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Project Management Performance Domains: The application of Artificial Intelligence Solutions

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Master in Computer Science and Business Management

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September, 2024



TECNOLOGIAS
E ARQUITETURA

Department of Information Science and Technology

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Acknowledgement

I want to start by expressing my greatest appreciation to my supervisor, Dr. Luísa Domingues, for her constant assistance and encouragement, throughout the entire process of this dissertation. Dr. Luísa mentoring and guidance, together with her expertise and knowledge, were fundamental to help me accomplish this dissertation and achieve my ambitions. I am deeply grateful for the consistent support and I truly admire her and her commitment and work ethic, which was indispensable in the development of this thesis.

To my parents, Conceição and Eduardo, who are, and always were my number one supports, I want to express my deepest gratitude for their never-ending support and motivation. Their dedication and determination provided me with amazing opportunities, paving my future brilliantly. I will always be sincerely moved by how they always believed in me and inspire me to follow my dreams. They are my greatest role models and I will forever remember the sacrifices they made for me.

Resumo

Esta pesquisa explora que soluções de Inteligência Artificial (IA) podem ser aplicáveis à Gestão de Projetos, de acordo com a estrutura dos domínios de performance. Pretende examinar e explorar que soluções de inteligência artificial estão já a ser aplicadas aos domínios de performance, e que inovações futuras são previsíveis nesta integração, verificando simultaneamente os seus benefícios. Além disso, investiga quais são os desafios dessas associações.

Identificar as ferramentas e tecnologias existentes e já utilizadas nos projetos, organizá-las no âmbito dos domínios de performance e, posteriormente, realizar entrevistas de campo, permitiu o confronto dos resultados, agregando conhecimento ao previamente encontrado.

Esta dissertação traz inovação ao entrevistar especialistas em gestão de projetos e chatbots, e ao usar as capacidades dos chatbots de IA para estudar ferramentas de IA. Ao confrontar as três principais fontes de informação, podemos facilmente avaliar que, por um lado, a literatura e as entrevistas com chatbots tendem a sugerir aplicações mais teóricas, onde a literatura tem expectativas mais realistas sobre as aplicações futuras da IA nos domínios de performance, e os chatbots tendem a sugerir mais tecnologias avançadas e de ponta; por outro lado, as entrevistas com especialistas tendem a propor aplicações mais práticas para preocupações da vida real onde a IA pode ser utilizada, num contexto de gestão de projetos para ajudar a gerir as atividades diárias.

Este estudo contribui para a área de Inteligência Artificial, juntamente com a área de Gestão de Projetos, fornecendo insights e aplicações práticas sobre esta aliança para projetos futuros.

Palavras-Chave: Inteligência Artificial, Ferramentas de IA, Soluções de IA, Técnicas de IA, Gestão de Projetos, Domínios de Performance

Abstract

This research explores what Artificial Intelligence solutions may be applicable to Project Management, according to the performance domain's structure. It aims to examine and explore what artificial intelligence solutions are already being applied to performance domains, and what future innovations are foreseeable in this integration, while ascertaining its benefits. Additionally, it investigates the challenges of said associations.

Identifying the existing tools and technologies already being used on projects, organizing them on a performance domains' scope, and later performing field interviews, allowed a confrontation of results, adding knowledge to what had been previously found.

This dissertation brings innovation by interviewing project management experts and chatbots, and using the capacities of AI chatbots to study AI tools. By confronting the three major information sources we can easily assess that on one hand, literature and chatbots interviews tend to suggest more theoretical applications, whereas literature has more realistic expectations concerning the future applications of AI Performance Domains, and chatbots tend to suggest more advanced and cutting-edge technologies; on the other hand, interviews with experts tend to propose more practical applications to real-life concerns where AI can be utilised, on a Project Management context to help manage daily activities.

This study contributes to the Artificial Intelligence area, along with the Project Management area by providing purposeful insights and practical applications on their alliance for future projects.

Keywords: Artificial Intelligence, AI, AI Tools, AI Solutions, AI Techniques, Project Management, Performance Domains

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Glossary of Abbreviations

AI	-	Artificial Intelligence
DSRM	-	Design Science Research Methodology
IT	-	Information Technology
ES	-	Expert Systems
ML	-	Machine Learning
NLP	-	Natural Language Processing
NN	-	Neural Networks
PD	-	Performance Domain
PM	-	Project Management
PMI	-	Project Management Institute
PMPD	-	Project Management Performance Domain
PMBOK	-	Project Management Body of Knowledge

Introduction

1.1. Research Context

Over the past few years technological advancements increased at an unprecedented pace, reinventing the world and how we perceive it. The field of Artificial Intelligence (AI) is a primary reason for this outstanding progress and evolution, due to its' disruptive transformations across multiple domains. These innovations have not only redefined industries but also reshaped how we connect, learn, work, and communicate [1]. Authors in [2] highlight how the depth of AI and its diverse and various forms emphasize its ability to revolutionize countless aspects of our lives continuously.

The concept of Project Management (PM) and its modern discipline as we know it evolved immensely over the years, across a variety of fields. It is possible to date the beginning of PM to early civilizations, where it was used to construct architectural structures, although not in the way we understand it today. In the present day, PM stands as a well-defined area, deeply embedded across industries and sectors, integrating the best practices, technology and evolving methodologies [3].

According to [4] forty-eight trillion dollars are utilized in projects yearly. However, only approximately 35% of projects thrive because most companies use outdated technologies and methods. Additionally, the authors mention how there were made predictions that by 2030 AI will be automating 80% of PM tasks that are powered by big data, Machine Learning (ML) and Natural Language Processing (NLP). Furthermore, the writers identify six areas where AI will disrupt PM, these being:

1. Improved Project Selection and Prioritization: With the power of ML, organizations can now make data-driven decisions, by examining vast amounts of data, identifying patterns and predicting project outcomes with unparalleled accuracy. This will lead to a faster identification of high-potential projects, an optimization of project portfolios and it will reduce human bias.

2. Reinforced PMO Support: Automation and data analytics are empowering PMOs to become more strategic and efficient, bringing key benefits as proactive issue management, improved project visibility and augmented decision-making.

3. Accelerated Project Definition, Planning, and Reporting: Automated solutions are replacing manual processes that significantly enhance project definition, planning, and reporting. Such benefits include efficient project scoping, streamlined scheduling, and data-driven insights that provide actionable information on project performance, risks, and opportunities.

