting the risk may be cheaper for the project, but it also can mean accepting the potential damages that could result. In between these two extremes, there are a range of strategies that can help to find the right balance between cost and potential damages.

2.3.6 Risks Monitoring

Risk monitoring involves tracking risks and their associated measures and responses throughout the PLC. Effective risk monitoring ensures that the team is aware of changes in risk probability or impact, and can take timely action to address these changes.

The risks responsible should regularly review and update the Risk List, based on new information, changes in project scope or requirements, or changes in the external environment that may affect the project. The frequency of risk monitoring should be determined based on the level of risk and the complexity of the project. Documentation of the effectiveness and status of the measures by re-evaluating the risks is also important (PMI, 2021). Moreover, all the collected risk information must be communicated to stakeholders and team members in a timely and accurate manner. This can involve creating risk reports or dashboards that provide an overview of key risks and their status, as well as any changes or updates since the last review. Overall, effective RM is a continuous process that requires ongoing monitoring and evaluation, assuring the project is well-positioned to achieve its objectives while minimizing potential negative consequences (Miguel, 2019).

Chapter 3

Research Methodology

This chapter outlines the methodology employed in this master's thesis. The selection of an appropriate methodology is a critical step in any research project, as it determines the overall direction of the investigation and influences the selection of methods and techniques necessary to achieve the defined goals. In light of this, choosing a methodology should be a carefully considered process that requires thorough reflection and study by the researcher (Bogdan & Biklen, 2003).

To conduct this investigation, the researcher followed the onion model proposed by Saunders, Lewis, and Thornhill (2009). This model, shown in Figure 3.1, provides a systematic and structured framework for designing and conducting research, covering various aspects such as research philosophies, approaches, strategies, choices, time horizons, techniques, and procedures. Figure 3.1 highlights the methodological choices that were made for this research, based on the research onion model. This approach allowed to ensure that all aspects of the research process were adequately defined and that the chosen methodology was appropriate for the research questions and objectives.

i. PHILOSOPHY: The adopted research philosophy is the **Interpretivism**. This is an epistemology that emphasizes the importance of the researcher understanding the differences between human beings in their roles as social actors. This philosophy justifies the researcher's view of reality as subjective, subject to multiple interpretations and meanings.

ii. APPROACH: The **Deductive** approach was chosen to conduct the present research, which involves starting with a theory or set of theories and using them to generate predictions or hypotheses about what might be observed in the real world. This approach process involved analyzing the existing theories and literature related to Risk Management, in order to develop proposals for improvement.

iii. STRATEGY: The underlying strategy for the research methodology employed in this project is a **Case Study** approach. This approach can be formal defined as *"an empirical inquiry that*

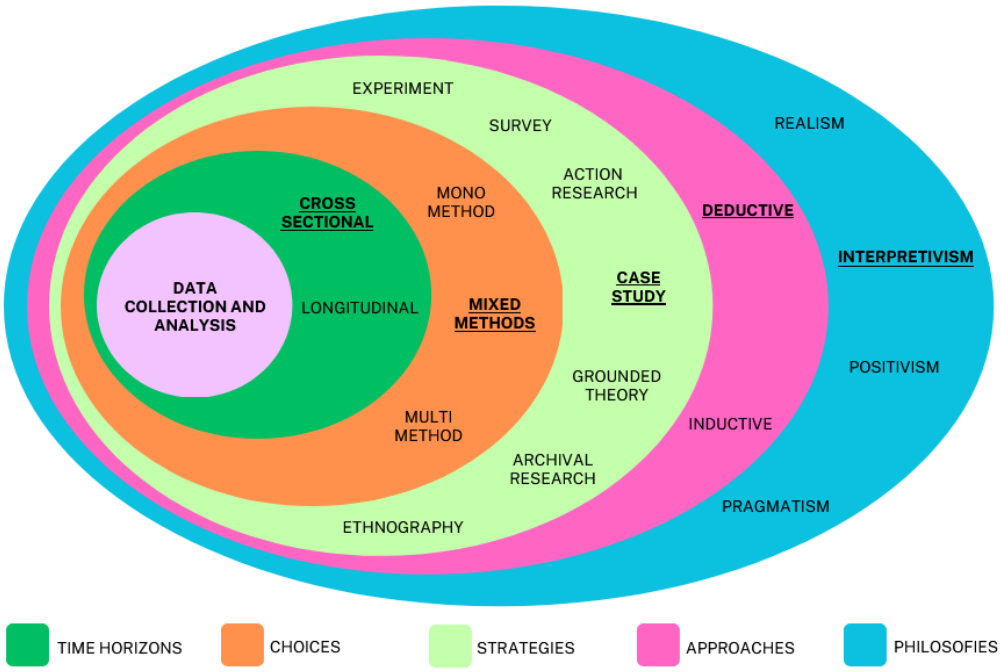

Figure 3.1: Research Onion applied in this thesis
Adapted from Saunders et al. (2009)

investigates a contemporary phenomena within its real-life context and addresses a situation in which the boundaries between phenomenon and context are not clearly evident" (Yin, 1994, p. 13). Briefly, this strategy enables a comprehensive understanding of the current situation, providing the researcher with an opportunity to suggest new practices.

iv. CHOICES: In the development of the research, **Mixed Methods** were applied. Therefore, the researcher was able to gather both qualitative and quantitative data, which provided a more comprehensive understanding of the research problem and allowed for triangulation of the findings.

v. TIME HORIZON: This research work is **Cross-Sectional**, as the topics addressed were studied and developed during a specific period of time, from February 2023 to July 2023.

vi. DATA COLLECTION AND ANALYSIS: This is the final layer of the onion, which refers to the selection of the data collection and analyzing techniques and procedures. Referring to Yin (2014), there are six sources of evidence that can be used to collect information about the case being studied. However, the researcher must be aware of the limitations of each source, and choose the most appropriate one will depend on the objectives of the study, the time and resources available, and the nature of the case. It is essential for the researcher to carefully consider the techniques and procedures that will be used, aiming to increase the chances of producing high-quality research findings.

In this thesis, the researcher used both primary and secondary data. Primary data refers to data collected by the researcher, while secondary data refers to data that has already been collected by someone else. Primary data is typically collected through questionnaires, interviews, or participant observation. Secondary data can be found in a variety of sources, such as reports, journals, articles, statistical databases, or other documents (Saunders et al., 2009). This combination of data sources allowed the researcher to gain a more comprehensive understanding of the research problem. The techniques that were used in this master thesis are pointed out and briefly described in section 3.1 and section 3.2.

3.1 Secondary Data

Saunders et al. (2009, p. 256) state that *"secondary data can be a valuable source of information for case study research, as it can provide insights into the organization's context and environment"*.

i. INTERNAL DOCUMENTARY ANALYSIS: Bosch Group (BG), the organization where the work was carried out, maintains a large repository of documents that were consulted and analyzed, such as central guidelines, handbooks, articles, videos, presentations, internal forums, and others. This documentary analysis was conducted to understand the company's organizational structure, business areas, products and other important aspects to be considered in the contextualization of the research environment. This was performed to understand more of the standard practices and processes in these domains within the company and to acquire knowledge of the internal tools.

ii. EXTERNAL DOCUMENTARY ANALYSIS: The researcher also consulted external documentation, to develop further knowledge regarding the domains of Project Management and specifically of Risk Management. This documentation included books, published articles, and websites. It's important to highlight the A Guide to the Project Management Body of Knowledge (PMBOK® *Guide*) published by the Project Management Institute (PMI) as it was a central focus of the documentary analysis.

3.2 Primary Data

"Primary data are the lifeblood of research. They provide the researcher with the opportunity to collect data that is specific to the research question and that is not available from secondary sources" (Robson & McCartan, 2016, p. 88).

i. PARTICIPANT OBSERVATION: Observation is a complex method, but it can be valuable for gaining a deeper understanding of the environment of the object of study and getting closer contact with it (Saunders et al., 2009). In this case, the observation was participant, as the researcher participated in the activities of the team under observation, being daily in touch with the Project Manager and the other team members of the project. This involved participating in the activities such as attending meetings, reviewing project documentation, and observing the team's behaviors and interactions with each other and with stakeholders.

ii. DATA EXTRACTION: Primary quantitative data were extracted, mainly in order to assess the overall risk profile of the project. This extraction involved a systematic evaluation of the platform to conclude about the team's dynamics and their relationship with the tool under analysis.

iii. QUESTIONNAIRES: During the early stages of this master's thesis, a questionnaire was developed to gather feedback on the current status and relationship between the team and the project's Risk Management process. The goal was to understand the team's perceptions and limitations on this matter, as well as their capabilities with the main RM tool. In addition to the brief assessment, the questionnaire also included a space for the team to make proposals. This was done to understand their needs and ensure that any proposals or improvements would be beneficial and meet their expectations.

iv. UNSTRUCTURED INTERVIEWS: Flexible interviews were conducted individually with experts in the field of PM and RM in order to better understand the standard processes within the company for these processes and what is "by the book" expected of the Pm and team regarding these domains. Moreover, another open-ended interview was performed with the Project Managers of several different projects in BG. This brainstorming and knowledge-sharing session was designed to gather in-depth insights into the experiences and perspectives on RM of other teams with similar projects. The goal was to discuss best practices, share ideas, and eventually gather new ideas that could improve the process.

Chapter 4

Case Study

Having presented the theoretical basis underpinning the research, this chapter will focus on the case study presentation. The main goal is to provide an in-depth analysis of the situation that was identified, necessary for understanding the research context.

Section 4.1 begins with the introduction of Bosch Group (BG), the company in which the project was developed. Subsequently, section 4.2 focuses on the examination of the overall Project Management practices within BG for New Product Development projects. Following that, section 4.3 contextualizes a specific development project in which the researcher was involved. Lastly, the chapter concludes with an analysis of the current practices and the level of Risk Management maturity within Bosch and more specifically in the project under study.

4.1 Company Presentation[1]

This section provides a comprehensive overview of Bosch Group, including its background, industry sectors, and organizational structure. This familiarization with the company gives important details for understanding the case study. This section is divided into three progressively more industry-specific parts, starting by presenting Bosch Worldwide in subsection 4.1.1, moving on to Bosch Portugal in subsection 4.1.2 and finalizing with Bosch Braga in subsection 4.1.3.

4.1.1 Bosch Worldwide

Bosch's history started when Robert Bosch opened a workshop for Precision Mechanics and Electrical Engineering in Stuttgart (Germany), in the year of 1886. From that point onward, the company has strongly evolved, overcoming a lot of challenges, such as the step toward independence, its integration in the

[1] This section has been developed using (Bosch, 2023a) as a primary reference source.

automotive market, and the expansion into markets outside Germany and even Europe, along with others. Nowadays, completing almost 140 years of existence, Bosch Group (BG) has a factory floor of large manufacturing, that places it as a world-leading supplier of technology and different services. Figure 4.1 illustrates the most recent iteration of the company's logo.

Figure 4.1: Bosch Group logo
(2023)

Currently, BG is headquartered in the city of Gerlingen, in Germany, and it aims, in short, to develop technologies that make people's lives simpler and better, therefore the motto: *"Invented for life"*. To achieve this goal and provide the world with solutions that will improve daily routines, Bosch pursues and relies on several aspects. This company aligns the needs of society and environment with the continuous improvement, relying on the thirst for knowledge and the pursuit of perfection in the development of software, hardware, and services. This is referred to as *"Decoding tomorrow"*, which is also a motto of BG. The main values of the company are listed and described below.

i. FUTURE AND RESULT FOCUS: *"Our actions are result-focused. This allows us to secure our future. It also creates a sound basis for the social initiatives of the company and the foundation."*

ii. RESPONSIBILITY AND SUSTAINABILITY: *"We act prudently and responsibly for the benefit of society and the environment."*

iii. INITIATIVE AND DETERMINATION: *"We act on our own initiative, take entrepreneurial responsibility, and pursue our goals with determination."*

iv. OPENNESS AND TRUST: *"We communicate important company matters in a timely and open fashion. This is the best foundation for a relationship built on trust."*

v. FAIRNESS: *"We deal fairly with our colleagues and business partners and view this fairness as a cornerstone of our corporate success."*

vi. RELIABILITY, CREDIBILITY, LEGALITY: *"We promise only what we can deliver, accept agreements as binding, and respect and observe the law in all our business transactions."*

vii. DIVERSITY: *"We appreciate and encourage diversity for the enrichment it brings and see it as essential for our success"*

According to the data from December 2022, Bosch has a headcount of approximately 420,000 associates, who work across roughly 440 subsidiaries and regional companies spread over nearly 60 countries. The sales data for 2022 reveals a remarkable achievement, with the company generating a total of 88.4 billion euros.

Bosch Group is a company that has consistently transformed its activities to maintain its position in the technology and services sectors. Its operations can be clustered in four domains, which are: Mobility Solutions (BBM); Costumer Goods (BBG); Industrial Technology (BBI) and Energy and Building Technology (BBE). Together, these business sectors provide advanced solutions for smart homes, industry 4.0, and connected mobility, providing its customers with connected and cross-domain solutions from a single source. A more detailed breakdown of these four business sectors is provided in Figure 4.2.

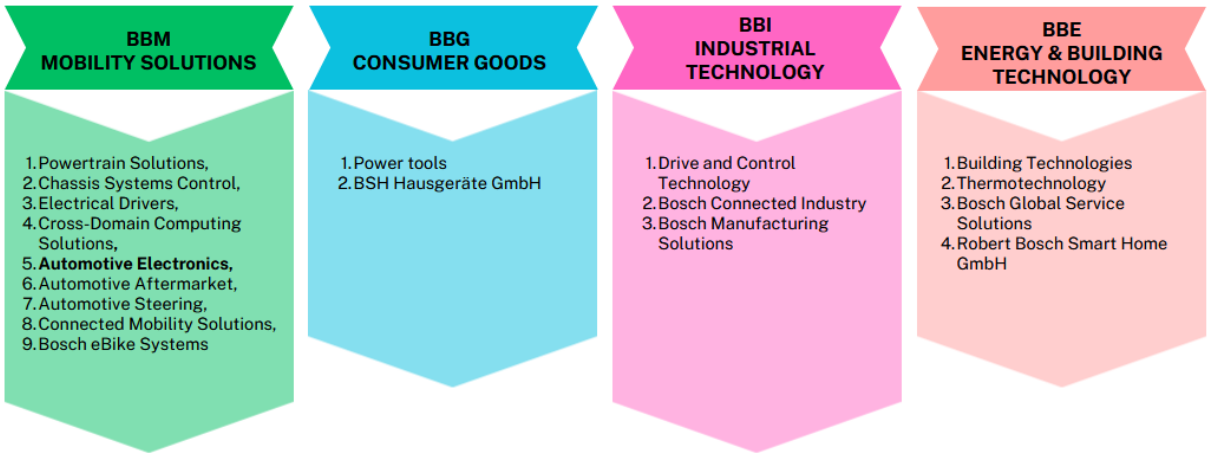

Figure 4.2: Bosch Group business sectors
Adapted (2023)

When comparing these four sectors, and analyzing Figure 4.3, Mobility Solutions clearly stands out as the most profitable, accounting for 58% of the total revenue for that year, followed by the Costumer Goods with an account of 27%.

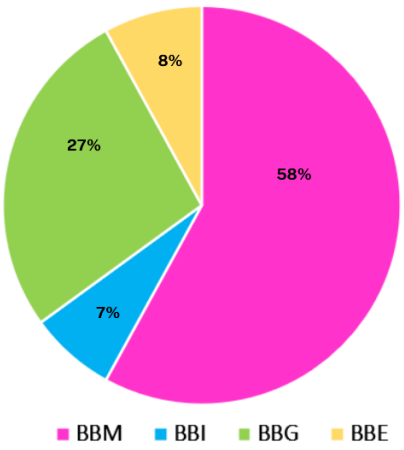

Figure 4.3: Distribution of revenue across business sectors of the Bosch Group
Adapted (2021)

The present master thesis was developed within the scope of Automotive Electronics (AE), one of the nine divisions of the BBM business sector. This division specializes in developing hardware and software solutions for in-car entertainment, navigation, driver-assistance systems, and others. Its intelligent solutions make the integration of these systems more efficient and flexible, while still guaranteeing ease of use for the driver. Automotive Electronics section is also actively involved in shaping the future of connected mobility, with a special focus on semiconductors, sensors, and control units.

4.1.2 Bosch Portugal

Bosch has been present in Portugal since 1911 and is highly regarded as one of the country's most reputable companies. The company has established a significant market presence and according to data from 2021, exports over 97% of its locally-manufactured products to markets all over the world. With a workforce of more than 5,800 employees, the company is one of the largest industrial employers in Portugal and generated sales of 1.6 billion euros in 2020. *"If in the past we were focused on producing quality equipment - Made in Portugal - today we are also recognized for our ability to create innovative solutions for smart homes, smart cities, and mobility - Invented in Portugal."* Bosch has been expanding its research and development activities in various business sectors, which are distributed by four locations in Portugal: Braga; Aveiro; Lisboa and Ovar.

As can be consulted in the data of Figure 4.4, Bosch in Braga is the largest Bosch Company and employer in Portugal, especially focused on the scope of BBM. Bosch in Aveiro works mainly with smart home efficiency, being more focused in thermotechnology, inside the sector of BBE. As related to Bosch in Ovar, the primary emphasis goes to security systems, inside the domains of BBE and BBG. Finally, Lisbon

has the central functions for sales, marketing, accounting, and communication, related to all the sectors previously mentioned.