4. Rise of Virtual Project Assistants: AI-powered virtual assistants are becoming indispensable tools for project managers. These intelligent agents can handle routine tasks, provide information, and support decision-making. They add value through increased efficiency in the automation of time-

consuming tasks, improved communication as they facilitate seamless collaboration and information sharing, and optimized decision support

5. Advanced Testing and Quality Assurance: Automation is transforming the project testing phase, leading to higher-quality deliverables and faster time-to-market. It allows early defect detection, improved test coverage, and reduced testing costs.

6. Evolution of the Project Manager Role: PMs must develop strong leadership, strategic thinking, and interpersonal skills. Their key responsibilities will include strategic leadership, to guide the project towards achieving organizational goals, team development and adaptability to change, and managing the organization through the transition to new ways of working. Regarding the replacement of project managers with AI, [5] states that this will not be happening since AI cannot respond when presented with newness, it can only learn with past situations, and is not able to perceive things as humans do.

1.2. Research Problem and Motivation

Although it is feasible to identify the prominence that the application of AI has gained in PM, the integration of AI tools into PM practices is relatively recent [1], consequently, the use of AI in PM and its' impacts are only now starting to be put into practice.

As we search and read about the application of AI in PM it is possible to identify some research gaps. A prime example of this has already been identified by Taboada, Daneshpajouh, Toledo, and Vass [2] when coming to the conclusion that no studies have been conducted in the existing literature that address this subject and analyse the influence that AI tools have in the various project management performance domains (PMPD).

The objective of this dissertation is to explore the influence of AI on PM performance domains considering the theme under investigation and all of its issues. Therefore, the questions that follow will be pursued:

Research Question 1 - What AI solutions are available to support PM and its benefits, considering the structuring by performance domains?

Research Question 2 – What are the challenges and difficulties of AI integration in PM?

Hence, this dissertation aims to shed light on the influence that AI tools have in PMPD by identifying the benefits and challenges of this integration and determining what AI techniques can be applied in which performance domains.

1.3. Research Approach

The methodology chosen to conduct this work was the Design Science Research Methodology (DSRM). Brocke, Hevner, & Maedche [6] characterized design science research as “a problem-solving paradigm that seeks to enhance human knowledge via the creation of innovative artifacts”. The outcomes of DSRM comprise both the newly created artifacts and design knowledge, which offers a deeper comprehension of how the artifacts improve (or degrade) the relevant application contexts through design theories. This study also applies both a Systematic Literature Review (SLR) and a Multivocal Literature Analysis (MLR).

While the use of AI in PM has become increasingly prominent, the incorporation of AI tools into PM is still relatively new and insufficiently explored, and due to this reason, it is possible to find certain study gaps as we read and seek information on the use of AI in PM [7].

Being that the detected problem presents itself as the lack of information and studies about the influence of AI in PMPD, and the DSRM concentrates on the creation of solutions to solve a specific problem, this is the most efficient approach to execute the research. The DSRM offers the structure to create an artifact, and its iterative nature allows continuous improvements as more is discovered about the gap in question. Given these considerations, DSRM emerges as the optimal choice for methodology.

1.4. Work Structure

The Introductory chapter, which is the first one, sets the groundwork for this research by outlining key elements, such as, the context, problem identification, motivation and the selected approach.

The second chapter is dedicated to the Literature Review, organized into three sub-chapters. The first segment illustrates an overview of PM and its Performance Domains (PD), the second provides a characterization AI and its tools, and lastly a section analysing the existing impact of AI in PM. The third chapter encompasses a thorough portrayal of the type of methodology employed to conduct the study. Following, the fourth chapter encompasses data analysis, where the chatbots and experts' interviews are described, as well as their results. The fifth chapter contains a discussion of the findings withdrawn from it, and lastly the conclusions are presented in the sixth chapter.

Literature Review

2.1. Project Management

2.1.1. Overview

PM is one of the fundamental areas that assist organizations in ensuring that the projects they execute are managed properly [8]. As a leading academic discipline, in the subject of management science, PM harbours numerous definitions, for instance the Association for Project Management [9] describes PM as the application of processes, knowledge, skills, methods, and experience to accomplish project goals. Projects are the vehicles for change in an organization. They are not routine business activities.

PM navigates through various challenges and difficulties intrinsic to its practice. Managing scope modifications, often known as scope creep, is a common difficulty that can substantially influence budgets, deadlines, and resource allocation if left unaddressed. Modifications to a projects' scope can lead to increased uncertainty. With that being, there should be an examination of possible new risks introduced by a scope alteration [10]. Likewise, managing limited resources such as time, budget, human resources, and materials pose as a constant challenge. Additionally, effective identification, assessment, and mitigation of risks are essential, considering uncertainties that could disrupt project objectives. Engaging stakeholders, aligning their diverse needs, and ensuring robust communication are ongoing challenge that influence project success. Moreover, incorporating emerging technologies pose a challenge related to adaptation, training, and integration. The complexity is increased by the new technology and the uncertainty surrounding its application [10].

2.1.2. Standards

To carry out this investigation, it was necessary to select a specific standard in the PM field in order to conduct a cohesive and coherent research, with the intention of presenting the best findings and creating a purposeful artifact.

There are numerous PM approaches, manuals, and standards available today. The challenge of selecting a strategy from pre-existing guidelines, standards, and techniques or developing one of its own depends on what the project team decides. This choice will determine the project's parameters as well as the calibre of its output [11].

As stated by Jovanović and Berić [12] some of the most well-known PM standards are: PMI, IPMA, APM, YUPMA, PRINCE 2; and each one of them has its own methodologies:

- i. *Project Management Institute (PMI)*: The PMI, a large and influential group of project managers in the USA, developed the PMI methodology, which is documented in the Project Management Body of Knowledge (PMBOK) manual.
- ii. *International Project Management Association (IPMA)*: Instead of focusing on process technique, IPMA's methodology advocates project managers to enhance their knowledge, abilities, and expertise, allowing them to collaborate with the project team to manage the project efficiently.
- iii. *Association for Project Management (APM)*: The Association of PM, a UK association, established the APM methodology, which is described in the handbook as the APM Body of Knowledge [9]. The APM handbook is an extensive guide that addresses a wide range of subjects and areas crucial successfully using project management.
- iv. *YUPMA*: The Serbian Project Management Association, also known as YUPMA, created the YUPMA technique, which was first established for investment projects.
- v. *Prince2*: The PRINCE2 approach stands for Projects IN Controlled Environments. It was created to manage computer and information projects. Later, it was developed and changed, making it suitable for usage in other projects as well.

Some factors were taken into account when choosing which standard and respective methodology to use to conduct this study, such as recognition, structured approach, best practices and adaptability.

The PMI methodology was considered to be the best fit for this study. The PMI, [10] which was founded in 1969 and has developed into the top professional association for project managers. The PMI launched its PM certification program in 1984 and developed the most prestigious and well-known qualification in the PM field worldwide, the Project Management Professional (PMP). Additionally, PMI was the number one organization in history to have its certification system achieve ISO 9001 certification from the International Organization for Standardization [13]. Furthermore, the authors identified, throughout their study that "One of the things that PMI offers is a common dictionary and definitions to a lot of those things you don't find anywhere else" [13].

2.1.3. The PMI Approach

The PMBOK is a broad guide published by PMI, [10], that outlines the best practices, processes and conventional terminology in the field of PM. These standards serve as the base upon which all knowledge is constructed, and the guide compiles and condenses this body of knowledge. Currently, the latest published version of PMBOK is the 7th edition.

[10] The PMBOK helps people be more proactive and innovative with regular revisions to consider how PM techniques progress. The emergence of new technologies, new approaches, and rapid shifts

in the market drive the evolution of the profession. The 7th edition of PMBOK was updated to address these difficulties, assist people in being more proactive, creative, and agile, and align with the way they are working.

The PMBOK 6th edition, the predecessor to the most recent version, offers a framework divided into knowledge areas and process groups. It provided a methodical approach to PM with an emphasis on processes interactions. With the release of the 7th edition of PMBOK, a significant paradigm shift occurred. This latest version places more emphasis on principles rather than processes, outlining twelve guiding principles that serve as the foundation of PM.

Furthermore, a noteworthy innovation of PMBOK 7th edition is the incorporation of PDs. These domains offer a thorough understanding of the project landscape and represent key areas of focus in PM. This edition encompasses a full spectrum of development approaches (adaptive, agile, hybrid, predictive, traditional), and presents a section dedicated to adapting the approach and development processes [10], to better align with the evolution on new AI techniques. On Table 1 we can find the summarization of changes between these versions.

Table 1 - Changes summarization between 6th and 7th PMBOK edition adapted from [10]

PMBOK Guide 6 th Edition	PMBOK Guide 7 th Edition
Knowledge Guide: - Introduction - Knowledge Areas: <ul style="list-style-type: none"> ▪ Integration ▪ Scope ▪ Schedule ▪ Cost ▪ Quality ▪ Resources ▪ Communications ▪ Risk ▪ Procurement ▪ Stakeholders 	The Standard for Project Management: - Introduction - Value Deliver System - Principles
The Standard for Project Management: <ul style="list-style-type: none"> ▪ Initiating ▪ Planning ▪ Executing ▪ Monitoring & Controlling ▪ Closing 	Knowledge Guide: - Project PDs: <ul style="list-style-type: none"> ▪ Stakeholders ▪ Team ▪ Development ▪ Approach and Life Cycle ▪ Planning ▪ Delivery ▪ Measurement ▪ Uncertainty - Tailoring - Models, methods and artifacts

The PMBOK [10] also states that it is important to understand that the release of the 7th version does not invalidate the 6th, which many still rely on.

Being that the chosen standard was PMI, it is important to identify its' definition of PM. PMI described PM as the utilization of specific skills, knowledge, instruments, and methods to create and provide something significant to people. It is the process of directing project activity to produce the desired outcomes.

2.1.4. Project Management Performance Domains

The 7th PMBOK edition [10], describes a project PD as a collection of connected essential events to efficiently delivering a project outcome. These are characterized as dynamic, interconnected, and interdependent fields of concentration functioning in harmony to accomplish the intended project results [10].

According to [10], there exists eight PMPDs:

- i. **The Stakeholder Performance Domain:** The common definition of a stakeholder is a person, a group or an organization that is concerned with or concerned about a project or a part of it. A project can have different stakeholders during its' course according to the different project phases, and their interests and influences can shift. This domain is related to activities that involve managing and engaging stakeholders throughout the project lifecycle to ensure that their demands, necessities and expectations are addressed adequately. This domain delineates the necessary steps to deal with stakeholders effectively.
- ii. **The Team Performance Domain:** The Team PD is associated with creating project deliverables that achieve the business objectives. This performance domain focus on creating the culture and atmosphere necessary for a varied collection of people to develop into an effective project team. This entails acknowledging the tasks required to advance the teams' growth and motivating all team members to exhibit leadership qualities.
- iii. **The Development Approach & Life Cycle Performance Domain:** This PD covers the activities and operations related to the project's development methodology, cadence, and life cycle stages. How a project can be developed depends on the type of deliverable(s). This and development methodology impact the cadence of deliverables. The delivery strategy and intended cadence decide the delivery cycle, project life, and its phases.
- iv. **The Planning Performance Domain:** The Planning PD covers the tasks and operations related to the starting, continuing, and changing planning and coordinating required to produce project deliverables and results. The aim of planning is to develop a proactive strategy for producing deliverables, which are the outcomes that the endeavour was set to accomplish.

- v. **The Project Work Performance Domain:** Project work involves creating processes and carrying them out for the team to provide the required deliverables and results. This PD involves assignments and responsibilities related to setting up project procedures, overseeing material assets, and cultivating an educational atmosphere. The project manager and team define the procedures that the team uses to carry out their activities. These are regularly reviewed.
- vi. **The Delivery Performance Domain:** The focus of the Delivery PD actions and activities have the purpose of accomplishing the scope and excellence that was initially set out for the project. Projects assist in accomplishing business goals and carry out strategies. The delivery project's main goal is to provide the anticipated deliverables that would result in the desired outcomes by complying to specifications, scope, and quality expectations.
- vii. **The Measurement Performance Domain:** The Measurement PD handles the activities and actions related to evaluating the performance of the project, and implementing the required actions to preserve acceptability. This domain assesses how the operations performed in the delivery PD meet the indicators established in the planning PD.
- viii. **The Uncertainty Performance Domain:** Projects are conducted in various unpredictable contexts. Project teams must consider the opportunities and threats that uncertainty brings before deciding how to respond. Uncertainty Performance encompasses duties and activities linked to risk and uncertainty.

2.2. Artificial Intelligence

2.2.1. Overview

It was John McCarthy [14] who first used the term "Artificial Intelligence" in 1956 and described it as "the science and engineering of making intelligent machines, brilliant computer programs", and further stated that it was equivalent to the analogous purpose of utilizing computers to study human intellect.

Sharma and Garg's insights [15] emphasize that the integration of AI doesn't seek to supplant human capabilities but rather to fortify them, thereby enhancing overall performance. Their research highlights numerous collaborative avenues between humans and AI. These encompass amplifying existing abilities and refining perception and comprehension. Additionally, the infusion of analytics into AI-reliant industries are recognized.