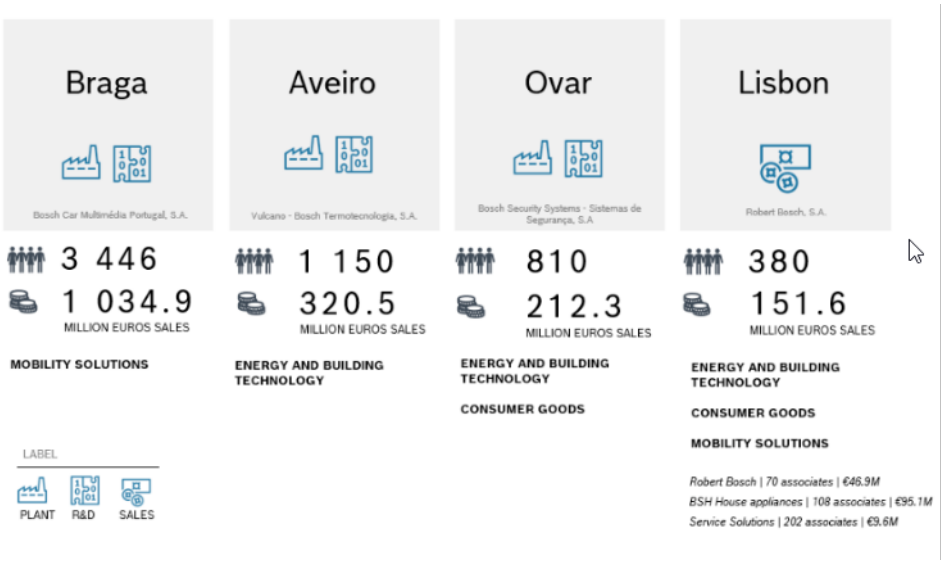

Figure 4.4: Locations, business sectors and statistics of Bosch Portugal (2021)

4.1.3 Bosch Braga

Bosch Braga is a prominent facility that falls under the Automotive Electronics division of the BBM sector. It is the largest of Bosch's locations in Portugal and one of their largest facilities globally, employing 3,446 people as of the end of 2021 and generating €1,035 billion in revenue, which accounted for 60% of all Bosch units' revenue in the country.

There are two main sectors in Bosch Braga, the Plant and Development. The Plant is the physical manufacturing facility where products are made, while the Development is responsible for conducting research and development activities aimed at improving existing products or creating new ones.

The Bosch Braga (BrgP) Plant is the main plant in the AE division and is the largest Bosch Company in Portugal, serving as a competence centre for the European market. The Plant has a Research & Development department, a manufacturing unit for Mobility Solutions (BBM), after-sales services, and education. The BBM business sector focuses on supplying automotive components and subsystems, as well as providing mobility life cycle services to fleet operators and mobility platforms. Automotive Electronics is part of Bosch BBM business sector, which develops and supplies electronic systems that serve as interfaces between drivers and their vehicles, including infotainment, display, connectivity, interior-sensor, and user personalization solutions for a wide range of vehicles. The BrgP Plant specializes in

manufacturing multimedia solutions and car sensors, including infotainment systems, instrumentation, and security sensors, as well as divisions such as Cross-Domain Computing Solutions, Chassis Systems Control, and Automotive Aftermarket. Additionally, the facility hosts several central service areas of the Group, including Information Systems & Services and Global Services.

Regarding the Development sector, it is divided into 5 buildings in Braga. This seeks to expand BrgP business areas and competencies and is responsible for researching and developing new products and technologies that meet the evolving needs of customers while promoting values such as innovation and sustainability. This master thesis was developed in this sector, regarding the process of developing a new product for a customer.

Bosch serves a diverse customer base spread across various geographical regions. The company's clients include well-known brands such as BMW, Jaguar, Land Rover, Mercedes-Benz, and others, as illustrated in Figure 4.5.

Figure 4.5: BrgP customers for series deliveries (2023)

Overall, Bosch Braga plays a significant role in Bosch's operations, both in Portugal and globally, as the largest Bosch Company in the country. The BrgP sectors expertise in developing and manufacturing multimedia solutions, coupled with its focus on supplying automotive components and subsystems and providing mobility life cycle services, makes it a crucial hub in Bosch's Mobility Solutions business sector.

4.2 NPD Projects at Bosch[2]

The complexity of customer projects has continuously increased over the recent years, allied with an increasing number of activities beyond product creation being carried out as projects. Additionally, as per data from 2018, projects that involve multiple departments or line functions account for over 80% of Bosch's sales. These facts serve to highlight the crucial role of Project Management at Bosch. Therefore, Bosch has a strong culture of project orientation, and PM is considered a core competence that is relevant to product development projects.

"Project Management at Bosch is a benchmark in our industries" (2022).

To describe and standardize the recommended elements of Project Management at Bosch worldwide, the company created a central directive titled **Bosch Project Management Handbook**, formerly Robert Bosch Project Management Body of Knowledge. Despite internal rules, processes, and methods, this guide is based on the PMBOK® *Guide* and will be presented throughout this section.

The PM approach at Bosch can be summarized into five main topics, which are extensively covered in the Bosch Project Management Handbook: *Strategy and Leadership; Processes and Methods; Support; Qualification and Career* and *Assessment and Review*. These topics together make up what is known as the Project Management Diamond, which is illustrated in Figure 4.6.

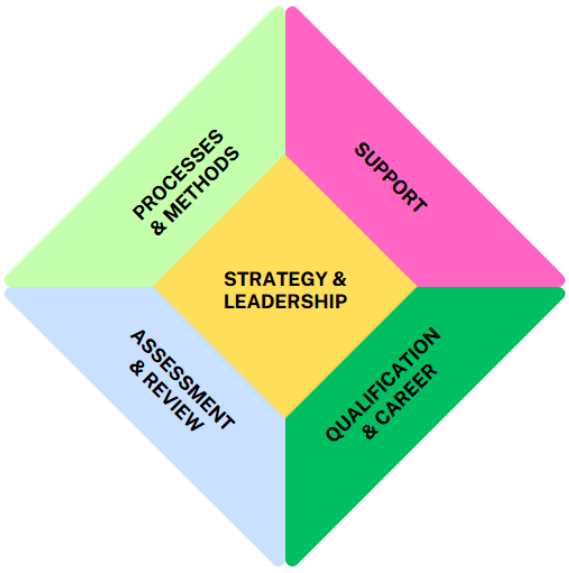

Figure 4.6: Project Management Diamond of Bosch
Adapted (2023)

[2] This section has been developed using Bosch (2023b) and Bosch (2023c) as main reference sources.

4.2.1 Project Life Cycle at Bosch

The Bosch Project Life Cycle Model provides a general framework for PM that applies to various types of projects across different operating units, such as Product Development, Manufacturing, Organizational Development, and IT Projects. This model adopts a **Stage Gate** approach with recommended sub-processes as stages. This model, represented in Figure 4.7 outlines the entire and global scope of a project, from the initial project request to it's completion. To mark each achievement, each milestone is set and approved by the Project Sponsor before moving on to the next phase.

Figure 4.7: Bosch PLC Model (2023)

Bosch adopted the process groups established by the PMI: *Initiating, Planning, Executing, Monitoring and Controlling* and *Closing*, explained in subsection 2.1.5. Following, there is performed an overview of each phase represented in Figure 4.7. For a more detailed information about the processes, milestones and activities in each phase, consult Figure A.1.

i. PHASE 0 - PROJECT REQUEST: This stage starts with milestone MO, which marks the formal approval to start working on a project request. This initial phase requires the project to demonstrate its compliance with the operating unit's established project acceptance criteria, as well as its potential benefits for the organization. The final milestone of this phase, M1, involves the approval of the Project Charter, which includes the official assignment of the Project Manager (Pm).

ii. PHASE 1 - PROJECT PREPARATION: At this stage the Pm gathers the Project Team, further defines the project scope, and begins developing the Project Management Plan. Once milestone M2 is approved, the Project Team is officially formed.

iii. PHASE 2 - PROJECT CONCEPTION: This stage is responsible for finalizing and approving the Project Management Plan, which is associated with milestone M3.

iv. PHASE 3 - PROJECT IMPLEMENTATION: This stage is where the main project work is carried out, and where the most value is added. This stage ends once both internal acceptance M4 and external acceptance M5 are obtained.

v. PHASE 4 - PROJECT COMPLETION: This stage involves performing the necessary activities to close the project, until obtaining the formal release from the Pm and Project Team at milestone M6.

Also related to the phase 0 of the PLC, it's important to note that Bosch has two distinct standard procedures that can be followed to initiate the project. The procedure used is dependent on whether the project was specifically requested by a customer or if the company has identified a new and innovative business opportunity in the market. These projects are called New Product Development (NPD) projects and their PLCs are detailed based on the specific requirements, goals, and specifications. This customization of the PLC for NPD projects ensures alignment with the distinctive characteristics and objectives of these kind of projects. This tailored approach can be referred to as the NPD process, as it encompasses the specific stages, activities, and considerations that are integral to the successful development of new products in the company.

In this master thesis the concerned project is regarding a product that was requested by a customer, and it's currently being developed according to the customer's specifications and requirements. Therefore, the milestones that are considered during this PLC are called Quality Gate Customer (QGC). In Figure 4.8 it's represented the New Product Development process at Bosch. As shown, first a project request is performed, supported by Sales Evaluations, represented as SE milestones. After that, the PLC begins, starting with the Project Preparation phase that ends with the Kick Off of the project. The rest of the PLC goes through a maximum of five evaluation stages (depending on the project type some milestones can be skipped) that are the represented QGC. The project that is being considered in this work has recently gone through it's QGC0, so it's currently at it's Product/Process Development phase.

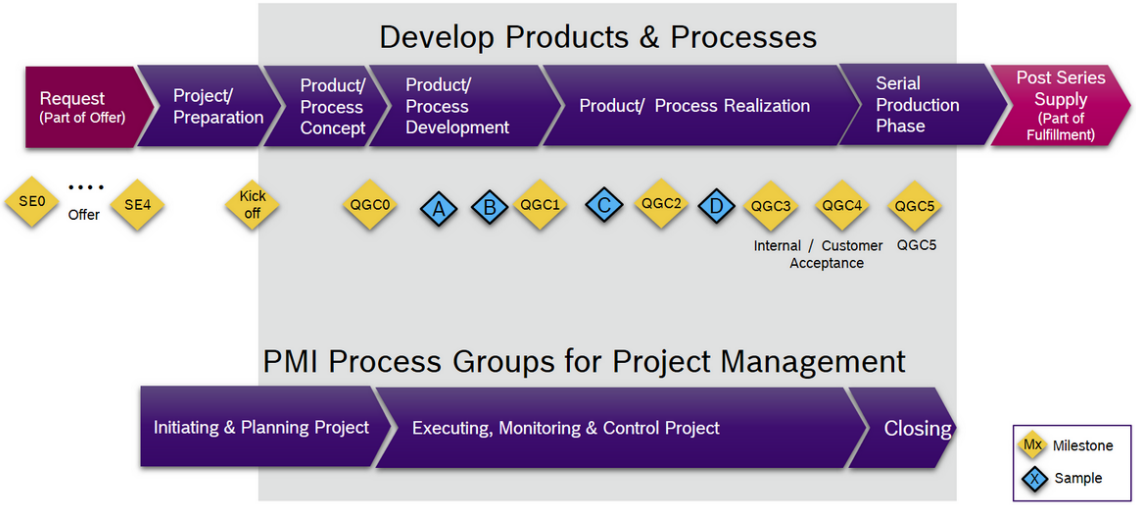

Figure 4.8: NPD process at Bosch (2021)

As also shown in Figure 4.8, during the NPD various sample phases are implemented to assess the product's maturity level as it progresses throughout the project. These sample phases are typically labeled as **A, B, C,** or **D**. Each sample phase represents a distinct stage of testing and refining different aspects of the product. The use of these sample phases is an essential component of the NPD, as it helps ensure that the final product meets the desired specifications and is ready for commercialization at the Start of Production (SOP) remark. More information about each sample phase is shown in Table 4.1. The product of the project that is being considered in this work is currently in its **B samples** production phase. For a more detailed and visual representation, including a more specific characterization of each sample phase process within the general pilot project of the NPD process at Bosch, please refer to Figure A.3.

Table 4.1: Sample phases of the NPD process in BG

Sample Phase	Use	Manufacturing
A	Information for the customer on function. Information for preliminary tests or packaging studies. Confirmation of function. For functional testing.	Special manufacturing (sample shop) or modification of existing products. Partially final materials and semi-finished parts only.
B	For preliminary tests by the customer. Ensure overall functional scope and technical requirements. Use/application in the targeted system (prototype). Internal (Bosch) design verification. Elimination of residual deficiencies.	Parts may be from trial/auxiliary tools. Largely made from semi-finished parts and final materials. General process design is finalized.
C	Tests by the customer to achieve technical release for Bosch as the supplier. Confirmation for internal product release (ending of development phase). Design validation by customer.	Processes and tools are defined for series production. Final materials and semi-finished parts are defined for series production. Suppliers for series production are selected.
D	Initial sample with test report for the customer as basis for release of series production delivery. Pilot series to prove out production robustness. Product audit. Validation by customer.	All parts are produced with series production tools and processes. All parts are mounted and tested under series production conditions.

The PM landscape and procedures vary across the different BG divisions, with each division having its own unique teams and working methods. It is important to recognize these differences and make allowances for them in order to effectively manage projects within each domain. The landscape of PM regarding the New

Product Development in BBM division, more specifically regarding Automotive Electronics, is represented in Figure 4.9.

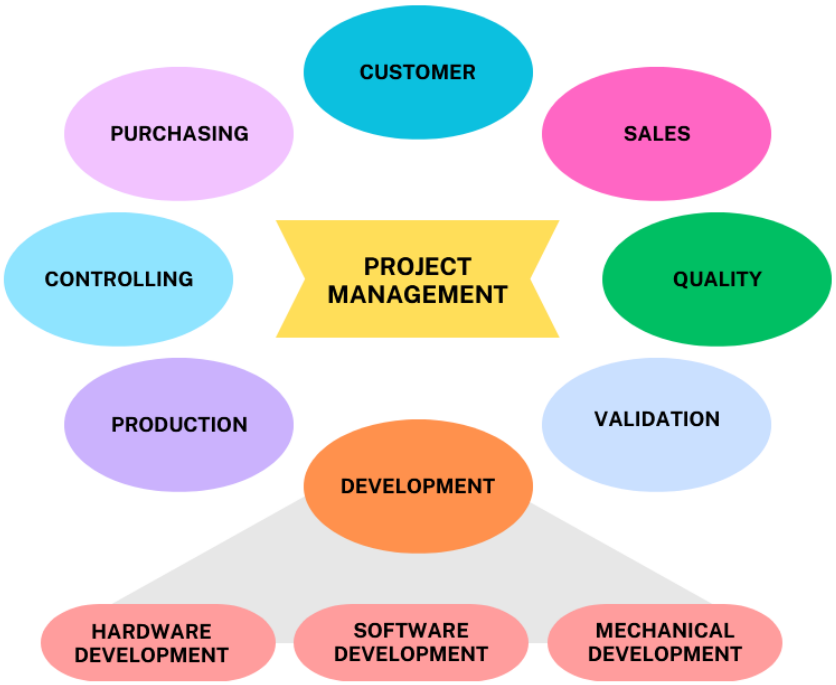

Figure 4.9: PM landscape at Bosch for AE NPD
Adapted (2021)

4.2.2 Meeting with experts

The success of any project heavily relies on proper Project Management practices. Therefore, it is essential to understand the standard processes within the company and what is expected of Pms and their teams.

To gain a better understanding of these processes, an online interview was conducted with an expert in RM and a PMO in the field of NPD projects that is responsible for development project's Lessons Learned. The interviewee, who holds extensive experience and knowledge in these fields, provided valuable insights into the company's standard approaches. This section presents the findings of the interview, which sheds light on the best practices and guidelines that are "by the book" expected of Pms and teams. Although some general questions were prepared, the interview followed an open-ended and conversational approach, allowing the conversation to flow naturally and for the interviewee to expand on their responses as needed. To ensure that the interviewee's guidelines and advice were more tailored to the project at hand, the interview began with a brief project contextualization and overview. The main questions posed to the interviewers aimed to explore their experiences and expertise mainly in the topic of RM and some are listed below:

i. *"What are the standard or expected practices for risk management in a project at Bosch?"*

ii. *"What strategies do you use to promote a risk-aware culture within project teams?"*

iii. *"What tools do you recommend and what are their utility?"*

iv. *"Any extra advice or best practice?"*

Based on the interview, it was acknowledged that there is a lack of documented information and clear standards for RM within the organization. Moreover, it was noted that for projects of a similar scope to the one under consideration and which were not considered critical for the company, there were no strict or critical specifications or requirements regarding Risk Management. This allowed Project Managers some freedom in determining how to manage risk for these projects. Based on this discussion, the PMO suggested scheduling a meeting with other Pms to gain an understanding of their RM routines and gather best practices. The goal of this meeting would be to document these best practices and make the knowledge available to everyone, with the aim of improving the overall process. This meeting outcomes are provided in subsection 4.2.5.

The input from the interviewees was helpful in providing an overview of the standards that were considered throughout the master thesis, and these inputs are detailed in subsection 4.2.3. However, it was noted here and also when consulting internal documentation at Bosch, the standards and practices related to RM were not clearly defined or well-established. This finding suggests a need for further research and development in this area, in order to establish more robust and consistent practices.

4.2.3 Risk Management at Bosch

"Through risk management, the project manager can stay in control of the project rather than being controlled by it" (Mulcahy & Diethelm, 2013, p. 407).

The Project Manager holds the primary responsibility for Project Risk Management. As per the PMI guidelines, Bosch's Project Risk Management involves risk management planning, identification, analysis, response planning, and controlling risk throughout the project. While the Pm bears the primary responsibility for identifying potential risks and planning how to respond to them proactively, it's essential not to overlook the importance of collaborating with the rest of the team in this matter. As also stated in the literature, risks are inherently uncertain and may have either positive or negative impacts on the project, being categorized respectively as opportunities or threats to the project.

Referring to Bosch (2023c) *"when risks are assessed, the project manager usually has to assess several things: How likely is it that the risk will happen, how will it affect the project if it happens, and how much will it cost if it happens? The project manager will be using a lot of risk analysis tools and techniques to answer these questions."*

As a best practice within the company, tracking the current status of the risks and outcomes of all implemented measures is essential, and this is achieved through an **Open Points List**. This is a list of open points in the project which need to be taken care of by the responsible team member by an agreed date. At Bosch, the recommended tool for the Open Points List management is Super Open Points List (SuperOPL), which is further analyzed and explained in subsection 4.2.4.

To ensure effective Risk Management, the Pm is expected to discuss this list during regular project team meetings, ensuring that all team members are aware of the project's progress and any outstanding risks. By regularly reviewing and updating the list, the team can identify areas for improvement, make more informed decisions, and take proactive measures to mitigate any risks that may arise. These regular revisions of the list can be achieved by including it as a regular agenda item in the team meeting or also by repeating a risk workshop. During these discussions, the Pm must update the status of each individual measure for the identified risks, assess any new risks that have emerged, and implement suitable measures to mitigate them. It's also essential to remain vigilant for new risks that may arise from other sources and promptly adopt them into the Risk List. The risks must then be assessed and remedied by installing suitable measures based on the predefined criteria.