2.2.2. Artificial Intelligence Tools

A detailed examination of AI tools various applications was essential to achieve a thorough comprehension of the landscape of AI technologies. In Table 2 are presented six of the seven areas of AI application that will assist in understanding the purpose of AI techniques, identified by [16]. The aforementioned areas are Language Understanding, Learning and adaptive Systems, Problem Solving, Perception (visual), Modelling, Robots and Games.

Table 2 – Artificial Intelligence Application Areas

Application Area	Definition
Language Understanding	The capacity to "understand" and react to natural language. To transition from spoken language to written structure, as well as from a particular language to another one
Learning and Adaptive Systems	The capacity to modify behaviour in light of prior experiences and formulate conclusions regarding the world as a result.
Problem Solving	The capacity to define a problem in a suitable format, to design a solution, and to understand when more information is required and know how to acquire it
Perception (visual)	The capacity to examine a scene and relate it to an internal model is known as that organism "knowledge of the world". This analysis yields a structured collection of relationships between the scene's elements.
Modelling	The capacity to create an internal representation and a set of transformation rules allows one to predict how various real-world objects or entities would behave and interact.
Robotics - Chatbots	A chatbot is an AI-powered program that simulates human conversation to interact with users and provide assistance or information

Several authors have identified various types of AI techniques; however, for the purpose of this dissertation, I have chosen to focus specifically on a few of these. This decision was made for several

reasons, including the relevance of the technique to the research question and the need to maintain a manageable scope within the study. Following a summary of the main approaches is given:

NLP pertains with allowing computer machines to comprehend, grasp, and produce human language to gain practical understanding in order to address problems [15]. As observed by [2], NLP seeks to accomplish two objectives: (1) facilitate human communication; and (2) extract information from written language.

According to [15], ML concentrates on producing models and algorithms that help computers execute activities with no specific programming instructions. ML algorithms are built to learn and infer from patterns in data, enabling them to adjust and strengthen their capabilities continuously. This field covers multiples techniques, such as supervised and unsupervised learning, and reinforcement learning. The primary goal of ML is to allow machines to make independent decisions.

[17] provided a detailed explanation of Neural Networks (NN) and declared that these are computational systems based on the architecture and functioning of biological NN. These are composed of interconnected nodes organized in layers. NNs process input data through layers of interconnected neurons, where each neuron calculates a weighted sum of its inputs and then applies an activation function.

Fuzzy logic (FL) is a mathematical approach to reasoning that is approximate rather than precise. It allows the representation of uncertainty and vagueness in decision-making. [2] argued that FL expands Boolean logic (1 or 0) by focusing thinking and decision-making on all potential answers between 0 and 1.

Expert Systems (ES) emulate the decision-making ability of a highly skilled individual in a specific area [15]. These mechanisms encode domain-specific knowledge in the form of rules or facts and use inference engines to make deductions and provide recommendations or solutions. ES capture and preserve expertise and knowledge in specific domains, providing consistent and reliable decision support.

As stated by Sravanthi et al. [18] Chatbots, are AI programs designed to simulate a conversation with a user in natural language. They can interact via messaging services, webpages, mobile apps, or even over the phone. Additionally, chatbots may be integrated with other applications, for instance, PM systems. Table 3 presents a summarization of the AI techniques aforementioned

Table 3 – Artificial Intelligence Techniques

Technique	Application Area	Objective	Example
Machine Learning	Modelling, Learning and adaptive Systems, Problem Solving	Algorithms that instruct a system to perform data prediction and classification without them being specifically built for it	Siri [15]
Neural Networks	Modelling, Learning and adaptive Systems, Perception	Model complex connections in data and use learned patterns to support predictions.	Image Recognition on your Smartphone [15]
Natural Language Processing	Language Understanding	Enable computers to comprehend, grasp, and produce human language	Smartphone spell check and autocorrect [15]
Fuzzy Approaches	Modelling, Perception	Enable computers to simulate human thought processes	Consumer electronics and automobile [15]
Expert Systems	Learning and adaptive Systems, Problem Solving	Mimic the decision-making ability of a highly skilled individual in a specific area	Flight-tracking systems [15]
Chatbots	Language Understanding, Learning and Adaptive Systems, Problem Solving, Robotics - Chatbots	Simulate human-like interactions to answer questions, provide information, assist with tasks, and improve user experiences	Eliza [15]

As mentioned before some techniques that had been identified as AI were not pursued, such as Deep Learning, for being a subset of ML [15], and Games, since their application is not foreseeable in PM.

2.3. Artificial Intelligence in Project Management

2.3.1. Solutions supporting Project Management considering Performance Domains

While initially, there might be some uncertainty about merging PM and AI, many researchers have identified that PM is one area where AI undoubtedly has a big influence and has a lot of room to grow through AI integration. Although the use of AI in PM has become more prominent, the incorporation of AI technologies into PM processes is still relatively new [1]. According to authors in [19] AI has been in contact with PM as far as 1987, although its' widespread adoption and significant impact are only now becoming evident and, [20] states that, although the topic has been gathering attention since 2019, real interest began to surface once the pandemic accelerated digital disruption.

Regarding AI techniques, both [19] and [21] identified ES ML, NN, and Robotic Process Automation as some of the technologies that are having a big influence in PM. Additionally, [20] predicts that enterprises will slowly begin their AI transformation journey to provide a competitive advantage and

boost their market position, as also evidenced by PMI research in [22] where it is shown that over the next five years, 82% of senior leaders expect AI to alter their organization's PM practices.

Authors such as [23] and [24] mentioned that project managers dedicate a large amount of time performing administrative duties, as handling check-ins and overseeing updates. These authors suggest that AI can help project managers reduce their workload by prompting them to maintain records, updating statuses, and notifying stakeholders. This would allow project managers to devote more attention to the intricate processes behind their management. With time spared using AI enabled PM systems, they would be able to dedicate extra time to supporting their employees, potentially empowering them, and uncovering further proficiencies.

Simultaneously, [25] identified that adopting AI in PM also represents some disadvantages and barriers, that impede its widespread integration. One significant obstacle is human assistance in refining ML capabilities, highlighting the need for skilled professionals to enhance AI systems effectively. Another challenge arises from the expense associated with labelling data, which can be prohibitively costly, thus hindering AI implementation efforts. Moreover, establishing a robust support infrastructure is essential for facilitating wide-scale AI implementation within PM frameworks. Furthermore, the scarcity of training data may lead to performance degradation, compromising the effectiveness of AI applications in PM contexts.

According to Alshaikhi and Khayyat [1], PM has embraced AI, promising positive outcomes for future project activities, even though, despite its potential, PM is still in the early stages within the realm of AI and requires further development to achieve its primary objectives. Moreover, the authors have stated that several issues and challenges in PM have been identified, those which AI systems could address. Thus, there is a significant opportunity for various AI systems to improve the efficiency of project managers' daily tasks.

Utilizing available resources, prioritizing emerging tools and techniques beneficial for PM, and establishing realistic project schedules constitute pivotal areas where the AI-powered system can significantly enhance PM conditions for organizations. Developing a streamlined system PM utilizing ML models could yield a more sustainable solution [8].

It is also important to note that the PMBOK 6th edition [26], the predecessor to the most recent version, offers a framework divided into knowledge areas, which many authors, such as [23], [24] and [27], used to base their research and tried to create a framework applying AI in these areas. Meanwhile, some updates were made to the 7th edition, and these knowledge areas were not integrated in this edition; the Performance Domains were incorporated.

After conducting both literature reviews (SLR and MLR) and analysing the existing literature already identified, it was possible to gather an overview of the possible associations between different AI techniques and different PMPDs.

Regarding the **Stakeholder PD**, Taboada [2], identifies various studies that had experimented with multiple AI techniques, ML, NLP, and NN, all oriented to Stakeholder Management. Additionally, this author identified that Pérez Vera and Bermudez Pena [28] contributed with a study regarding a fuzzy inference system that classifies stakeholders by utilizing two ML clustering algorithms. Accordingly, [27] suggests that AI can be used in Stakeholder Management, more specifically, to analyse stakeholder communication and monitor involvement to maintain satisfaction at a high level. In addition, authors [27] and [29] claim that AI could be useful in Stakeholder Identification to help identify and comprehend who are the project stakeholders, whether they are internal or external, what are their requirements and commitments with the project, as well as in Stakeholder Engagement by recommending actions to help keep these interested parties engaged and satisfied. This comprehends creating a communication plan to keep the stakeholders informed about emerging concerns, according to their involvement in the project.

Concerning **Team PD**, writers in [2] noted that projects where AI-assisted communication using ML is used have the potential to improve Team Performance. On another note, scholars in [30] mention how project managers spend a considerable amount of time working on administrative activities, that are relatively simple but repetitive and how an AI-based system can perform these actions accurately. Additionally, [27] and [18] complement this theory with the possibility of AI helping prioritize project tasks, therefore saving a substantial amount of time for project team members on Task Management. Moreover, [1] mentions three tools for automating PM tasks, these being: Rescoper, which assists in handling the tedious management parts so the team can be more focused; Clickup, that helps in predicting the best member of the team for some particular tasks and helps in assigning the tasks. It also involves task managing through notifications when there are new updates and estimates for specific tasks; Clarizen, a tool that helps to track and share data. Furthermore, AI uses data visualization to give instant updates on project progress, which allows the team and project manager make informed decisions about the project's important aspects, facilitating discussions with the team about the project's status [18]. Concerning Team Management, Niederman [29] argues that globalization and the growing tendency of multicultural teams generate the need for tools that are able to accommodate these teams, and how this support for a seamless team interaction can evaluate the teams' spirit to help project manager intervene if necessary. Additionally, [31] explains how AI can improve team communication and collaboration, which can lead to overall higher project delivery efficiency.

Even though there was no literature concerning, directly, the **Development Approach and Life Cycle PD** [2] it is possible to forecast how AI could affect this domain. It is expected AI techniques will impact the project methodology, life cycle, and deliverables since these aspects are the base of this domain [10]. Holzmann et al. [27] suggest that AI can be applied to extract and verify deliverables,

even though it is in a project scope management view, helping identify deliverables and similar components. Following the main components of this domain, [23] refers the possibility of having a “digital project manager” that would be able to automatically choose the correct methodology according to a project’s characteristics and goals. The impact on these aspects would contribute to an improved management of the project’s deliverables. There were no studies that suggested how an AI tool could impact a project’s life cycle.

About the **Planning PD** many authors reported how important and impactful AI is when planning a project, on various aspects and, research on [19] concluded that “AI is most likely to be used during project planning”. Concerning budgeting, [27] hints the utilization of AI to create an initial draft of a projects budget, examining cost drivers, financial trends, and identify potential savings opportunities, while keeping to analyse this information continuously to keep the plan updated, as well as, creating a budget plan for emerging concerns. Accordingly, Gupta [32] claims that AI tools can be used for project budgeting, to maintain projects under their budget and draw attention to any spending risks; and forecasting of resources, risks and budget, allowing a company to utilize resources at their optimum capability. Additionally, [23] suggests a “complete AI solution”, a chatbot that communicates AI-based budget estimates, and in line, [24] indicates that AI technologies will help minimize human errors and biases in budgeting.

AI-assisted resource allocation optimizes allocating resources, including persons and equipment, to project tasks and activities. This can assist project managers in optimizing resource use, improving scheduling and completion timelines, and reducing costs. This has been discussed by Sravanthi et al. [18], where examples of AI-based resource allocation strategies include linear programming, genetic algorithms, and NN, which help project managers plan projects more accurately and track progress more efficiently. Likewise, [32] also supported the idea that AI is an advantage to resource allocation, adding that by using AI technologies, we are capable of tracking resources and identify the appropriate skill based on previous projects.

Regarding project scheduling, various authors, such as [2], [27] and [18], reference this as an aspect that AI can make a difference, suggesting that it allows to create precise project timelines and track progress against them, based on complexity of activities, available resources, team expertise, and restrictions, as well as, constantly updating them upon the appearance of news variables that should be considered.

In terms of existing AI-based solutions, [1] and [18] enunciate a range of tools that already aid to PM in this area. For instance, Primavera P6 is a PM software that offers resource levelling, optimization, and scheduling capabilities, as well as, track project performance by valuing completed work, creating precise timetables and track progress against them, and identification and management of project

risks. It also includes a functionality that predicts project duration through historical project data. On another hand, Zivebox uses AI to assess the time required to conclude a task.

Regarding the **Project Work PD** authors in [2] identified an already existing cost-efficient AI-powered chatbot framework tailored for PM, implemented on various environments such as Jira, google drive, skype, among others. This innovative solution holds promise in saving time for project managers and mitigating project failures. The authors mention AI technologies like fuzzy ES, ML, NLP and NN. Additionally this researcher ascertains more generic ideas from various authors, where it is mentioned that IT PM can be benefited by AI through improved visualization approaches for tracking project processes, which we can understand that falls into the Project Work PD. In a study conducted by [33], the authors propose a conceptual model for scrum framework. They suggest a methodology using different ML models to analyse relations between features and story points, and affirm that this model can help the project manager enhance PM processes.