Following, the stages of the expected Risk Management process at Bosch are outlined. It's important to highlight that these steps shall not be mistaken as phases, as they can and shall happen repeatedly and intertwined. Moreover, it is possible, for example, to start by defining a response strategy before performing any kind of risk analysis.

i. RISK IDENTIFICATION: Identifying potential threats or opportunities that can affect a project, the aim is to surface risk. This process should be conducted by the Pm and project team members and must be iterative since new risks can arise at any time. This involves the determination of risk type, category, event, and effect. The standard risk categorization at Bosch is detailed in the Risk Breakdown Structure, which is represented in Figure 4.10.

ii. QUALITATIVE RISK ANALYSIS: Classifying and prioritizing identified risks by updating the probability and impact of the potential risk. In order to mitigate the ambiguity of this process, there is a standard criterion set for qualitative analysis, common for Bosch Group worldwide. However, these

criteria are extensive and extremely detailed, making it challenging and time-consuming to consult them each time a risk assessment is performed.

iii. QUANTITATIVE RISK ANALYSIS: Assessing the quantitative impact of risks both in terms of the costs associated with the response and the potential benefits of mitigating or avoiding the risk altogether. To determine the financial impact of the events, it is common to use methods such as conducting interviews with relevant stakeholders or experts, obtaining expert ratings, or analyzing historical data.

iv. RISK TREATMENT: Decide the risk response according to the chosen risk strategy. The strategies will depend on the risk type, as it's shown in Figure 2.15.

v. DETERMINE MEASURES: Responses are defined through the development of measures to increase opportunities and reduce threats. There is also the need to evaluate them with respect to their implementation costs and effectiveness, in order to ensure the optimum level of RM.

vi. RISK MONITORING: Review the Risk List with the risk team, experts, and stakeholders, keeping it updated.

vii. RISK CLOSURE: Updating the final status of the risk characteristics and risk responses, recording the results as lessons learned documentation.

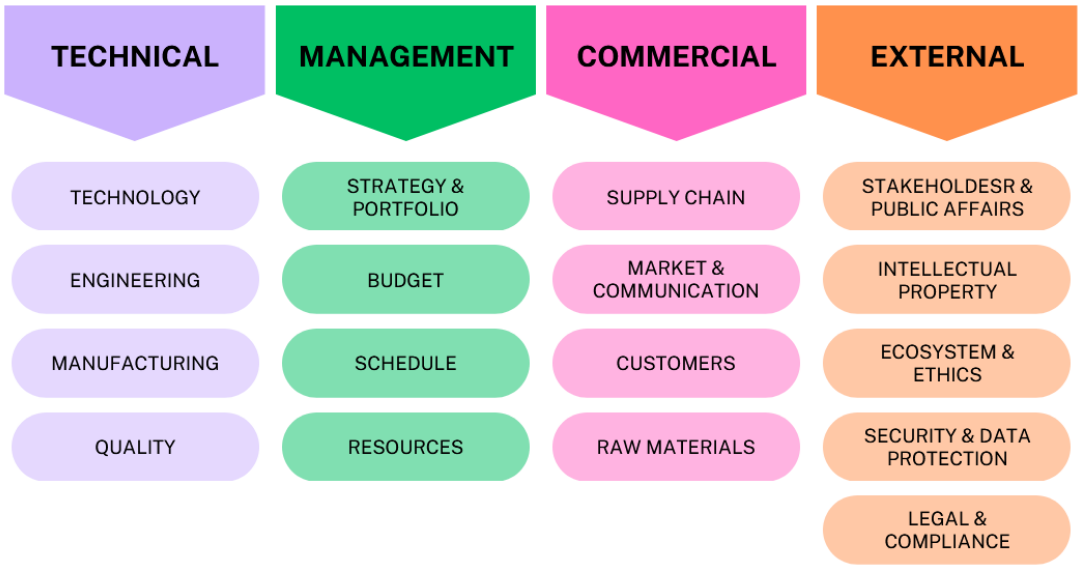

Figure 4.10: Standard Risk Breakdown Structure at Bosch
Adapted (2023)

4.2.4 SuperOPL

The SuperOPL is a software used internally by Bosch, especially for task and Risk Management. It allows the user to record the tasks of employees on individual projects in open point lists, that go through several states from draft to closed task. It is possible to delegate them or add interested employees, who are informed via email about changes in the tasks and other relevant information. It is also possible to organize meetings, create the agenda and meeting minutes, as well as create tasks that need to be further discussed, during the actual meeting. A Risk List is also incorporated in the tool with several useful features for RM. SuperOPL also helps to manage project problems, and lessons learned.

Currently, this software is used by around 70 000 users worldwide out of a total of 400 000 Bosch employees. Moreover, it is translated into twelve languages including Chinese and Japanese. The logo of this program is shown on Figure 4.11.

Figure 4.11: Super Open Points List (SuperOPL) logo (2023)

This is the tool that is being used in the project for RM, following the best practices recommended by Bosch. The use of this tool starts once a risk is identified, meaning it needs to be documented in the project's **Risk List**. In Appendix B the procedure to create a new risk is more detailed. As shown, the platform allows users to distinguish between threats and opportunities in the first mandatory field when creating a new risk, and to specify the risk category as technical, management, commercial, or external. The software prompts users to input the risk by referring to it's event and effect separately, encouraging the formulation of risks in the *"If...Then..."* format.

In addition to these mandatory fields, users can provide more information about the risk, such as whether the consequences of the risk extend to other products/projects, the causes of the risk, risk indicators, risk thresholds, and the estimated date of the risk, among other relevant notes.

SuperOPL allows users to conduct a risk analysis, whether quantitative, qualitative, or both, providing the necessary fields for users to input the required information. For instance, the risks can be rated according to their likelihood and impact, using a scale that ranges from very low to very high. This allows for the

automatic calculation of the Risk Indicator. Along with this process, a Butterfly Risk Matrix is automatically mapped, which permits a visual representation of the risks. This matrix divides the risks into quadrants based on their impact severity and the likelihood of occurrence, and it's commonly used as it is considered a best practice at Bosch when it comes to qualitative risk analysis. Furthermore, users can use tags to improve the organization of risks on the platform and facilitate their filtering.

Associated with each risk, measures can be added. Each measure, which can be defined as a decision or task, will be automatically added to the open points list in the software as an activity to be completed. When creating a measure, the associated strategy type (avoid, mitigate, transfer, or accept) and start date of the measure should be indicated. The platform also contains fields for adding other types of information, as shown in Figure B.3, in case the user wishes to do so. Among this information, the priority level, due date, associated cost, and the person responsible for the measure can be highlighted. The meeting that originated the measure can also be associated with it, and the minutes of the meeting and respective documents will be automatically linked to the measure.

SuperOPL will display all created risks and their respective measures in the Risk List as shown in Figure 4.12. Below are the measures for the risk, along with their respective responsible parties and due dates. It's important to note that the ideal situation is for all team members to keep their own risks and measures updated, meet the deadlines and complete the listed activities.

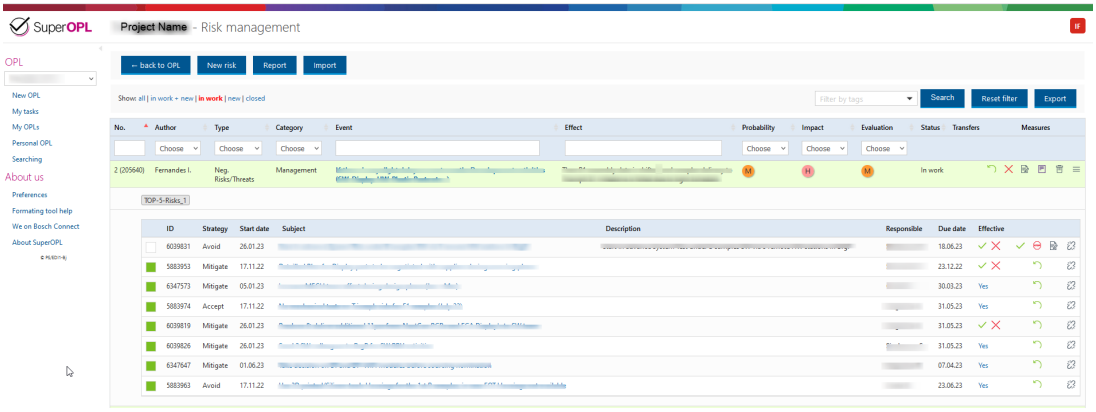

Figure 4.12: SuperOPL Risk List overview (2023)

4.2.5 Open session with Project Managers

As was mentioned in subsection 4.2.2, a face-to-face meeting was organized with all Project Managers of NPD projects to have an open discussion about their daily routines and practices related to RM. This collaborative approach to sharing knowledge and best practices aimed to gather insights from different

experiences in order to identify common practices and areas for improvement and develop more tailored and robust processes that reflect the needs and requirements of the development projects. The outcomes of this meeting were documented and shared with all project managers, ensuring that the knowledge is available to everyone, however, the consent to provide that document in this master's thesis was not provided. Nevertheless, some important conclusions and notes from this meeting are going to be detailed in this section.

Every Pm already used the SuperOPL software for performing RM and considered it a best practice.

Several ideas were discussed regarding meeting frequency and dynamics, with most proposals suggesting that risk-related topics be addressed on a weekly basis. There were differences in terms of when these topics should be discussed during the meeting, as some proposed discussing them at the beginning of the meeting, while others suggested addressing them at the end. On another hand, some proposed having a separate meeting entirely dedicated to this domain. In addition, there was a discussion about the concept of creating meeting clusters to specifically address risks, as opposed to always having global team meetings.

It was observed that no team was performing Quantitative Risk Analysis, as it was deemed too time-consuming and resource-intensive. Furthermore, the Quantitative Risk Analysis was mentioned as being *"tricky"* to perform with teams, as it can be difficult to reach a consensus on the numerical values assigned to risks and can lead to disagreements or misunderstandings among team members.

Another challenge that was identified by the Pms in their risk routines with teams was ensuring a proactive and risk-oriented mindset among team members, in order to ensure that risks are identified and followed up, and to keep the RM platform up-to-date. This challenge involves promoting a culture of risk awareness and encouraging team members to actively identify and report potential risks, as well as ensuring that risk management tasks are integrated into the team's daily routines and workflows.

4.3 The Project

Throughout the previous sections, some topics related to the project that served as the foundation for this work were introduced and mentioned. In order to provide more context about the work that was developed, the present section will present additional information about the project.

4.3.1 Project contextualization

The study being presented is centered around a project aimed at the development of a new product within the AE division of the company. Specifically, the project focuses on creating an advanced instrument cluster for motorcycles. This product is currently in the early stages of its PDP. It is worth noting that this product is being developed in collaboration with a specific customer, as the sales of the product are intended for that customer exclusively. Therefore, the PDP is being carried out in parallel with the customer's requirements and feedback.

As remarked as *"present work initiation"* in Figure 4.13, the data collection and analysis of current practices for Risk Management began actively quite before the start of B samples production. Therefore, the project was at a really early stage. The QGC0 was approaching and being prepared by the team and along with it RM was starting to be tailored for the project, by the Pm.

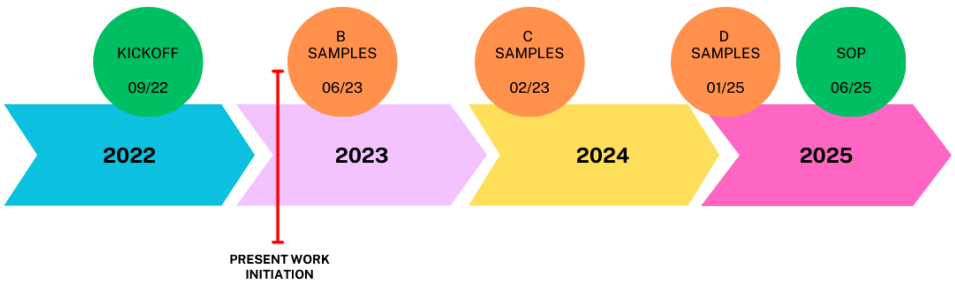

Figure 4.13: PM landscape at Bosch for AE NPD
Adapted (2021)

4.3.2 Team and organization

Certainly, the diversity of cultures and people in a project team has a significant impact on Project Management, and of course Risk Management as well.

"Everyone is different and these differences matter. Valuing the differences and integrating diversity into how we do our business every day, will become an increasingly important success factor." - Volkmar Denner, Bosch Group CEO.

To ensure that the resulting proposals of this study would be beneficial improvements for everyone's daily work, regardless of their cultural and other differences, it was important to start by understanding the organization of the team, and only then it's dynamics regarding PM and RM. Therefore, the first step was to understand the team's structure, and backgrounds as well as their level of awareness and maturity regarding the areas under focus. The current product development team is structured into departments,

accordingly to the overall landscape illustrated in Figure 4.9, but of course more complex. Each represented department corresponds to a separate team, and it's important to note that these teams are geographically dispersed across different countries, as depicted in Figure 4.14.

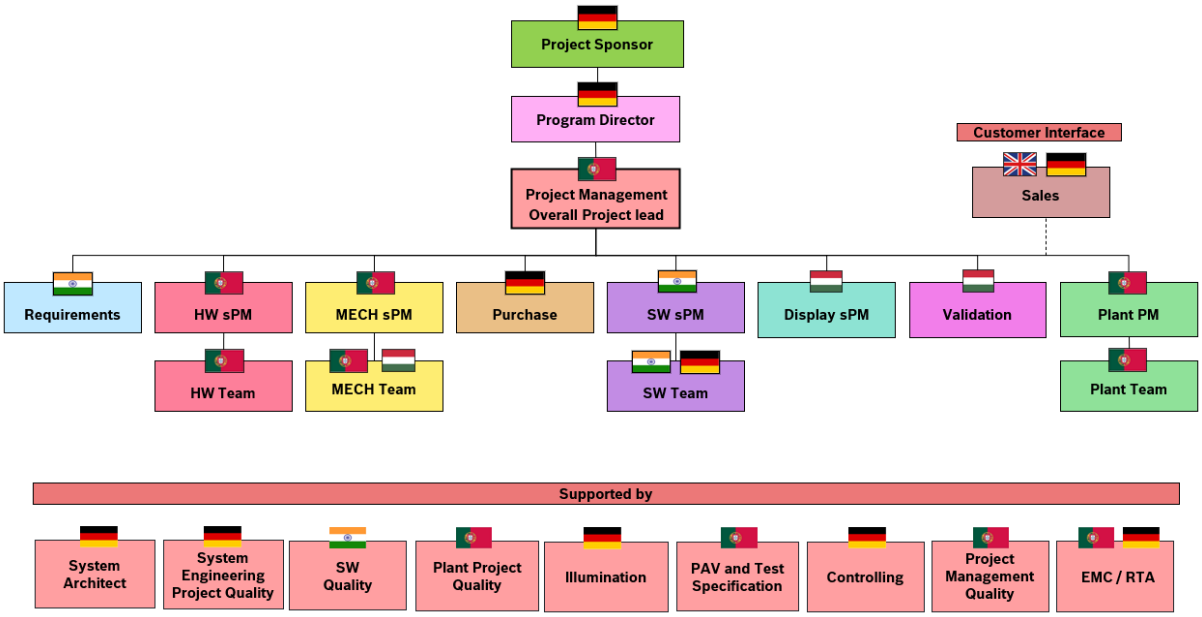

Figure 4.14: Project Organizational Chart - Roles and Nationalities (2023)

The **Core Team** is the most important stakeholder in ensuring the project's success, therefore, it is crucial to ensure that all the domains are aligned and coordinated. The Core Team in this project is composed by the following domains: Hardware (HW); Software (SW); Mechanics (MECH); Display; Plant; Purchase; Requirements and Validation. Moreover, the primary interface and source of information for the Project Manager and the team are the Sub-Project Managers of each development team (HW, MECH, SW and Plant) along with personnel responsible for the Display, Requirements, Purchase and Validation domains. Their role includes providing progress updates and reports on their respective domains. For these reasons, the main focus of this study was the Core Team, which is distributed by Portugal, Hungary, India, and Germany. Evidently, this cultural diversity within the team results in significant challenges for the Pm, despite the potential benefits that come with it. Cultural diversity can bring fresh ideas, new perspectives, and innovative approaches to the project, but it can also lead to communication barriers, misunderstandings, and conflicting work styles. For the Pm to ensure that the team is following the unified Bosch standard processes successfully, despite the differences in work styles and perspectives, it is essential for the Pm to manage the team through proactive communication, active listening, and a willingness to adapt to the unique needs of each team member, starting by understanding their characteristics.

4.4 Current State of Risk Management

4.4.1 Current Risk Management Plan

During the initial stages of a project, characterized by numerous risks and uncertainties, it is crucial to address these challenges. Therefore, it was expected that the Risk Management Plan (RMP) would already be scoped and in progress to ensure a comprehensive RM approach. However, as stated before in subsection 4.3.1, it was observed that Risk Management practices were still in a very preliminary phase, with routines and activities still being defined, tested, and encouraged in the team's dynamics by the Pm. Given this lack of maturity of the RMP, the team displayed a relaxed approach and lacked a proactive attitude towards risk identification, analysis, and control.

The team holds several meetings on various topics, either weekly or monthly, but special emphasis is placed on the team meeting that occurs weekly and is attended by all members previously shown in Figure 4.14. During this online meeting, the Pm sets aside time to ask the team about any updates on risk status, updating the SuperOPL as information is shared and discussing it on screen. Therefore, if any new risks or tasks are identified during the meeting, the Pm will add them to the software.

It was noticed that since the weekly team meeting is the only opportunity for the entire team to convene, many topics and issues are brought up during the meeting, which often results in insufficient time to discuss and review the project's Risk List or inquire the team about new risks. Although these topics are included in the meeting agenda by the Pm, they were not being discussed weekly in detail due to time constraints.

Additionally, it was common for the Pm to record identified risks directly in the meeting minutes, which are being shared on the screen during the meeting as a guide for the discussion topics, rather than opening the Risk List and updating it immediately during the meeting, due to time limitations. This may cause some risks to be overlooked and their tracking to be lost over time, as they are not recorded in the proper place.

4.4.2 Current Risk List

To gain a comprehensive understanding of the status of the Risk List, some data was collected and analyzed. Table 4.2 provides an overview of the current status, which includes information about the total number of risks formulated, the number of overdue risks, the number of positive risks, the number of

risks without measures created, and the number of risks without important information defined. For the purposes of the last metric, the risk event date was considered as important information, as category, type, event, and effect of the risks are mandatory fields when creating them in the software.