Writers in [2], conclude, about the **Delivery PD**, that automation of project quality management using AI-powered techniques, such as fuzzy approaches, ML, and NN offer the prospect of efficient project delivery. The author mentions some studies where NLP was used in order to check regulatory compliance documents, as well as, NN for quality management and classification.

This domain has a strong connection with the Development Approach and Life cycle PD the scope and quality that the project initially set out to achieve are being delivered. [27] presents the possibility of applying AI to help monitor scope creep, and deviations from plan, and analyse repercussions. A notion very relevant for this domain is the definition of Work Breakdown Structure (WBS) "A hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables" [10]. In their research, where they explored how project managers view the future of AI in PM [27], writers revealed that it is possible to utilize AI tools to create automated work breakdown structures (WBS), and that this was one of the top-ranked features identified by project managers in the study. Moreover, this can be an advantage to project teams as they sometimes opt to decompose their process using a WBS [10], allowing them to save time in the process.

In regard to the **Measurement PD** the authors in [2] identified that AI techniques can be employed to evaluate project performance metrics, identifying delays, implementing suitable responses, and monitoring activities leads to accurate project assessment. Furthermore, the authors pinpoint numerous existing works forecasting Earned Value Management and comparing them to AI techniques, where it was considered that AI techniques are better at predicting when the training and test groups are similar. Auth et al. [23] showed that the main objective of AI-based quality management research is to classify and evaluate project outputs, concluding that quality issues can be identified and avoided at an early stage. In terms of quality Holzmann et al. [27] proposed that AI can

be applied to quality assessment, create reports, examine product quality, overview processes and apply corrective measures if necessary. In addition, the writers suggest the utilization of AI to define or improve the KPIs used for quality control.

Concerning the **Uncertainty PD** authors [29], [30] and [32] expressed utilizing of various AI technologies and algorithms can aid in risk management. More specifically [29] suggests that maintaining a list of potential adverse effects, by utilizing advanced checklists or conducting variance analysis of what had been planned versus what happened. The author continues by suggesting the implementation of project-type intelligent sorting and grouping to help organizations anticipate and mitigate the costs associated with risk events more effectively. To sum up the author, considers views AI solutions as enablers to speedy response to undesirable situations by assessing, locating, calculating, preventing negative impacts, and planning backup strategies. Furthermore, [24] stated that effective PM involves thoroughly planning responses to project risks, and in addition, identified that ML has been successfully applied to assess the degree of risk and measure its anticipated impact, as well as, NLP application in risk identification. Additionally, the author stated that there is a distinct emphasis on ML techniques for risk assessment, alongside a clear dedication to risk identification, analysis and response planning, however other AI domains hold potential for application in these aspects. Palomares et al. as also pinpointed two case-based reasoning (AI approach that solves problems using adapted solutions form previous problems), that were created to help with risk response planification, where this AI approach helps retrieve analogous risks from previous projects and the corrections and strategies applied in those cases. This approach was also utilized for risk monitoring, on another system where it recovered past risk mitigation tactics that had been successful to help the project manager plan the best risk response strategy possible. A summary of the identified connections between PMPDs and AI Techniques are presented in Table 4.

Table 4 – Utilization of AI Techniques in Project Management Performance Domains

Performance Domains	AI Techniques	Impacted Aspects of PM	Contributions	Examples
Stakeholder	ML, NLP, NN, Fuzzy Approaches	Stakeholder Management [2] [27] Stakeholder Identification [2] [27] [29] Stakeholder Communication and Engagement [27] [29]	Improved Communication Risk Identification Opportunity Identification Expectation Alignment Improved Collaboration	Fuzzy Inference Systems to classify Stakeholders [28]
Team	Chatbots, ML	Team Performance [2] Task Management [1] [27] [18] Team Management [2] [27] [29] Team Communication and Management [31]	Improved Communication Knowledge Management Optimised Team Work Improved Motivation and Team Spirit Abilities Development Improved Work Culture	Rescoper [1] Clickup [1] Clarizen [1]
Development Approach & Life Cycle	Chatbots, ML, NN, Fuzzy Approaches, ES	Project Methodology [10] [23] Project Life Cycle [10] Project Deliverables [10] [27] [34]	Deliverables Management	Digital Project Manager [23]
Planning	Fuzzy Approaches, NN, ES, Chatbots, ML	Budgeting [23] [24] [27] [32] Forecasting [32] Resource Allocation [18] [32] [43] Project Scheduling [1] [2] [18]	Flexibility to Change Improved Risk Management Maximising Resources Efficiency	Primavera P6 [18] Zivebox [1] [18] Celoxis [18] Project Wise [18] Deltek Acumen [18] Polydone [18] Tara [23]
Project Work	ES, Fuzzy Approaches, NN, ML, NLP, Chatbots	Project Processes [2] [33] Quality Assessment [2]	Knowledge Management Optimised Team Work Improved Communication Continuous Learning	Clickup [1]
Delivery	NN, Fuzzy ES, AI Chatbots, ML, NLP	Scope Definition & Management [27] Scope Creep [10] [27]; Project Quality Management [2] Deliverables Management [10] [27]	Deliverables Quality Optimised Product	Model to consolidate Critical Success Factors [2], NLP model for Compliance check [2]
Measurement	ML, Fuzzy Approaches, NN, ES, AI Chatbots	Earned Value Methods [2] [24] Risk Monitoring [2] [23] [24] Quality Assessment and KPIs [1] [27] [47]	Refined Metrics Pattern Identification Risk Identification	Comparison between ML Algorithms and Earned Value Management (EVM) methods [2]
Uncertainty	Fuzzy Approaches, ML, NN, NLP, ES	Risk Management [30] [24] [27] [31] Response to Risk [24] Monitoring [24]	Improved Flexibility and Adaptability Improved Communication Improved Planning Continuous Learning	ML-based prediction system to forecast the risk [2]

2.3.2. Artificial Intelligence adoption challenges

Although AI holds great potential for PM, it remains significantly underdeveloped. Despite its promise, there is still a long road ahead, with many challenges and several disadvantages to address. While AI can revolutionize the field, its current limitations highlight the need for further advancements and careful consideration in its implementation.