The table presented as Table 4.2 indicates that 33 risks had been identified for the project within these five months, which is a relatively small number given the high level of uncertainty that typically characterizes the early stages of a project. Additionally, all of the identified risks were negative or threats, indicating that the team is not giving that much importance and attention when it comes to identifying opportunities. Moreover, over 42% of the risks were overdue, meaning that the expected risk event day had already passed, and no update was provided regarding the risk status. This raises concerns about the team's level of attentiveness and follow-up in RM, and suggests that they are not proactively updating the platform with relevant information. The fact that approximately 75% of the identified risks had no created measures, infers that the identified risks may not be receiving adequate attention or action to mitigate their potential consequences, highlighting once again the need for improvements in the RM process. Additionally, about 12% of the risks were not fully described in the Risk List.

Table 4.2: Risk List status after five months of SuperOPL usage

Total Nº of Risks	**Opportunities**	**Overdue Risks**	**Risks w/o Measures**	**Risks w/o info**
33	0 (0%)	14 (42,42%)	25 (75,76%)	4 (12,12%)

It was also observed that certain risks have not been adequately articulated in the form of *"If...Then..."* statements. As a consequence, the causal relationship between the risk and its potential impact has not been explicitly stated, leading to an ambiguous risk description that may not be easily comprehensible to all members of the team. Furthermore, it was noticed that some items on the list were not actually risks, but rather problems that were already occurring or situations that had already manifested. This reflects that the risk assessment has a lack of clarity and understanding about the difference between risks and problems, leading to inconsistencies in how team members identify and assess risks. The risk evaluation process can also be remarked as unstable, as a potential lack of consistency in the team's risk perception and assessment was noticed. None of the risks had a quantitative analysis performed, but some had information regarding probability and impact, which results in a qualitative rating of the risk. This assessment was, however, inconsistent, as there were no established criteria for assessing risks, leading to each person relying solely on their own perspective. This lack of a standardized approach results in varying levels of risk identification and prioritization among team members. It's clear that the cultural

Table 4.3: Risk List status after five months of SuperOPL usage, per domain

Department	Nº Risks	Created by the PM	Nº of tasks	Created by the PM
Hardware	5	5 (100%)	7	7 (100%)
Software	6	1 (17%)	10	4 (40%)
Mechanics	4	4 (100%)	2	2 (100%)
Plant	0	0	0	0
Display	2	2 (100%)	0	0
Purchase	4	4 (100%)	3	3 (100%)
Validation	0	0	0	0
Requirements	5	3 (60%)	2	2 (100%)
Other	7	7 (100%)	4	4 (100%)

differences among the team can lead to different interpretations of the severity of a risk, which in turn can lead to inconsistencies in the risk assessment. Some cultures tend to be more risk-averse, meaning that they are less likely to take risks and may view potential risks as more severe and threatening. On the other hand, some tend to be more risk-tolerant, meaning that they are more willing to take risks and may view potential risks as less severe or less threatening. These differences lead to different interpretations of the severity of a risk, which in turn can lead to inconsistencies in the risk assessment. This creates a lack of consensus and makes it difficult to prioritize risks effectively.

Table 4.3 displays information regarding the risks present in SuperOPL for the various domains. As can be observed, some departments had no risks identified, while those that did were practically all created by the Pm rather than the responsible parties. Software stands out as the most active and proactive in terms of RM, with five of the six identified risks being created by the SW sPM. The last row of the table is related to overall risks not directly related to one domain particularly, with some topics related also to Project Management.

4.4.3 Current Team Maturity on Risk Management

This chapter is based on a questionnaire that was distributed to the project team, with the purpose of exploring their perception of Risk Management concepts, and drawing conclusions about their attitudes and routines regarding this topic. The questionnaire can be consulted in Appendix C.

The form was distributed to all core team members and also the Pm, achieving a total of 9 responses. The

objective of the questionnaire was to assess the team's current level of maturity in managing risks and identify areas for improvement. Therefore, the responses were analyzed to identify the team's strengths and weaknesses in terms of RM. Questions were formulated to explore their perception of risk concepts, attitudes, and routines, and evaluate their level of engagement, limitations, and awareness regarding RM in the project.

The first section of the form consisted on three questions focused on evaluating the perception and knowledge of the team when it comes to RM. The results of these questions are provided in Figure 4.15 and Figure 4.16

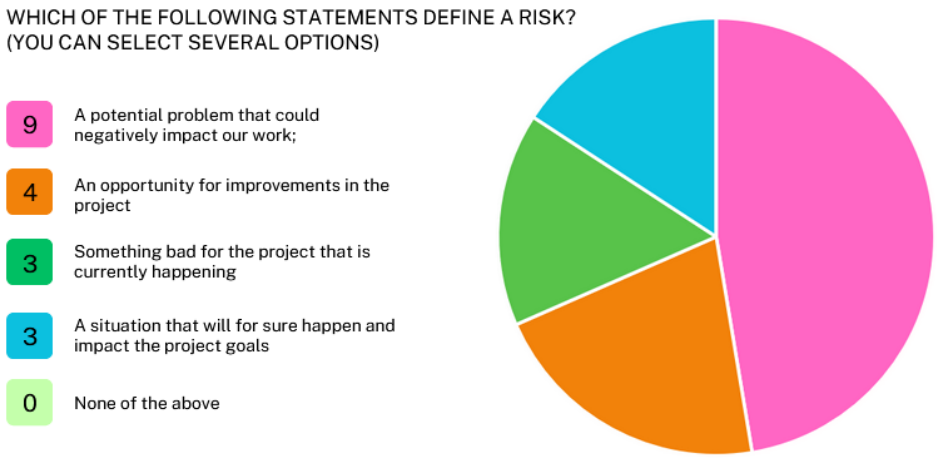

Figure 4.15: Team Questionnaire - Question 2 result

Upon analyzing Figure 4.15, it becomes apparent that the team lacks a clear understanding of the actual definition of risk. According to the theoretical framework, the correct answer for this question was both options marked as pink (*"A potential problem that could negatively impact our work"*) and orange (*"An opportunity for improvements in the project"*), while the statements in blue and green refer to the definition of a problem.

As previously observed in subsection 4.4.2, where a lack of registered opportunities in the project's Risk List was noted, the team does not acknowledge opportunities as risks and is primarily focused on threats. This was further confirmed by this questionnaire result, where only four out of nine team members, which is less than 50%, selected the option referring to positive risks.

Additionally, as observed during the evaluation of the project's Risk List, many team members view problems as risks, which is not the desirable mindset. The questionnaire results show that three team members selected the option marked as green (*"Something bad for the project that is currently happening"*), which defines a problem as it is already happening. Furthermore, three team members acknowledged that a

situation with a 100% probability of occurrence is also a risk, as they selected the blue option (*"A situation that will for sure happen and impact the project goals"*).

These findings highlight the need for the team to improve their understanding on RM concepts so they can develop a more effective approach to Risk Management, which must include both threats and opportunities. Therefore, it is essential to address these gaps in the team's knowledge and mindset to enhance their ability to manage risks in the project.

Figure 4.16: Team Questionnaire - Questions 3 and 4 result

The results of the next two questions of this first questionnaire section are presented in Figure 4.16. Regarding the first question marked as pink, which asked respondents how familiar they are with RM, the results show that most team members do not feel very confident in this domain. Six out of nine team members, which represents approximately 67% percent, selected level three on a scale of one to five. Moreover, one sPM selected level 2, which indicates a basic level of familiarity.

These findings suggest that the team may require additional training on RM best practices and processes to improve their knowledge and understanding. Without a solid foundation of knowledge in this area, the team may struggle to effectively manage risks and end up facing problems or missing opportunities which can impact the project's success.

The other question that is shown, marked in green, asked sPMs if they believed RM is an important factor for project success. The results of this question were very positive, as the majority of the team selected either level four or five, which are the highest levels on the scale. This acknowledgment may reflect a willingness among the sPMs to invest more in RM and improve their skills and knowledge in this area, which is very optimistic.

The next section of the questionnaire was designed to evaluate the subjectivity in risk assessment among the team, which had already been noted subsection 4.4.2. The assessment of risks observed during the evaluation of the project's risks was found to be ambiguous and inconsistent and appeared to be influenced by the team's cultural diversity.

To further explore this perception, three hypothetical risk statements were presented in the form, and it was asked to assess their impact on a scale from one to five. The three hypothetical risks that were raised during the questionnaire were based on different categories, including cost increase, internal deadline postponement, and external deadline postponement. To make the results easier to interpret, the answers were organized and *Boxplot* graphics were created for each question, as they permit to better identify outliers and see the spread of responses more clearly. These graphics are shown in Figure 4.17.

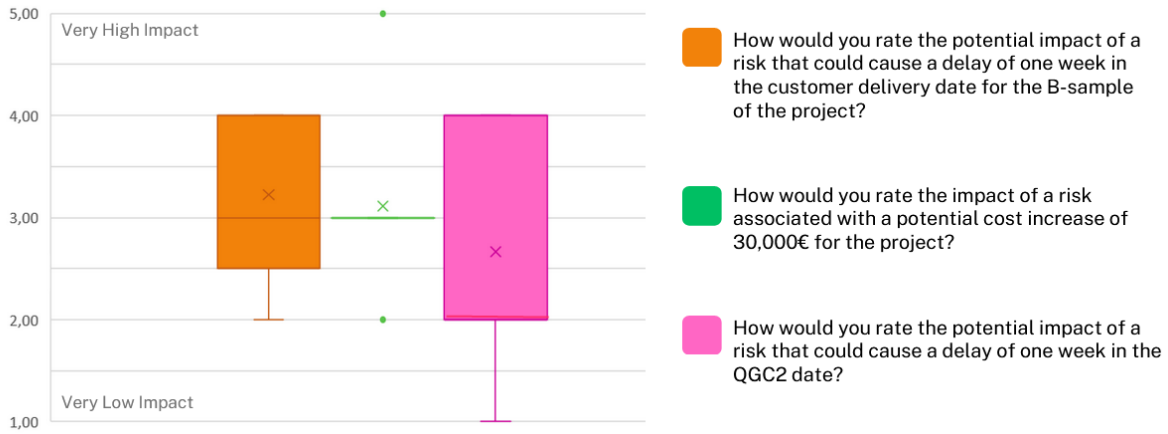

Figure 4.17: Team Questionnaire - Questions 5, 6 and 7 result

As observed from the results, there were several different opinions for each question in the form. The question regarding the cost increase, marked as green, stands out as the obtained answers were overall consistent on the medium impact rating (3), however, with two noticeable outliers on levels 5 and 2. This highlights a variance in the team's perceptions and opinions on what a monetary value increase represents to the project, which confirms the presence of team members who are clearly risk-averse, while others have a more tolerant mindset. This variation and inconsistency regarding risk assessment within the sPMs

are confirmed even more by the other *Boxplot*s, as the area of the graphics is bigger, indicating a higher degree of variation among the responses. This variation suggests that the team's perceptions are clearly spread out, and there is a wider range of opinions and perceptions. It is important to address these differing perceptions and attitudes towards risk and ensure that everyone has a clear understanding of the potential risks and their impact on the project.

The next section of the inquiry was designed to evaluate the team's limitations and capabilities in dealing with the required tool for RM in the project, with a focus on the Super Open Points List (SuperOPL) software. The results of this section are shown in the representation of Figure 4.18.

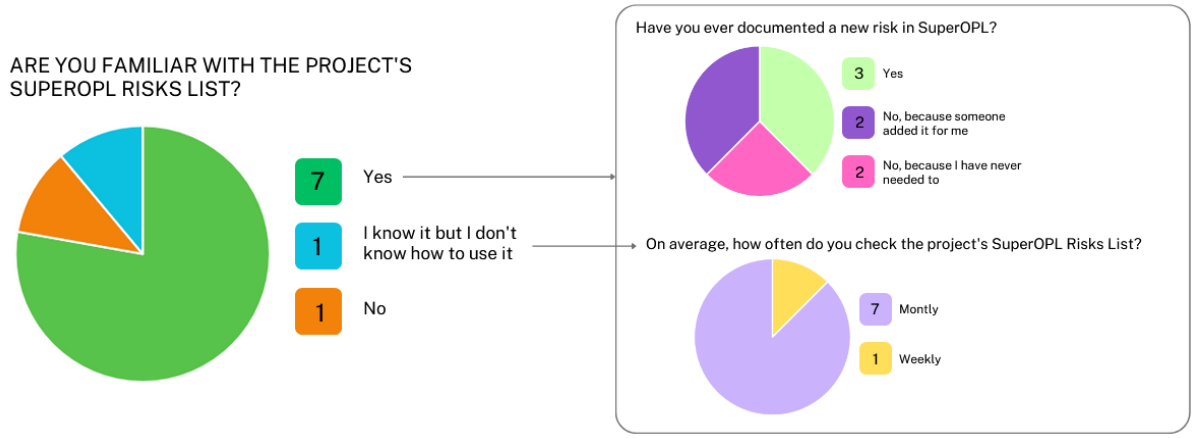

Figure 4.18: Team Questionnaire - Questions 8, 9 and 10 result

The first question of this section immediately highlights a gap in the team's Risk Management maturity, as one sPM acknowledged that they were not familiar with the Risk List of the project, furthermore, another stated that they knew about the Risk List but did not know how to use the platform. This reflects the need to provide training for the sPMs team on how to use SuperOPL to ensure that risks are being effectively handled. Despite this, it is positive to note that most of the team was familiar with SuperOPL.

The seven responders who stated that they knew SuperOPL were directed to a subsequent question about their activity on the platform. As shown in Figure 4.18, the results reflect what was already stated in the previous chapter, namely that very few people update the platform themselves and that it is common for the Pm to report the risks instead of team members. It is important to highlight that the practice of reporting risks to the Pm for registration is not considered a bad practice. However, it is undoubtedly beneficial to encourage proactive and autonomous risk behavior among the team members to ensure that risks are being effectively identified and managed in a timely manner.

Additionally, it is noteworthy to note that two people stated that they had never needed to register a risk.

However, given the critical months of the project initiation that went by and the project's dimensions, it seems unlikely that no risks appeared in their departments during this period. This response reflects a mindset that may not be actively seeking to identify risks in the team's daily work, which could lead to missed opportunities or threats. As a result, these sPMs may not feel the need to register risks as they do not recognize them as potential issues. This highlights the need to improve the domain of Risk Identification, as well as for encouraging a culture of proactive risk behavior.

The eight-team members who stated that they were familiar with the RM platform were then asked a question regarding the frequency with which they checked the Risk List. The majority of response was monthly. Is a positive sign that none of the respondents selected "never" which was also an available option.

The next section was built to conclude about the current risk practices and routines of the Sub-Project Managers. The first question was really simple and straightforward: *"Do you consider yourself proactive in identifying potential risks in your daily work?"*. While no one answered negatively, four people out of nine responded with "Maybe", indicating some uncertainty or insecurity in this area. This response may suggest that there may be a lack of clarity about what is expected of them regarding risk identification and management.

The second question of the section asked sPMs about their actions when confronted with risk. They were given several options and could select a maximum of three answers. The results are shown in Figure 4.19.

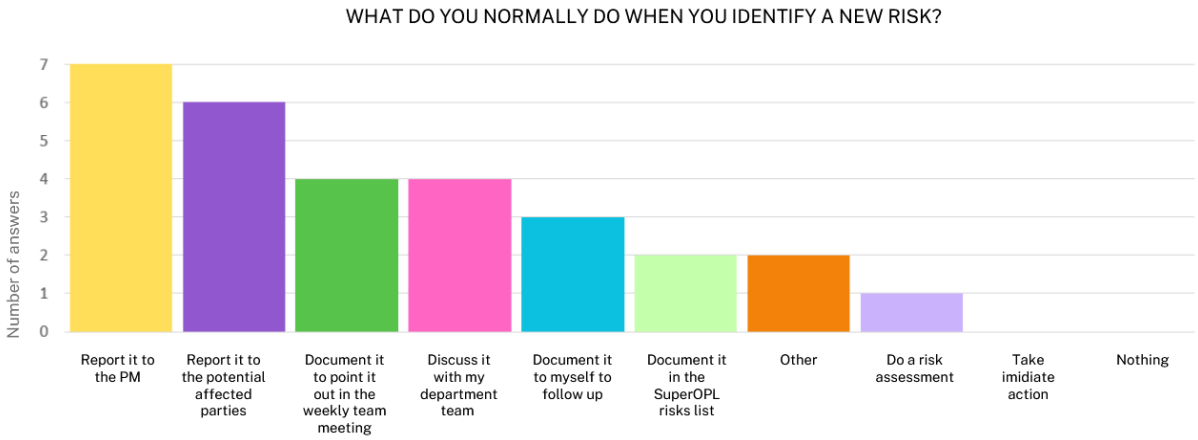

Figure 4.19: Team Questionnaire - Question 12 result

As previously assessed, most team members tend to prefer to report risks to the Pm, which may lead to a subconscious resting on transferring the risk and responsibility. The second most common response was to report the identified risk to the affected parties. This response indicates an understanding of the

importance of communicating risks to those who may be affected by them, moreover, having this sort of discussion is good for a deeper understanding of the risk and a comprehensive risk assessment. After that, most team members tend to document the risk in order to share it with the team during weekly meetings.

The next question aimed to determine whether team members acknowledged that RM was part of their job and how they approached it. The majority of team members considered RM to be part of their roles in the project and viewed it as an important subject that held their attention. However, two out of the nine respondents confessed that while they considered this matter to be part of their job, they did not take it as seriously as intended. This response suggests a potential lack of understanding or appreciation for the importance of RM in the project's success.

The question that follows aimed to assess the team's perception of the current risk management practices in the project by asking them to rate their level of agreement with the statement: *"Do you consider that the risks of the project are currently being well handled?"* on a scale of one to five. The team's average rating was four out of five, indicating a positive perception of the current RM practices in the project.

Finally, the team's need and availability for a risk-related meeting were evaluated, and a question was posed to the team: *"Do you believe that scheduling a team meeting specifically to discuss risk-related topics would be beneficial for the project and the team? (Conduct risk identification activities, check risk status updates, carry out risk assessment, follow up on action measures...)."* The results showed that the majority of the team members (approximately 78%) responded positively, indicating their willingness to actively participate in the RM process. After gathering this feedback, an open box was provided for the team to suggest the frequency of the meeting. The responses varied from bi-weekly to bi-monthly, with most team members indicating that monthly meetings would be their preferred frequency.

The last question of the form was another open box for the team to suggest possible improvements to the RM process. Here are the written suggestions that were given by the sPMs:

i. "Repetitive meetings for this topic."
ii. "Every risk must be evaluated with all domains in the meeting."
iii. "Measures shall be discussed together."
iv. "Focus more on the forecast, and the position of the risk in the *butterfly.*"
v. "Specific team meeting is required to discuss each risk and make all stakeholders in same understanding. Otherwise, we can have a defined time slot in the team meeting for Risk discussion."

Acknowledging the team's needs regarding RM, proactive steps can be taken to provide the necessary resources and training to the team. Overall, the questionnaire results suggest that while the team may require some clarification on certain risk-related concepts and additional training on the project's Risk Management tool, they are receptive to the idea of investing more time and effort in this domain.

The team's willingness and motivation to learn more about RM can serve as a positive foundation for implementing effective strategies within the project. By harnessing this motivation and enthusiasm, the Pm can foster a culture of risk-awareness and proactive RM more easily, which ultimately contributes to the project's success.

Chapter 5

Proposal of improvements

This chapter focuses on presenting the suggested improvements to improve Risk Management practices within the project and the company.

Regarding all the information that was acknowledged, the priority was to elaborate an efficient Risk Management Plan (RMP), in order to document standards and define a framework to ensure the team is successfully addressing risks in the project. This RMP proposal is detailed in section 5.1. To initiate the enhancement process of RM practices it was recommended to perform a Risks Workshop, to provide some training and basic important knowledge. This designed session is presented and detailed in section 5.2. In section 5.3 of the chapter, further proposals and suggestions are presented for the development and implementation of a comprehensive RM process, presenting some further details of the proposed RMP. A routine was designed and recommended to facilitate the installation of an effective framework for handling risks. Additionally, several suggestions were put forth to optimize the utilization and capabilities of the Super Open Points List. These recommendations are listed and discussed in section 5.4.

Lastly, at the end of the chapter, a summary was formulated in section 5.5 to provide a concise and synthesized overview of all the proposals that emerged from the investigation. This summary serves as a culmination of the chapter, highlighting the key recommendations and proposals for improving the RM process.

5.1 Risk Management Plan Improvement

To improve the RM process within the project, some tailoring and improvements were needed on the **Risk Management Plan**. To achieve this, there was a collaboration with the Project Manager to define the necessary tools, standards, and procedures based on the knowledge and feedback that was gathered during the case study. The tailoring and improvements made to the RMP aimed to ensure that the plan is

specific to the project's needs and effectively manages potential risks. After the tailoring of the process, it can be more easily implemented.

i. METHODOLOGY AND STRATEGY: As previously defined, the official project tool for RM is the SuperOPL and this good practice must be maintained and enhanced. Based on the team and experts' feedback, no further tools were deemed necessary for this subject, as this is comprehensive and complete software for managing risks.

   Risk-related meeting schedules must be defined and their frequency scoped. In addition, the standard meeting approach can be defined to be followed during these meetings. This approach will ensure that all relevant information is captured accurately and consistently, making it easier to track and monitor potential risks. To ensure that more specific and technical risks are addressed appropriately, extraordinary meetings with the risk core team must be scheduled as needed. All of these steps were developed and are further elaborated in section 5.3.

ii. ROLES AND RESPONSIBILITIES: In this project, and mostly all NPD projects at BG the RM team can be mainly defined as comprising the overall project leader and all Sub-Project Managers. In this case, the sPMs considered were from the following domains: HW, SW, MECH, Display, Plant, Purchase, Requirements, and Validation.

   While the main responsibility for the process is owned by the Pm, it was agreed to spread the responsibility for updating SuperOPL among all risk teams. sPMs should be responsible for proactively updating the platform and reporting these updates to the Pm for overall monitoring and control. Further details on the defined dynamics and responsibilities of the RM team are provided in section section 5.3.

   Furthermore, the researcher was regarded as a supportive risk expert for the project in RM. It was determined that having a risk expert involved in the project throughout its PLC would be beneficial.

iii. BUDGETING: A comprehensive analysis must be conducted with the Pm, Project Director, and other experts to examine the current budgeting of the project and understand the potential impact of different monetary increases on the project's overall success. This analysis was performed but due to the sensitive nature of the budgeting information, it was kept confidential to maintain the security and privacy of the company and project. This analysis provided valuable insights into assessment processes for the project.

iv. SCHEDULING AND TIMING: Meeting schedules must be defined and their frequency scoped taking

into account the activities of the Project Life Cycle. This frequency must be a forecast that considers the needs of the project for risk meetings.

v. SCORING: As already mentioned in section 4.3, the process of assessing risks can be really challenging, even more in multicultural and diverse teams. This may be due to the influence of various factors, such as language, cultural norms, and personal biases, various perceptions of risk severity may arise. As a result, it's essential to have a standardized and objective approach to assess the potential impact of risks that works for all team members to avoid high deviations during risk assessment.

   To address this challenge, a set of standard criteria for assessing the severity of risk impact was developed and must be shared with all sPMs for use. These criteria were mainly developed by taking into account the Risk Standard Criteria for performing Qualitative Risk Analysis at Bosch. However, it was intended to summarize and simplify it, in order to put it more practical and straightforward to facilitate their regular use by the teams. Therefore, standards, practices, and lessons learned from other projects were considered, always trying to personalize the criteria and adapt the topics to the specific project. Moreover, Bosch's subject matter experts were consulted and their inputs were considered.

   Table 5.1 outlines the criteria that were developed to assess the severity of the impact of identified threats. There were also created criteria regarding the impact of positive risks that can be consulted in Appendix D, and also criteria for addressing the risk probability of occurrence, which is shown in Table D. By having a standardized approach, the aim was to improve the accuracy of risk assessments and ensure that everyone had a shared understanding of the potential consequences of identified risks.

   A Quantitative Analysis process must also be implemented, which is recommended to be done during regular meetings with Sales and Purchasing teams, together with relevant stakeholders of the most high-rated risks. Also, a risk expert participation is encouraged to provide some guidance.

   Due to the size of the company, it is often challenging or time-consuming to obtain costs associated with specific risks or potential response actions. In order to address the difficulty of this process, it is proposed to develop a user-friendly tool that enables quick access to cost-based risk analysis. This tool would enable stakeholders from various departments to easily input and access relevant cost information, supporting a comprehensive understanding of the financial implications associated with different risks. The tool would provide a centralized database that consolidates and

organizes cost-related information, addressing a significant constraint faced by large and complex companies like BG, as this would eliminate the difficulties in accessing specific cost-related details. This information would provide a unique perspective that is crucial in decision-making and make this process a lot more easy and straightforward.

Table 5.1: Criteria for assigning impact levels for threats in qualitative risk analysis

THREATS	**Domain**		
Severity of Impact	**Cost**	**Time**	**Specification/Quality**
Very Low (1)	No significant increase in costs	Department postponement of date only. No significant changes in the overall project schedule.	Slight deviation from the specification. It is unlikely that the flaw could have any perceivable effect on the device behavior.
Low (2)	<10% increase in costs	Department postponement of date only. No significant changes in the overall project schedule.	Slight deviation from the specification. The flaw is of minor importance (minor annoying impact).
Medium (3)	10-20% increase in costs	Small postponement of internal delivery dates (e.g. samples) and/or milestones. Not affecting customer deadlines.	Clear deviation from the specification but most probably acceptable for all stakeholders.
High (4)	20-40% increase in costs	Postponement of important delivery dates (e.g. release samples) and/or QGCs. Delay affecting customer deadlines. No expected delays on SOP.	Clear deviation from the specification and not acceptable for stakeholders. Operational capability of the device is strongly reduced.
Very High (5)	>40% increase in costs	Postponement of important delivery dates for customer. Delays that may cause SOP to be postponed.	Clear deviation from the specification, not acceptable for customer. Flaw that may have a detrimental safety effect and/or violates legal regulations.

vi. CATEGORIZATION: The *Risk Breakdown Structure* to follow throughout the project's management of risks must be aligned with the team. The structure that was defined for this project was decided to be the same as the standard one at Bosch, previously presented in Figure 4.10.

In addition to this standard risk categorization, *tags* were created and suggested to be implemented to further classify and categorize risks within the project. This would help to implement more efficient risk filtering and procurement. They were designed to capture key risk-related information, such as high risk rates as well as the specific domains or areas of the project that were affected by these risks. Table 5.2 shows the created *tags* and respective meanings.

As it is represented, a *tag* for each core team department was suggested, as well as an "ALERT" *tag* to add on risks rated as high or very high on SuperOPL. Each risk can have more than one *tag* associated with it, and the purpose is to remark the main affected parties by associating its identification with the risk. The use of an "ALERT" *tag* helps to draw immediate attention to the

most critical risks, ensuring that they are addressed in a timely and effective manner.

Table 5.2: Created *TAGS* for risks categorization

TAG	**Department**
ALERT	Very High & High Rated Risks
PLANT	Industrialization Plant
PM	Project Management
MECH	Mechanics
HW	Hardware
DISP	Display
PUR	Purchasing
SW	Software
REQ	Requirements
VAL	Validation

vii. FORMATS AND TEMPLATES: The *Butterfly Diagram* was chosen as the primary graphic presentation for the project team regarding RM. This choice was made not only because it is a practical and simple visualization tool, but also because it can be automatically generated by SuperOPL. Moreover, the platform has a *Risk Report* that is generated automatically and exported in PDF format, showing all information of the current risk list.

Additionally, it was established that every created risk must be inputted into the SuperOPL software in the *"If...Then..."* format. This standard must be established to ensure that every risk is identified and captured in a consistent manner, making it easier to manage them effectively. This rule is intended to be spread across the project team to help to minimize the risk of errors or confusion in communication, ensuring that everyone is on the same page when it comes to risk interpretation. This would also help everyone to quickly capture the risk's triggers and consequences.

viii. TRACING: In order to have a clear understanding of the risks' progress throughout the PLC, some procedures were defined and suggested to implement in the project's risk process. The primary responsibility for these procedures should fall on the Pm. All the measures that are created must be closed after implementation, by the respective sPM responsible. In addition, a rating must be provided on SuperOPL on which the measure was actually effective or not.

Another key procedure established was that, whenever a risk was closed, the outcome must be

documented. This documentation should state whether the risk occurred or not, and if applicable, what the impact of the risk was. This documentation can be entered into the pop-up box that appears on the screen when closing out a risk. The following guideline for risk closure was defined to be spread among the team: *1) State if the risk actually happened or not; 2) State the impact on the project (if applicable)*. However, the team must be encouraged to add further information they found relevant such as highlighting unexpected results and lessons learned.

This good practice will permit us to trace the risks and have documentation regarding their outcomes. It was suggested for the Pm to document these lessons learned and problem-solving approaches on BG's official knowledge-sharing platform. This recommendation aims to ensure that valuable insights and solutions are recorded and made accessible to the entire team, stakeholders and other project's within the company as well, promoting a culture of learning and collaboration within the organization. This practice would enable learning from past experiences and improve the handling of risks on all BG projects.

All these standards that were defined for the project team should help a better organization and understanding of the Risk Management process in order to carry it out more efficiently during the project life. This procedure also ensures accountability and ownership of the RM process by all the risk team, as every team member has a clear guidance of their role and responsibilities in managing risks.

These proposals regarding the RMP were presented to the Pm with a suggestion to develop and implement them with the team. However, due to time limitations within the study timeline, it was not possible to implement the entire process as scoped and gather results. Nevertheless, some minor best practices described in the proposals were started to implement.

5.2 Risks Workshop

Intending to install a culture of effective RM within the team, a session has been designed, to promote RM practices and encourage active participation from team members on this topic. The session was presented to the Pm initially, who then must be responsible for performing it with the rest of the team. The main goal of the session is to raise awareness about risks and highlight some of the best practices for effective RM, in order to standardize the processes and understandings among the team. Therefore, a visual and simple presentation was prepared and presented in this workshop, which can be consulted in Appendix E.

The session follows the standard RM process guidelines, covering each step from planning to risk monitor-

ing. The session provides a comprehensive overview of the key concepts within each step and highlighted some of the best practices for effective RM. The session also provides training on SuperOPL. This training is meant to equip team members with the necessary skills and knowledge to use the tool effectively and efficiently.

The need to understand the actual risk concept is crucial for an effective RM, in order to make sure all team members are able to identify them proactively and correctly. After the results of the questionnaire, provided in subsection 4.4.3 it was proven that some of the team members were confusing risks with problems or facts. Moreover, it was also concluded that some didn't know that opportunities were also considered in RM, as risks. Therefore, some clarifications regarding these topics are aligned in the presentation, defining with the team five important concepts, as suggested in Figure 5.1.

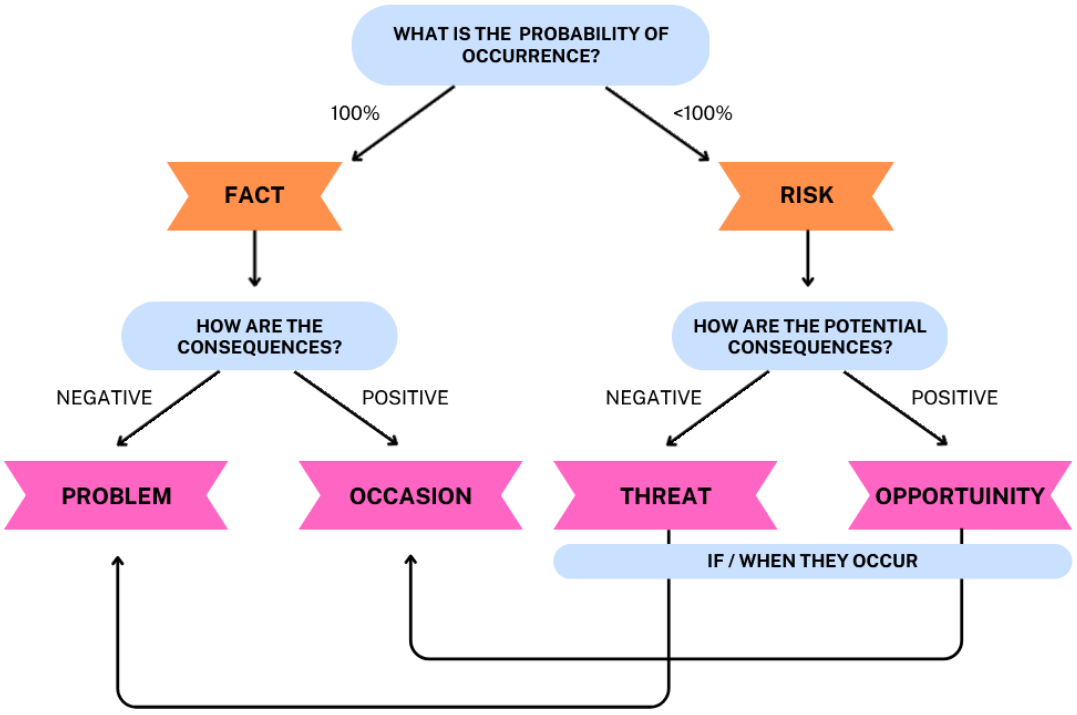

Figure 5.1: Risk vs Fact elucidation chart

Analyzing the chart, and referring to Bosch (2023b), it is delineated with a team that risks are uncertainties, with a probability of occurrence that is less than 100%. Moreover, the distinction between opportunities and threats is aligned, as well as the concept of problem, which refers to something that has already occurred and is negatively affecting the project.

After comprehending this main topic, it is important to encourage the team to learn the correct way to formulate risks in order to improve future communication and avoid misunderstandings and different interpretations. This will also ensure that all formulated risks include all important information needed.

To achieve this, risks are defined in three parts: cause, event, and effect. This structure is represented in Figure 5.2.

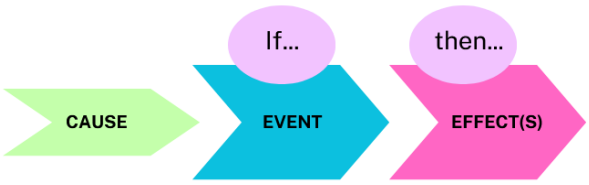

Figure 5.2: Risk formulation representation

The team must be encouraged to use and always keep this structure in mind and use the *"If...Then..."* format to articulate risks. To consolidate this idea some examples are provided in the presentation.

After this brief introduction, the presentation is divided into several phases, each one referring to a step of the standard Risk Management process. Starting with Risk Identification, some examples of how to correctly state a risk are provided, giving hints on the importance of specificity importance for the risk to be fully and equally understood when read by different people. Following, there is an explanation on how to properly document risk in SuperOPL. Following Risk Qualitative Analysis, the criteria that were created for assessing the risk impact severity are presented, after a brief elucidation of the purpose of the *Risk Indicator*.

It is defined that this assessment, even being performed using the standard guidelines provided in Table 5.1, is meant to be performed by at least three stakeholders. This involvement of several parties can ensure that the potential impacts have been evaluated from multiple perspectives and that the assessment is thorough and comprehensive. Hearing the opinions of individuals with different perspectives, experiences, and expertise, can help to identify potential impacts that may not have been identified by a single individual. Another guideline on how to document the Risk Quality Analysis outcome on the SuperOPL is provided, as well as an explanation of how to interpret the *Butterfly Diagram*.

Risk Quantitative analysis is also explored, as it was agreed to be performed at least for the three most high-rated risks. This analysis is presented as being an output of a meeting that should be scheduled with the relevant stakeholders and the Purchase and Sales teams.

After, the Risk Responses Plan is explained in the Risk session. The first thing that is emphasized is to always have at least one registered measure for every risk. This was proposed with the goal of creating a mindset to proactive RM and ensuring that appropriate measures are always put in place. By requiring at least one registered measure for every identified risk, the sPMs are encouraged to think proactively about how to manage risks. Furthermore, each team member is actively involved in the RM process and

takes ownership of managing and following up on the risks that they have identified. This helps to avoid a situation where team members feel that they have simply passed the responsibility for the risk to the Pm once they report it, for example, and can instead feel empowered to manage the risk proactively.

Having this defined among all the team, a quick guide on how to address measures to risks is provided in the workshop. These measures creation guideline, as well as the one about the creation of the risk, has defined all the required information that must be registered, as not all campuses are crucial for the documentation of the measure in the platform.

During the Implementation of Measures topic, the main focus of the next slides is to stimulate the team to go over the risk list and ensure that they are taking care of the tasks that are assigned to them. As discussed in subsection 4.4.3, it was found that most sPMs checked the risk list on a monthly basis, while new tasks should appear on the risk list much more frequently. To address this issue, it is suggested that they could filter the risks and measures in order to see what is currently under their main responsibility, using the implemented *tags*. This would allow everyone to focus on the tasks that are relevant to their role, and ensure that they are taking appropriate action to manage the identified risks.

Lastly, regarding Risk Control, the good practice of rating the measured outcome regarding its response effectiveness is introduced and explained. Moreover, the rule of providing relevant feedback following the established guideline every time they close a risk is presented, as also explained in section 5.1.

5.3 Risk Management Routine

A new risk routine was suggested to implement among the team to improve the Risk Management process, with the goal of improving communication and ensuring that risks were being addressed in daily work.

To achieve this, several meetings with different purposes were suggested to be scheduled to ensure team participation on risk-related topics and to ensure that RM practices were being carried out regularly. Additionally, the routine was intended to promote a culture of risk awareness among team members and to encourage a proactive approach to identifying and managing risks.

The suggested meeting agenda that was designed is exposed below in Figure 5.3. Considering the team's level of maturity regarding Risk Management and the criticality of the ongoing sample phases production, as well as feedback from the team and Pm related in subsection 4.4.3, it was proposed a separate one-hour meeting specifically for risk-related topics, represented in red. This meeting would take place weekly for the first weeks in order to ensure that the team gets familiar and comfortable with risk topics. After

this initial period, it is expected that the team will be more self-sufficient regarding the RM process and, as such, it was proposed to join this risk meeting to the standard weekly team meeting, by extending the last one in twenty minutes to include a discussion on risks during that time slot. This meeting is represented in Figure 5.3 in blue.

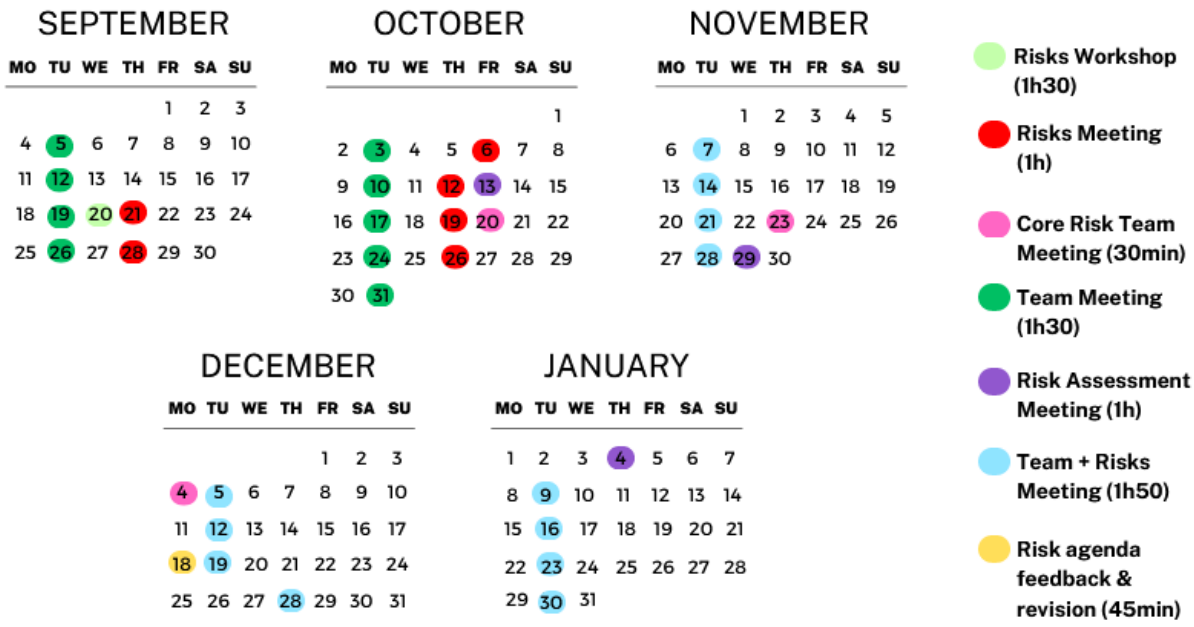

Figure 5.3: Proposed Agenda for Risk Management Routine kick off 2023/2024

Every one and a half months approximately, a twenty-minutes meeting with the core risk team must be scheduled, represented in pink. This meeting is meant to track the risks and measures under work, discuss other important topics, and review important aspects. This meeting should include the most relevant stakeholders to discuss more technical aspects and perform a more extensive risk follow-up.

The specific meeting to perform Risk Analysis is represented in purple, focusing mainly on the Quantitative assessment, which is the most problematic. This meeting must be scheduled with both the Purchasing and Sales teams, as well as the Core Risk Team and the Pm. This meeting has the main purpose of evaluating the monetary impact of the risks with the *tag* "ALERT" in SuperOPL.

Remarked in light green, is the Risks Workshop that should be presented to the team, explained in section 5.2. It was deemed important to schedule this separate workshop as soon as possible and before the start of the regular risk meetings, in order to ensure that the team fully embraces the implementation of the new risk-focused routine. By doing so, the team will be better equipped to actively participate in the process and to identify and manage risks.

Finally, a quick meeting was suggested to be scheduled with the Risk Core team to provide feedback on the improvements achieved during the past months on the RM process. The purpose of this meeting is to review what is working well and what needs improvement from the team's perspective, to evaluate the frequency of the meetings, and to potentially adjust aspects of the agenda for the upcoming months. By conducting this review, the team can ensure that the risk routine continues to meet the needs of the project. This meeting is highlighted in yellow in Figure 5.3. Promoting an active involvement of the team in the feedback and review process of the RM process has multiple benefits. On one hand, it fosters a sense of ownership and engagement among team members, enhancing their motivation and commitment. On another hand, involving the team also helps address resistance to changes in the routine by giving them a voice in decision-making and a sense of control. This collaborative approach promotes teamwork, knowledge sharing, and continuous improvement, resulting in a more effective and tailored RM process.

In order to help the kick-off of these meetings and to ensure all the crucial topics were discussed properly, the standard procedure presented in Table 5.3 was developed to provide some guidance on the first Risk Meetings.

Table 5.3: Initial Risks Meetings standard guidance

Order	**Topics and Procedures**
1	Risk Identification - New risks and measures creation in SuperOPL
2	Filter new risks and perform Qualitative Analysis with relevant stakeholders
3	Filter for each domain *Tag* and review risk list status for updates
4	Other topics

The main goal of these meetings is to establish a recurring practice and habit among the sPMs, so that they can afterward independently identify and manage risks whenever they arise. As shown in the agenda in 5.3, the aim is for these regular risk meetings to become unnecessary after October, with risk-related topics being discussed during the weekly team meetings in a designated time slot of only twenty minutes.

Teaching and habituating the team to proactively identify and assess risks can create a more efficient and effective risk-oriented environment. Therefore, after the integration of these habits during Risk Meetings, a weekly twenty-minute follow-up with the entire project team is believed to be sufficient for RM. Additionally, adopting a proactive approach can help to improve overall outcomes and ensure that risks are addressed in a timely manner.

In addition, having more time for risk identification during the Risk Meetings, with all the core team gath-

ered in the discussion, will provide the opportunity for a more comprehensive detection of threats and opportunities for the project. As was identified in subsection 4.4.3, the SuperOPL was found in a really primary stage, with a few threats identified and no opportunity documented. With additional time, the team can engage more in brainstorming and analysis of Lessons Learned from past similar projects, for instance, which can help to identify potential risks and opportunities that may have been overlooked before. This can lead to a more thorough understanding of the project's risk landscape and enable the team to develop more effective RM strategies. Furthermore, these discussions can help to foster a culture of risk awareness and proactive risk identification among the team, potentially leading to improved RM outcomes.

5.4 SuperOPL improvements

Some improvement opportunities were identified in the SuperOPL and they were proposed in order to improve the daily usage of the RM framework and facilitate its update and follow-up for the users. These improvements are listed below.

i. ADDRESS A RISK RESPONSIBLE - In the current state of the SuperOPL, it is limited to assigning a responsible person to tasks in the *Open Points List* and to measures designed to address identified risks (which are automatically converted to tasks, as explained in subsection 4.2.4). These assigned users receive email updates regarding their assigned tasks. However, it is proposed that the capability to assign a responsible person to risk should be introduced in order to ensure ongoing monitoring and follow-up of the identified risks. This enhancement would contribute to the comprehensive tracking and management of risks within the SuperOPL framework.

ii. BUG CORRECTION FOR MEASURE CREATION - During regular usage of the software, a bug was identified that significantly impacted the platform's efficiency. Specifically, when creating a measure for risk, the Risk List would reset to the beginning each time a measure was uploaded. Consequently, users were required to scroll through the entire risk list again to access the specific risk they were working on before. This issue adversely affected the user experience and workflow efficiency.

iii. INCORPORATE RISK TOOL TO MEETING MINUTES TOOL: To optimize the process of documenting new risks, it was proposed to incorporate the option to create new risks directly within the meeting minutes tool in SuperOPL. Currently, while registering the meeting minutes, tasks can be created and added to the Open Points List seamlessly. However, to create a new risk, users are required to leave the meetings tool and navigate to the Risk Management tool within the platform.

To address this inconvenience, it was suggested to have both the meeting minutes and Risk Management SuperOPL tools open simultaneously during meetings. However, further improvement can be achieved by integrating the risk creation option within the meeting minutes tool itself. This enhancement would streamline the process and optimize the registration of risks, allowing users to create and document risks during meeting discussions without the need for additional navigation between tools.

iv. RISK OCCURRENCE REPORT: Currently, when a user closes a risk, an open text box appears where they can write any relevant information they deem necessary. However, it is suggested to enhance this feature by replacing the open text box with a concise questionnaire containing the following components:

   (a) *Risk occurrence* input, with both yes or no check boxes included, to state whether the risk actually occurred or not;

   (b) An open text box for the user to describe the impact of the risk if it did occur, or any other relevant statements they deem necessary.

   Integrating these elements into the risk closure process in the software will allow users to provide more structured and specific information about the occurrence of the risk and its impact. This enhanced data collection will not only benefit the current project but also provide valuable inputs for future projects, by adding relevant information to Lessons Learned reports, for example. By keeping risks recorded and traced, organizations can build a repository of knowledge and experiences that can inform RM strategies, improve decision-making, and enhance overall project outcomes.

5.5 Proposals Summary

In the present section, all the ideas discussed above are summarized and listed in order to provide a more synthetic understanding of the improvements that were proposed and described during chapter 5.

i. TAGS CREATION ON SOPL: Tags were suggested to be implemented to facilitate the filtering of risks and the risk list navigation in SuperOPL, as suggested in Table 5.2.

ii. CRITERIA FOR QUALITATIVE ANALYSIS: A standard for risk qualitative assessment was developed to address the ambiguity and sPMs differences in risk severity perceptions, showed in Table 5.1 and Appendix D. Nevertheless, this assessment must be done considering at least the inputs and opinions of three stakeholders.

iii. SOPL USAGE RULES: Standards for managing the risk tool were suggested to ensure effective RM and improve risk communication:

   (a) Standard information is defined as mandatory when creating a risk.

   (b) Never have risks without measures created.

   (c) Always state the risk in the *"If...Then..."* format.

   (d) Document the risk in a specific and accurate manner.

   (e) Always leave a comment on the risks closure stating the outcomes.

   (f) Always leave a comment on measures closure stating the results.

   (g) Always rate the effectiveness of closed measures.

iv. QUANTITATIVE ANALYSIS IMPLEMENTATION: A quantitative assessment was proposed to be implemented, by scheduling a meeting with the Sales and Purchase departments, together with relevant stakeholders, to address at least the risks with the "ALERT" *tag*.

v. DEVELOPING A COST-BASED RISK ANALYSIS TOOL: This tool was proposed to address the difficulty of accessing cost-related details and optimize the process of Quantitative Risk Analysis.

vi. RISK AGENDA IMPLEMENTATION: An agenda for RM meetings was proposed to ensure risks are duly considered and followed up on. This agenda includes:

   (a) RISKS WORKSHOP: As described in section 5.2, a workshop was designed and proposed to be performed with the team, to address the lack of knowledge on the RM domain.

   (b) RISK MEETING: One-hour separate Risk Meetings were proposed to establish a recurring practice and habit among the sPMs in the early stage of RM process implementation.

   (c) TEAM + RISK MEETING: A proposal has been made to extend the weekly team meeting by twenty minutes to address risk-related topics. This additional time is deemed sufficient for RM discussions, considering that the team is expected to be actively engaged and proactive in the process.

   (d) CORE RISK MEETING: A separate quick meeting has been proposed to address more specific topics and go deeper on risk topics.

   (e) RISK ASSESSMENT MEETING: Meeting with Purchase, Sales, and relevant risk stakeholders to ensure risk quantitative analysis and other assessments as needed.

(f) RISK AGENDA FEEDBACK AND REVISION: Meeting to gather feedback on the RM process from the project team.

vii. SOPL SOFTWARE IMPROVEMENTS: Improvements were suggested for the software for it to be more user-friendly and comprehensive:

(a) Address a risk responsible.

(b) Bug correction on measures creation.

(c) Incorporate the new risk creation into the meeting minutes tool.

(d) Risk occurrence report integration.

viii. RM CULTURE DEVELOPMENT: Good practices and suggestions for distributing responsibilities in the team to increase awareness and attention to risks were suggested:

(a) The sPMs should be responsible for proactively documenting new risks that are identified.

(b) The responsible parties should take ownership of ensuring risk and measures follow-up and closure.

(c) The Pm should ensure SuperOPL is being updated and covered by the team.

ix. RISK EXPERT INCORPORATION: A risk expert should be incorporated into the project to provide some support on RM activities.

x. LESSONS LEARNED DOCUMENTATION: It was suggested to document lessons learned and problem-solving approaches to the faced risks to promote a culture of learning and collaboration within the organization.

Chapter 6

Conclusion

The primary objective of this case study was to provide recommendations for enhancing Risk Management in New Product Development projects within the specific context of an automotive company, answering the research question: *'How can Risk Management practices be improved?'*. Following an extensive study on the subject, challenges and opportunities in the RM processes of the analyzed project were investigated and identified. Based on these findings, insights, and recommendations were proposed to improve the current project RM practices.

The present chapter presents in section 6.1 the conclusions drawn from the findings of the investigation. Simultaneously, the limitations of the case study are discussed in this section. Lastly, section 6.2 focuses on providing recommendations for future work based on the previously presented findings and limitations. These recommendations suggest potential directions for further research or actions that can be taken to build upon the current case study.

6.1 Research findings and limitations

Through the conducted study, a significant maturity gap in the project under investigation was perceived, which was also evident in most NPD projects across the company. Referring to the project under analysis, several weaknesses were identified in the current RMP, as well as in the team dynamics and mindset. The process was unclear and not customized, leading the team to neglect the proper importance and attention to risks. Therefore, the proposed solutions aim to address these gaps and enhance the RM process, not only in this project but also potentially in other projects within the company.

Several opportunities for improvement were identified, structured, and presented in this master thesis with the intention of being implemented in the project. Gaps were identified in both the RM process itself and the team's mindset and routines regarding the risks approach. As a result, processes were formulated to

address the different phases of RM that are defined in the PMBOK® *Guide* and the internal documentation at Bosch Group. Additionally, ideas on how to motivate and create awareness regarding risk-related topics were proposed.

Due to the time constraints of the present investigation, it was not feasible to implement and analyze the proposed actions within the project, as was initially planned. During the course of this investigation, certain measures were able to be implemented, particularly those that were simpler and required less adaptation from the team. For example, the creation of tags associated with risks in the SuperOPL software and the implementation of standard criteria for conducting Qualitative Risk Analysis with stakeholders. However, the impact of these changes was not measured or studied. Additionally, the improvements on the software that were proposed were submitted to the SuperOPL managers and programmers, however, no feedback was received during the timeline of the study.

The primary reason for the impossibility of implementing the proposed improvements was the timing of the study, which coincided with summer season, resulting in fluctuating project team attendance. It was deemed inappropriate to introduce and establish new RM routines in the project team given these circumstances. This factor may also have further accentuated the lack of maturity in the project's RM.

Another notable limitation was the organizational size, which posed challenges in terms of accessing information and communicating with colleagues in a timely manner. Due to the company's extensive dimension, obtaining required data or information often involved a series of interactions with individuals across different locations within the global organization. Moreover, it is crucial to highlight that the level of RM within the NPD projects in Bosch Braga did not meet the predicted standards.

This research serves as a foundation for the implementation of best practices recommended by accredited standards in the field of the project RM in NPD. Although this master thesis primarily focuses on one specific project, the study and the measures identified were the result of a comprehensive analysis that considered inputs from several Pms of other development projects, risk experts, and relevant stakeholders on the topic within the company. Therefore, while the improvements are tailored to the specific project, it is possible to consider these implementation suggestions as best practices and guidance for scoping the RM process in other projects as well. The insights and lessons learned from this study can be extrapolated and applied to enhance RM practices across the organization and help other Pms to enhance RM on their projects as well.

In summary, the research presented its main contributions, addressing the objectives and research question, supported by a carefully selected literature review that informed all deliberations.

6.2 Future Work

In the future, it is crucial for the New Product Development management department to clearly define priorities while considering top management and long-term vision for the goals and mission of the company. Promoting motivation and enthusiasm for Risk Management practices is essential, and this mindset can only be embedded in the company's culture if encouraged by its leaders. To foster this culture, it is crucial for leaders to actively encourage and support RM initiatives. Efforts should be made to raise awareness about the benefits of this knowledge area performance throughout the organization, ensuring that employees understand its value and how it aligns with the company's purposes.

The present thesis study has addressed a highly relevant topic in the context of Project Management in the automotive industry, laying the groundwork for future investigations and opportunities for further studies. The findings and insights gained from this research can serve as a foundation for implementing standardized and customized Risk Management practices not only in New Product Development projects in Bosch Braga but also across global Bosch Group. By ensuring a consistent approach to RM across projects, industries can enhance their capabilities, improve decision-making processes, and ultimately achieve better project outcomes.

In summary, the proposals and achievements outlined in this thesis present a road map for further enhancing Risk Management practices within the automotive industries, emphasizing the importance of leadership support, fostering a risk-aware culture, and pursuing continuous improvements in the process. By building upon this research, the organization can continue to strengthen its RM framework and drive success in future projects.

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Appendix A

Project Life Cycle and New Product Development Model at Bosch [1]

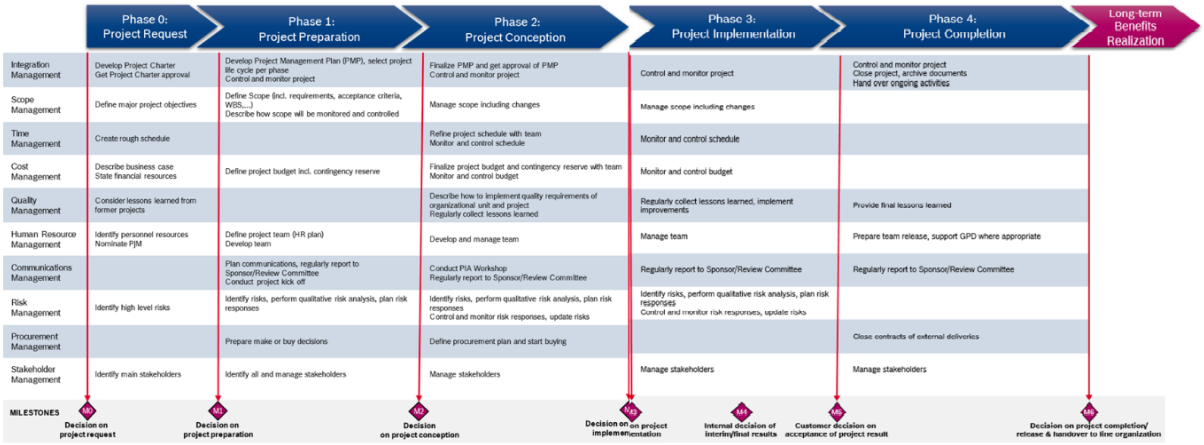


Figure A.1: Detailed PLC Model (2023)

[1] All figures included in this appendix chapter were taken from Bosch (2023a).

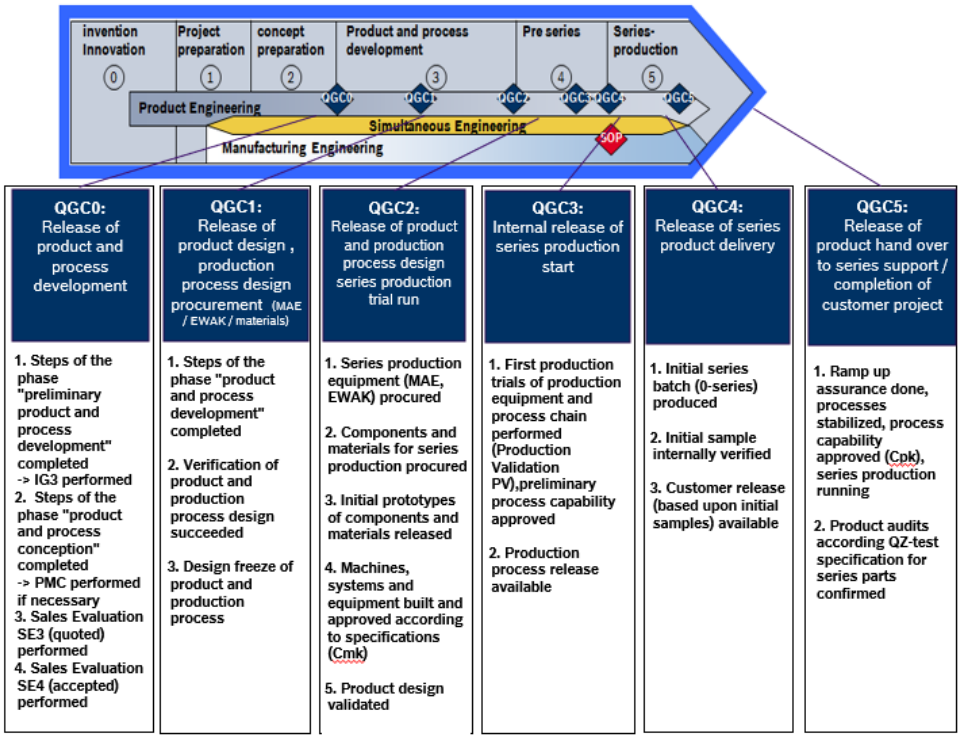


Figure A.2: Quality Gate Customer (QGC) milestones detailed (2020)

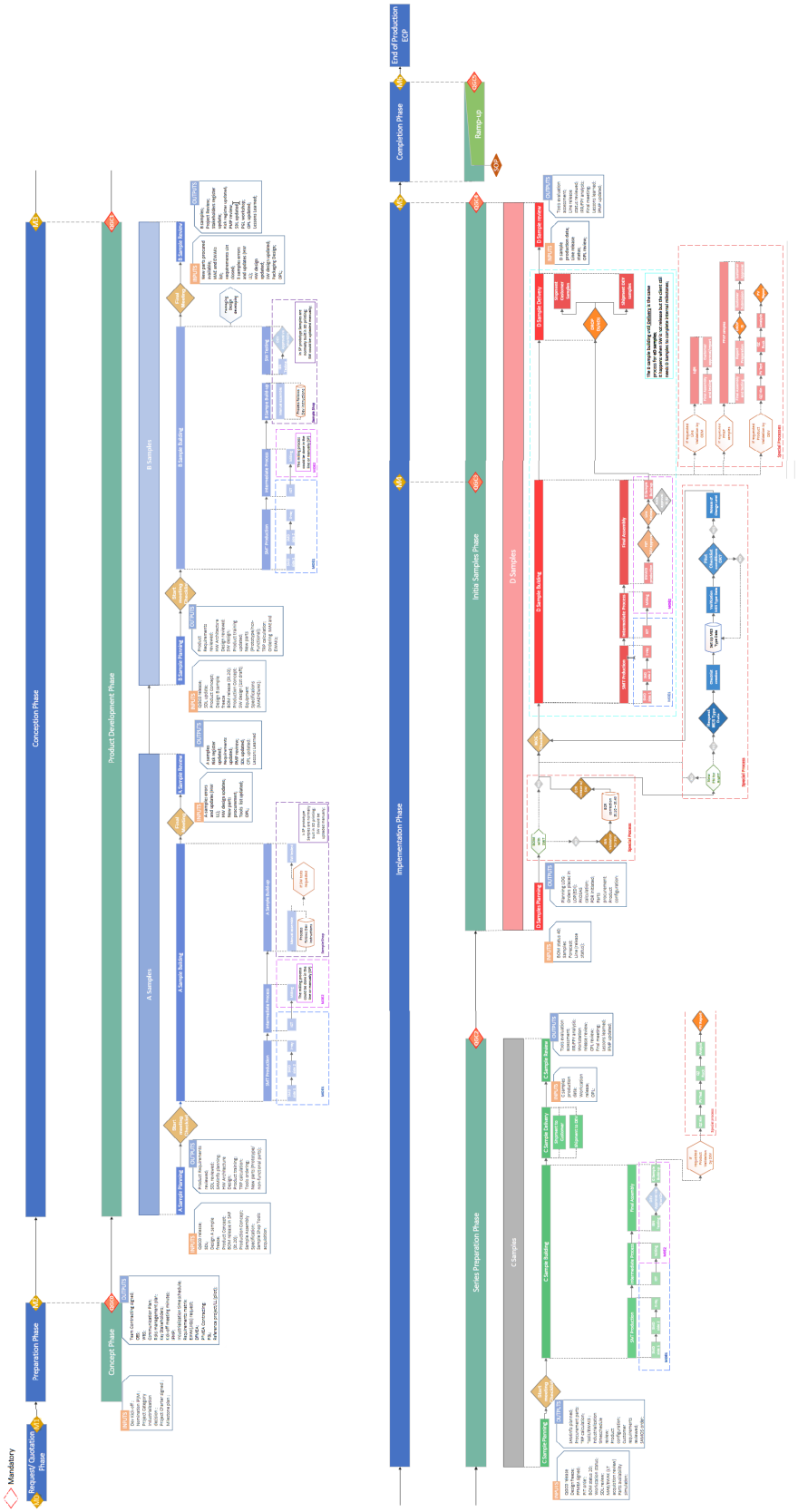


Figure A.3: Fluxogram of Pilot Project for New Product Development (2020)

Appendix B

SuperOPL software[1]

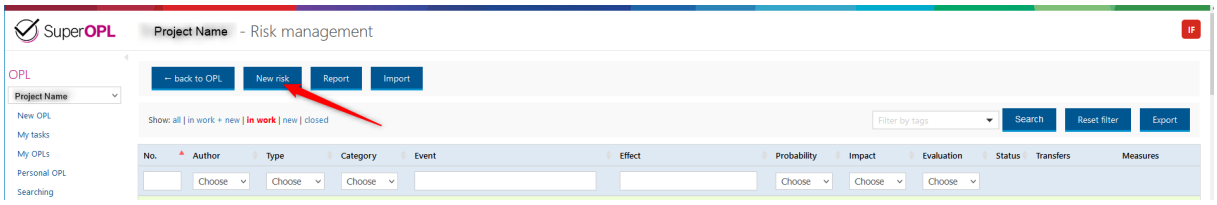


Figure B.1: How to create a new risk in SuperOPL

(2023)

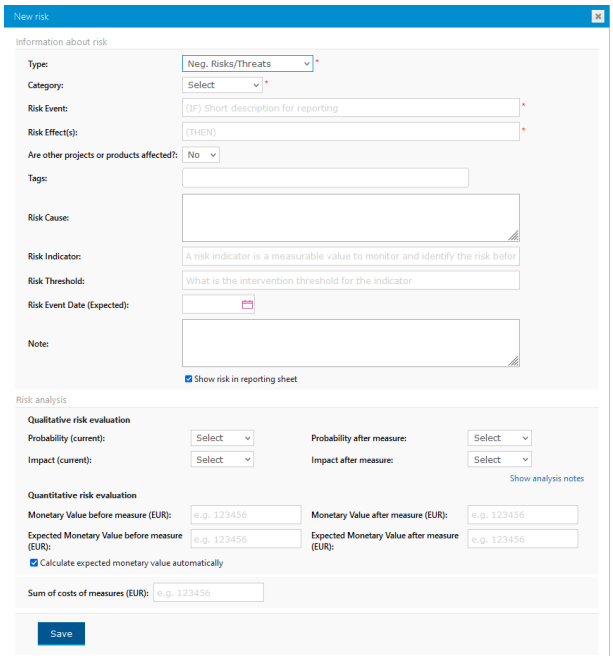


Figure B.2: Fields to fill in when creating a new risk in SuperOPL

(2023)

[1] All figures included in this appendix chapter were taken from the SOPL software.

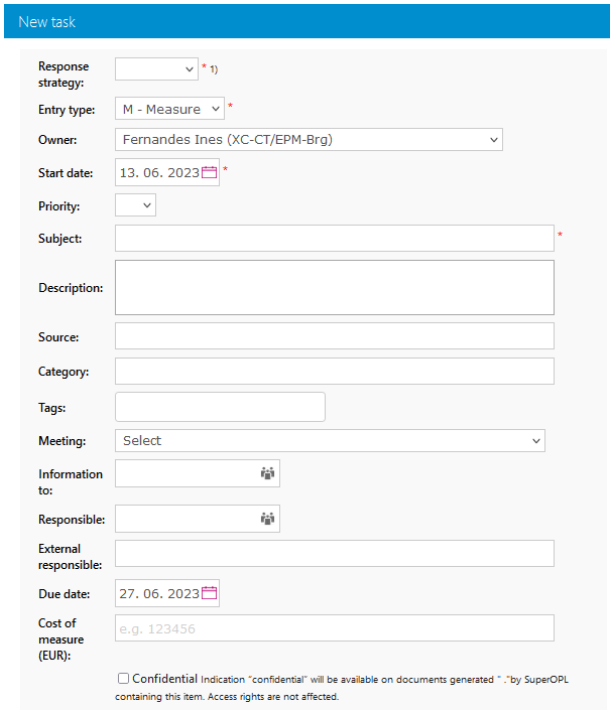
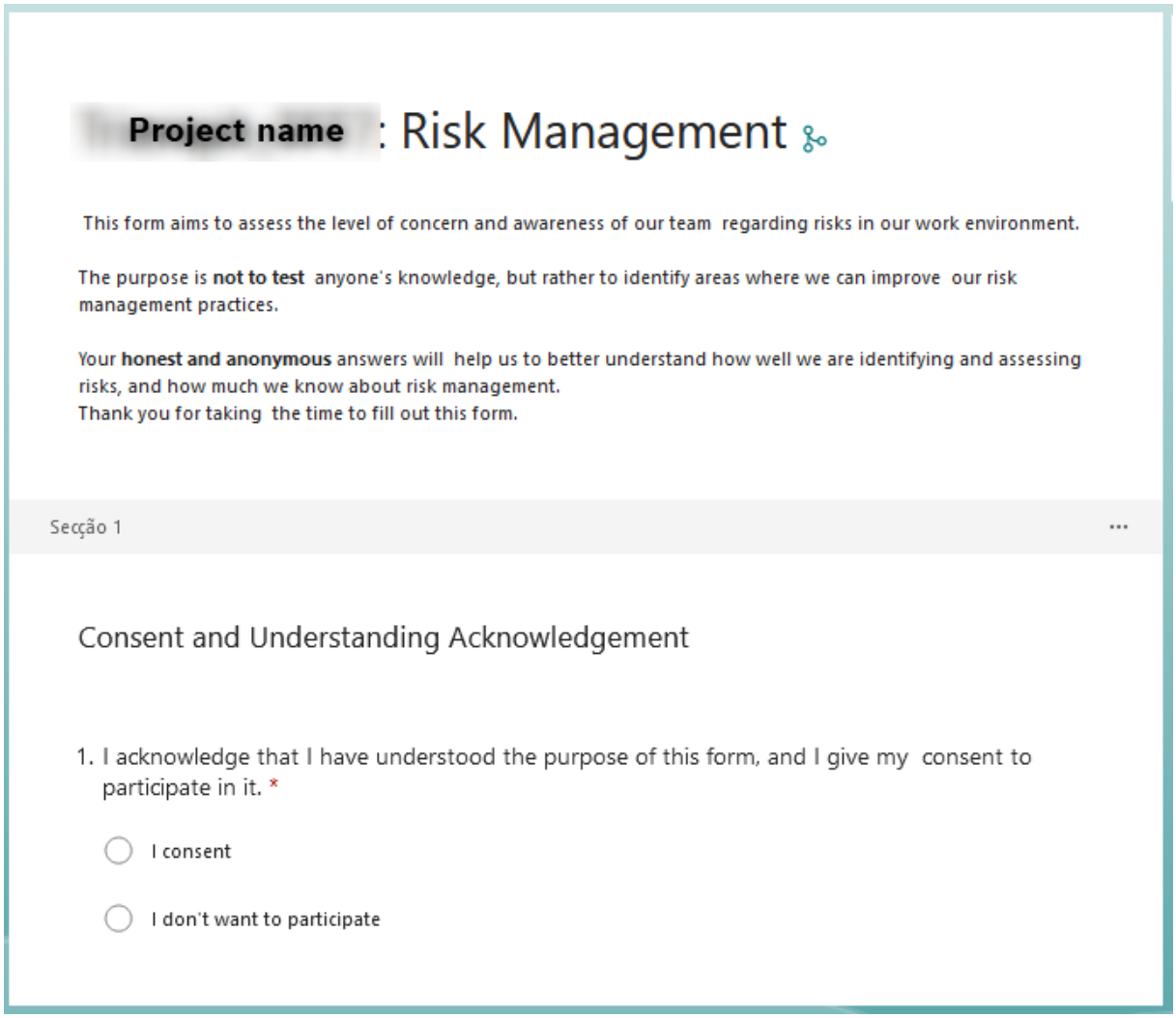


Figure B.3: Fields to fill in when creating a new measure for a risk in SuperOPL (2023)

Appendix C

Questionnaire on Team Risk Management Maturity



Project name : Risk Management

This form aims to assess the level of concern and awareness of our team regarding risks in our work environment.

The purpose is **not to test** anyone's knowledge, but rather to identify areas where we can improve our risk management practices.

Your **honest and anonymous** answers will help us to better understand how well we are identifying and assessing risks, and how much we know about risk management.
Thank you for taking the time to fill out this form.

Secção 1

Consent and Understanding Acknowledgement

1. I acknowledge that I have understood the purpose of this form, and I give my consent to participate in it. *

- I consent
- I don't want to participate

Secção 2 ...

Project name : Overall Risk Management

2. Which of the following statements define a risk? (You can select several options) *

- [ ] A potential problem that could negatively impact our work
- [ ] An opportunity for improvements in the project
- [ ] Something bad for the project that is currently happening
- [ ] A situation that will for sure happen and impact the project goals
- [ ] None of the above

3. How familiar are you with risk management? (best practices, process...) *

1	2	3	4	5

Not at all — Very Familiar

4. Do you believe risk management is an important factor for a project success? *

1	2	3	4	5

Not at all — Very important

Secção 3

Project name: Risk Assessment

Consider the following statements regarding our project.

5. How would you rate the potential impact of a risk that could cause a delay of one week in the customer delivery date for the B-sample of the project? *

1	2	3	4	5

Very Low Very High

6. How would you rate the impact of a risk associated with a potential cost increase of 30,000€ for the project? *

1	2	3	4	5

Very Low Very High

7. How would you rate the potential impact of a risk that could cause a delay of one week in the QGC2 date? *

1	2	3	4	5

Very Low Very High

Secção 4

Project name: SuperOPL Risks List

8. Are you familiar with the project's SuperOPL Risks List? *

- ○ Yes
- ○ I know it but I don't know how to use it
- ○ No

9. Have you ever documented a new risk in SuperOPL? *

- ○ Yes
- ○ No, because I don't know how to do so
- ○ No, because someone added it for me
- ○ No, because I have never needed to

10. On average, how often do you check the project's SuperOPL Risks List? *

- ○ Never
- ○ Daily
- ○ Weekly
- ○ Monthly

Secção 5

Project name : Risk Practices

11. Do you consider yourself proactive on identifying potential risks in your daily work? *

- ◯ Yes
- ◯ No
- ◯ Maybe

12. What do you normally do when you identify a new risk? *

Selecione, no máximo, 3 opções.

- ☐ Report it to the Project Manager
- ☐ Document it in the Project's SuperOPL Risks List
- ☐ Document it to point it out in the weekly team meeting
- ☐ Report it to the potential affected parties
- ☐ Document it to myself to follow up
- ☐ Discuss it with my department team
- ☐ Take imidiate action to mitigate/eliminate it
- ☐ Do a risk assessment regarding it's likelihood and potential impact
- ☐ Nothing
- ☐ Other

13. If you selected 'Other', please describe your typical approach.

Introduza a sua resposta

14. Which of the following best describes your attitude towards risk management? *

- ◯ It is an important part of my job and I take it seriously
- ◯ It is something that I am aware of, but I don't think about it much
- ◯ It is not something that I consider as part of my job
- ◯ Other

15. If you selected Other, please describe wat you consider your attitude.

Introduza a sua resposta

16. Do you consider that the risks of the project are currently being well handled? *

17. Do you believe that scheduling a team meeting specifically to discuss risk-related topics would be beneficial for the project and the team? (Conduct risk identification activities, check risk status updates, carry out risk assessment, follow up on action measures...) *

- ◯ Yes, I believe it would be beneficial to have a dedicated meeting for this.
- ◯ I'm not sure, but I am open to the idea of a dedicated meeting for risk-related topics.
- ◯ No, I think we can totally address and follow up risk-related topics in our meetings.

18. If you answered 'Yes' or 'I'm not sure' to the previous question, how often do you think a dedicated team meeting for discussing risk-related topics should be held?

Introduza a sua resposta

19. Make your suggestions to improve Risk Management in our project :)

Introduza a sua resposta

Appendix D

Qualitative Risk Assessment Criteria

Table D.1: Criteria for assigning impact levels for opportunities in qualitative risk analysis

OPPORTUNITIES	**Domain**		
Severity of Impact	**Cost**	**Time**	**Specification/Quality**
Very Low (1)	No significant decrease in costs	No significant advantage on the overall project time schedule. Departments minor time savings.	Has negligible alignment with quality specifications, offering marginal or negligible improvement in the product. No relevant benefits to stakeholders on product characteristics.
Low (2)	<10% decrease in costs	No significant advantage on the overall project time schedule. Departments minor time savings.	Has minimal alignment with quality specifications, offering marginal or minimal improvement in the product. No relevant benefits to stakeholders on product characteristics.
Medium (3)	10-20% decrease in costs	Moderate time savings on internal milestones. No significant improvement on the overall project schedule.	The opportunity partially aligns with quality specifications and requirements. Noticeable improvement in the project and internal stakeholders satisfaction.
High (4)	20-40% decrease in costs	Significant time savings or enhancements in project schedule performance. Improvements mainly in the scope of customer delivery dates and important internal milestones, such as QGCs.	Considerable improvement on customer satisfaction. High deviation from the specification that clearly benefits the stakeholders. Transforming effect on project success.
Very High (5)	>40% decrease in costs	Results in significant time savings, accelerated project schedule, or improvements in important milestones. Improvements mainly in ensuring the SOP and customer delivery dates.	Customer quality specifications/expectations are exceeded. Major value added on processes and product. High transformation effect on project success.

Table D.2: Risk Probability assessment criteria

Probability	**Percentage**	**Likelihood**
Very Low (1)	<20%	Almost impossible
Low (2)	21 % - 40%	Unlikely to happen
Medium (3)	41% - 60%	Fairly likely to happen
High (4)	61% - 80%	Likely to happen
Very High (5)	>80%	Almost certain

Appendix E

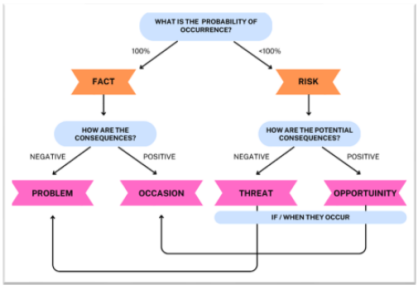
Risk Workshop Presentation

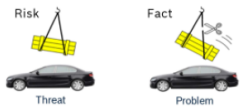
1

2

Risk Concept
Difference between Risk and Fact

- **RISK** – Probability of occurrence < 100%
  - Opportunity or Threat
- **FACT** – Probability of occurrence = 100%
  - Problem or Occasion





A threat that occurs becomes a problem, na opportunity that occurs becomes an occasion.

BOSCH

3

Risk Concept
Difference between Risk and Fact

- The following sentences are risks or facts?
  - We have never worked on such a type of project **FACT**
  - We have too little resources or budget **FACT**
  - The manager might approve our proposal **RISK**
  - Our experts are not sufficiently trained **FACT**
  - Our product might fail the test **RISK**
  - Our supplier is not reliable **FACT**

PMI®:
"Risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives", namely on time, costs, scope, or quality.

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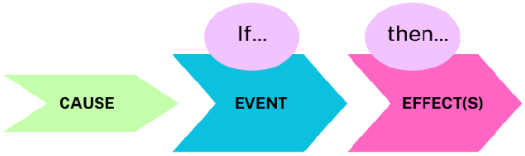
4

Risk Concept
Chain of cause, event and effect



Example of opportunity
■ **If** we could shorten our release process from 8 weeks to 4 weeks by introducing a digital circulation for signatures, **then** we could launch the new product before the Christmas business starts. This would increase our sales by an estimated 25%.

Example of threat
■ **If** the technicians would not read the assembly instructions carefully and proceed according to the proven old assembly sequence of the predecessor product, **then** the boiler might get cracks in test mode (threat). This would lead to a delay in completion of the project by 1-2 months and to a 100-200T€ penalty.

BOSCH

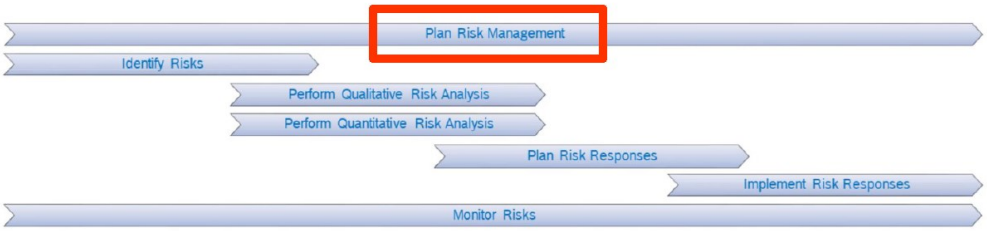
5

Risk Concept
Chain of cause, event and effect

- The following sentences are causes, events or effects?
  - We have never worked on such type of project — CAUSE
  - Sales figures might go down — EVENT
  - We could go over the approved costs — EFFECT
  - The weather might be better than usual — EVENT
  - I'm allergic to fish — CAUSE
  - Our experts are not sufficiently trained — CAUSE
  - The customer time line would not be respected — EFFECT
  - Our supplier is not reliable — CAUSE
  - The production plant might not deliver on time — EVENT
  - There's a risk that we will be late — EFFECT

6

Risk Management
Process overview

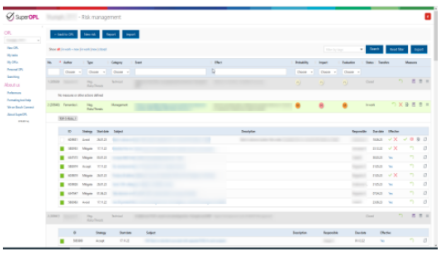


Risk management plan: Describes how risk management activities will be structured and performed.

7

Risk Management
Plan Risk Management

- Risk Register: **SuperOPL** - link



- Risk Breakdown Structure:

8

Risk Management
Process overview

Risk Identification: Risks are determined, named and listed. This is conducted by the PM together with the project team.

BOSCH

9

Risk Management
Risk Identification

- Whenever you identify a new risk, document it on SuperOPL!
- Document the risk properly ☺

Event (If...)	Effect (Then...)
Human resources not available	Milestones not reached
FTO due to high number of patents not confirmed till PoC and NA delivery. CR support not confirmed	No delivery
Insufficient maturity or availability of components	Delayed delivery
Competitors are faster or better	Hindered market entry

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10

Risk Management
Risk Identification

Risks need to be documented as accurate as possible to raise attention and define measures!

Event (If...)	Effect (Then...)
The expert for functional safety is not available until Dec. 15, 2020	The B-sample delivery in February 2021 would be delayed by at least 3 months
We are not able to check all product related patents until proof of concept milestone in 12/2020	Operation of demonstrators in North America could lead to patent infringements
The maturity of the connector set is not sufficient for C-sample evaluation in 08/2020	Evaluation of C-samples would be late or incomplete for pre-series in 01/2021
Miller&Sons can provide their new control unit earlier than we can provide ours	We would lose at least 50% of the projected customers

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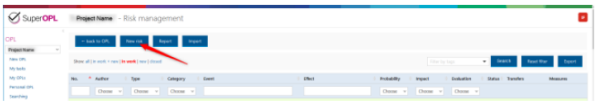
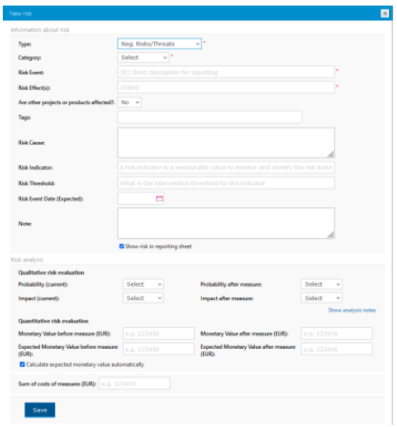
11

Risk Management
Super OPL – How to add a new risk





1. Create the risk
2. Fill in it's type and category
3. Write down the risk (If... Then...)
4. Add a due date
5. Add your department tag

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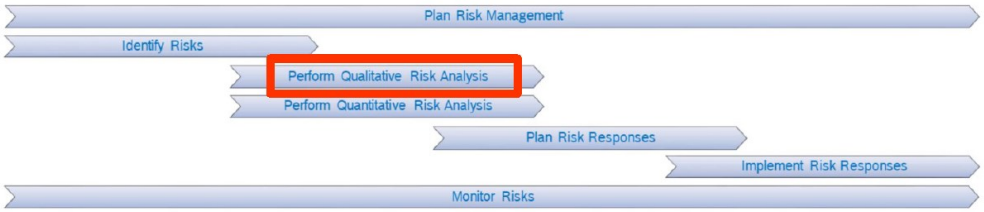
Risk Management
Process overview



Prioritize risks!

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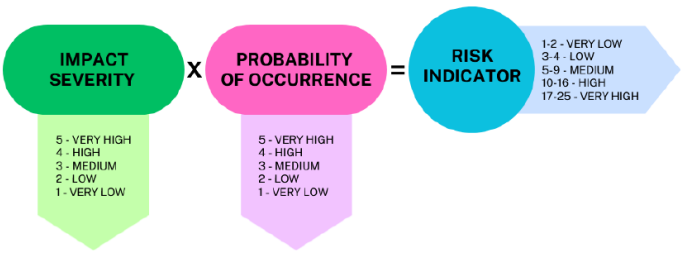
Risk Management
Qualitative Risk Analysis



- Avoid ambiguity!
- High risk indicator - priority risk :)
- Risk assessment must be performed by at least 3 of it's stakeholders!

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Risk Management
Qualitative Risk Analysis

- Criteria to evaluate probability

Probability	Percentage	Likelihood
Very Low (1)	<5%	Almost impossible
Low (2)	6 % - 25%	Unlikely to happen
Medium (3)	26% - 50%	Fairly likely to happen
High (4)	51% - 75%	Most likely to happen
Very High (5)	>75%	Almost certain

- Criteria to evaluate negative impact

THREATS	Domain		
Severity of Impact	**Cost**	**Time**	**Specification/Quality**
Very Low (1)	No significant increase in costs	Department postponement of date only No significant changes in the overall project schedule	Slight deviation from the specification It is unlikely that the flaw could have any perceivable effect on the device behavior.
Low (2)	<10% increase in costs	Department postponement of date only No significant changes in the overall project schedule	Slight deviation from the specification The flaw is of minor importance (minor annoying impact)
Medium (3)	10-20% increase in costs	Small postponement of internal delivery dates (e.g. samples) and/or milestones Not affecting customer deadlines	Clear deviation from the specification but most probably acceptable for all stakeholders
High (4)	20-40% increase in costs	Postponement of important delivery dates (e.g. release samples) and/or QGCs Delay affecting customer deadlines No expected delays on SOP	Clear deviation from the specification and not acceptable for stakeholders Operational capability of the device is strongly reduced
Very High (5)	>40% increase in costs	Postponement of important delivery dates for customer; Delays that may cause SOP to be postponed	Clear deviation from the specification, not acceptable for customer Flaw that may have a detrimental safety effect and/or violates legal regulations

- Criteria to evaluate positive impact

OPPORTUNITIES	Domain		
Severity of Impact	**Cost**	**Time**	**Specification/Quality**
Very Low (1)	No significant decrease in costs	No significant advantage on the overall project time schedule. Departments minor time savings.	Has negligible alignment with quality specifications, offering marginal or negligible improvement in the product. No relevant benefits to stakeholders on product characteristics.
Low (2)	<10% decrease in costs	No significant advantage on the overall project time schedule. Departments minor time savings.	Has minimal alignment with quality specifications, offering marginal or minimal improvement in the product. No relevant benefits to stakeholders on product characteristics.
Medium (3)	10-20% decrease in costs	Moderate time savings on internal milestones. No significant improvement on the overall project schedule.	The opportunity partially aligns with quality specifications and requirements. Noticeable improvement in the project and internal stakeholders satisfaction.
High (4)	20-40% decrease in costs	Significant time savings or enhancements in project schedule performance. Improvements mainly in the scope of customer delivery dates and important internal milestones, such as QGCs.	Considerable improvement on customer satisfaction. High deviation from the specification that clearly benefits the stakeholders. Transforming effect on project success.
Very High (5)	>40% decrease in costs	Results in significant time savings, accelerated project schedule, or improvements in important milestones. Improvements mainly in ensuring the SOP and customer delivery dates.	Customer quality specifications/expectations are exceeded. Major value added on processes and product. High transformation effect on project success.

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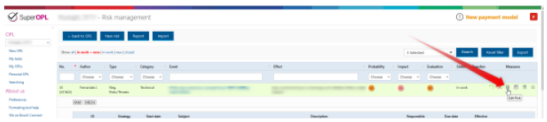
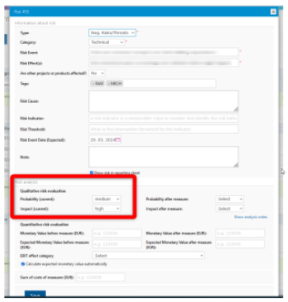
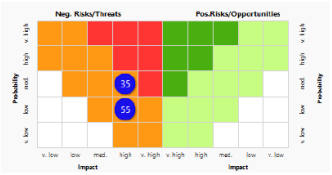
Risk Management
Super OPL – How to assess a risk

- Click on Edit Risk



- Select the probability and impact





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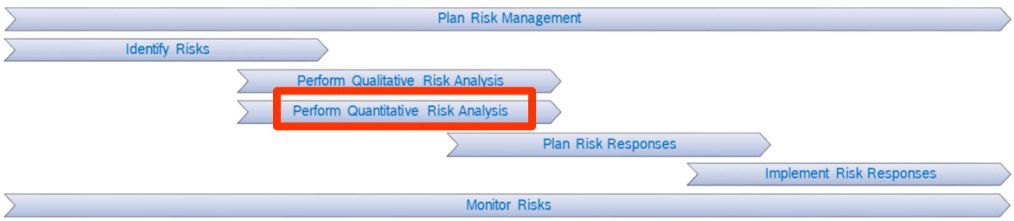
Risk Management
Process overview



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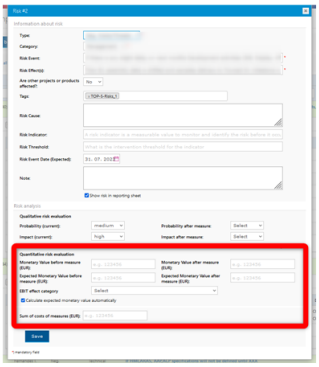
Risk Management
Quantitative Risk Analysis

Meeting to assess the risk - DO FOR **TOP 3** RISKS!



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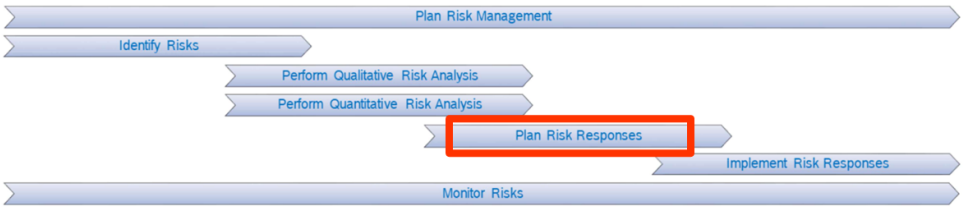
Risk Management
Process overview



Whenever ou create a risk, create a measure on it.

It's forbidden to have risks without any measures!

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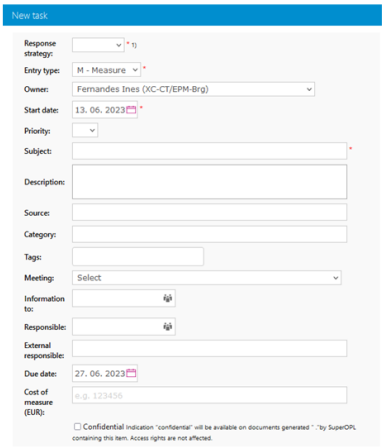
Risk Management
Super OPL

- Add a new measure to a risk

1. Create the measure
2. Fill in it's strategy and type
3. Write down the subject of the measure
4. Add a start and due date
5. Add a responsible for the measure
6. Add the tag



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Risk Management
Process overview

- Measures are addressed to a responsible
- Always check your tasks!

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Risk Management
Process overview

- Measures are addressed to a responsible
- Always check your tasks!

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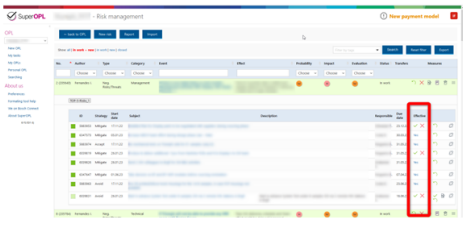
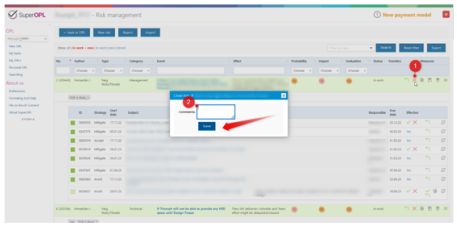
Risk Management
Monitor Risks in SOPL

- Always rate the effectiveness of the implemented measure



- Document Risk output when closing it!

1) Did the risk happen?
2) What was the impact?
   Optional:
   -Unexpected outcomes; Lessons learned; etc



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Thank you!

Any question?

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