Authors in [1] consider that one of the significant challenges in implementing AI is data availability. Data is often inconsistent and unorganized due to weak quality. AI can only perform tasks that it has

been specifically programmed or designed to handle, limiting its versatility. In accordance, Cubric [25] considers data scarcity a major challenge, specifically for large training datasets which are difficult to collect and maintain, often containing confidential information, not to mention the struggles with unstructured data. This limitation reduces AI's effectiveness in managing projects that involve such data. Additionally, inadequate training data can degrade AI performance, leading to suboptimal results. Budeli [35], explains how data not being properly captured presents a challenge to PMO, as lessons learned should be documented continuously throughout the project's life, since these insights are valuable for improving current projects and refining PM processes. Failing to learn from past mistakes increases the risk of repeating them in the future. Additionally, [31] and [20] mention how incomplete and inaccurate data presents as a vulnerability that leads to unreliable results and flawed predictions. Additionally, Cubric [25] states that adopting, implementing and maintaining AI is not easy, as it is a time-consuming process that involves high operational costs and expensive equipment, this becomes a barrier.

Furthermore, [25] researcher mentions that reusing AI models for different problems is complicated and that there exists a lack of knowledge regarding the potential capability of ML approaches for certain problems. Similarly, [29] concludes that using AI is not easy and it presents as a challenge to many professionals, how lack knowledge and training in AI and find its utilization to be challenging.

In addition, Gupta [32] explains how project managers excel in areas where AI tools fall short. They can influence and motivate teams, ensuring everyone works toward a common goal, which leads to better outcomes and project success. Project Managers also handle negotiations and adapt plans based on ongoing discussions, which is something that AI tools cannot do effectively. They are able to fill gaps as the project evolves, continuously seeking solutions while the team focuses on their activities. The author notes how the human touch is crucial, and how project managers connect the team and foster collaboration. Moreover, skilled project managers are essential for setting up AI-enabled tools, ensuring they are configured correctly and adjusted as project plans change. This is supported by [20], who also states that human judgement, experience and intuition remain crucial. This challenge is deeply connected with the overlying on AI, point by authors in [20], where they explain how overreliance on AI can be risky and user should always maintain their human intuition and critical thinking.

Moreover, [25] highlights how unrealistic the expectations of technology are and how the systems future users need to not only know how to work with the AI system but also understand its characteristics, a point which authors in [1] also highlight.

They believe that AI adoption will not function correctly if users lack technical skills, and [25] and [19] state how significantly low the number of trained project professionals is. Moreover, the writers explain how well-trained staff is necessary to manoeuvre the systems and incorporate them with the business strand, and how the lack of capability to perform this integration presents as a challenge.

Moreover, researchers in [34] conducted a study where there were identified several barriers to AI-adoption for PM, divided by three pillars: regulative, normative and cultural-cognitive. One primary barrier is the lack of knowledge about AI technologies and their potential applications. Many organizations are unfamiliar with AI's capabilities and how to leverage it effectively. On the same note, another two challenges highlighted were the lack of skilled and trained employees to work with these systems and the difficulty in employing said experts. In addition, the time required to learn and adapt to new AI tools can be consuming as mentioned before by [1].

Another challenge, identified by [31], lays on AI models being unstable and erratic, causing performance issues. Additionally [29] and [36] state that AI biases can lead to ethical and legal concerns, resulting in financial costs and a loss of reputation for the company, explaining how AI presents concerns about acceptance, trustworthiness, transparency, legality, ethics, and moral responsibility. Moreover, writers [31] and [20], mention how AI systems are susceptible compromising data and privacy as they are easy targets for hackers.

Regarding job displacement, several authors [25] [31] [20] identified that AI can easily automate certain activities and it is possible that these tasks might begin to be developed by AI systems, thus changing job roles as we know them. Additionally, how AI systems are subject to hacks, data breaches, and privacy abuses, which can cause security issues and compromise important confidential information.

Finally, authors in [1] believe that AI implementation could possibly mean a more sedentary lifestyle for people, as machines complete a broad task portion in a very short period. Table 5 summarizes the challenges identified by the literature.

Table 5 – Summarization of challenges identified by the literature

Disadvantages and Challenges	
Data availability [1] [25] [31] [20]	Lack of trained staff and technical skills [1] [34]
Data Quality [1] [25] [35] [31] [20]	Lack of knowledge about AI [1] [25] [19]
Adoption and maintenance are hard, expensive	Performance instability [31]
AI models are hard to use/reuse [25] [19]	Bias, ethical concerns and resistance to change [29] [31] [36] [20]
Human touch is crucial [31] [32]	Security and Privacy [31]
Overreliance [20]	Job displacement [25] [31] [20]
Unrealistic expectations [1] [20]	Sedentary Lifestyle [1]

Research Methodology

3.1. Research Context and Methodology Research Design

As stated in the introductory chapter, Research Methodology, the selected technique was the Design Science Research Methodology (DSRM), purposed by Brocke, Hevner, & Maedche [6], and it is characterized by design science research as “a problem-solving paradigm that seeks to enhance human knowledge via the creation of innovative artifacts”.

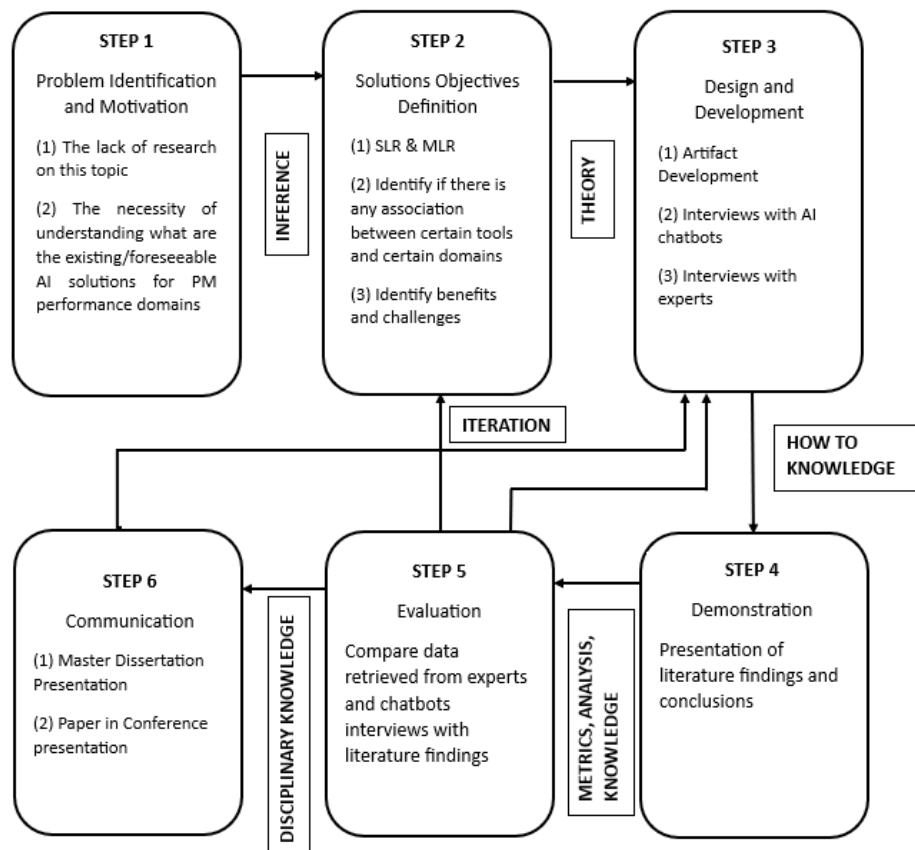


Figure 1 – Design Science Research Methodology

As it is possible to observe in Figure 1, this methodology is structured in six steps, those being:

- i. Problem Identification and Motivation: The lack of research on this topic identified the problem and motivated the need to understand what AI solutions can be used in PM.
- ii. Solutions Objectives Definition: The process started with a SLR that required searching and examining several scientific publications that addressed the effects of AI tools on PM. Throughout the SLR, it became clear that there was a gap in the effects of AI technologies on PMPD, emphasizing the need for further investigation and comprehension in this area. Following, an MLR was conducted from various sources to acquire a broad picture of the current state of AI tools and how they relate to PM performance domains. Afterward the

emphasis turned to finding what particular AI technologies are being used, or could be use int the future, on PMPD;

- iii. Design and Development: This step concentrates on the construction of the artifact;
- iv. Demonstration: This process comprises a comprehensive overview of literature findings and conclusions;
- v. Evaluation: To demonstrate the importance and veracity of the study there will be conducted interviews with chatbots and experts, and afterwards the feedback retrieved from these will be compared with the findings of the literature review;
- vi. Communication: First, there will be the master thesis presentation. Second there will be the enrolment and presentation on a conference.

3.2. Systematic Literature Review

The primary purpose of the SLR is to examine and synthesize existing scholarly research about the utilization of AI tools in PMPD. As stated by Kitchenham, et al., [37] the SLR approach is a methodologically rigorous evaluation of research findings, and its' objective is to promote the creation of evidence-based guidance for practitioners in addition to compiling all available data on a research subject. Figure 4 demonstrates the multiples steps of the research process as outlined by [37].

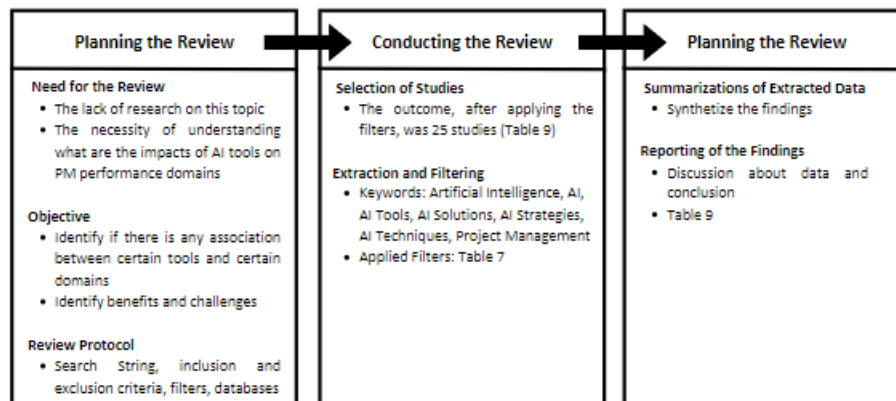


Figure 2 – SLR Steps

The search string used was composed by the combination of three keywords presented on Table 6. As it is possible to observe some abbreviations and synonyms were employed to ensure that no study would be unconsidered for having a very restrictive string.

It is also important to mention that the construction of the Search String was carefully done and it took a long process. In the first instance, instead of having three major groups (represented by the keywords) combined, there were four, with the fourth group specifically focusing on PD. Throughout the strings' construction various iterations involving this fourth group were tested to optimize the

outcome. The majority of the search results were not relevant to this research and so I opted to broaden my search and make it less specific.

Taboada, Daneshpajouh, Toledo, & Vass already identified this constatation [2], when stated that “there are no studies covering this topic in the literature that focus on the analysis of AI techniques in the different PM performance domains (PDs)” and “there has been no systematic literature review (SLR) of the application of AI technologies in PMPDs, which are introduced in the PMBOK 7th edition”.

Table 6 - Description of Keywords and Final Search String

Keywords	Artificial Intelligence, AI, AI Tools, AI Solutions, AI Strategies, AI Techniques, Project Management
Search String	("Artificial Intelligence" OR "AI") AND ("Project Management") AND ("Tools" OR "Solutions" OR "Techniques" OR "Strategies")

The database selection resulted in the search string being applied to five scientific databases, these being: Scopus, IEEE Xplore Digital Library, EBSCO, Web of Science and ACM Digital Library. In the pursuit of synthesizing the outcomes of the body of literature, some inclusive and exclusive criteria were used, as summarized in Table 7. These criteria serve as guiding principles, mandating the inclusion or exclusion of studies based on parameters linked with the review's research objectives. They are fundamental since they operate as filters, ensuring that the studies gathered are not only relevant, but also meet specified quality and methodological requirements.

Table 7 - Inclusive and Exclusive Criteria

	Inclusive Criteria		Exclusive Criteria
IC1	Keywords are present on the studies' abstract	EC1	Keywords are not present on the studies' abstract
IC2	Study was published between 2018 and 2023	EC2	Study was published before 2018
IC3	Study is a scientific paper, from conferences, journals or articles	EC3	Study is not a scientific paper, white paper
IC4	The language used for writing was English	EC4	The language used for writing was not English
IC5	The study contents are relevant to the literature review	EC5	The study contents are not relevant to the literature review
IC6	Study is not duplicated	EC6	Study is duplicated

The first stage of this process consisted on applying the search string on the selected databases which resulted on a total of 205318 articles, which dropped significantly to 1224 studies after applying the IC1 and EC1, selecting only papers that present the keywords on their abstract, and removing the ones that failed to do so.

Afterwards, IC2, IC3, and IC4 were applied to select scientific papers, such as conference papers, journals, or articles, published in English, from a date interval from 2018 to 2023. Simultaneously, EC2,

EC3, and EC4 excluded papers that were not in accordance with the intended parameters, non-scientific papers published before 2018, and papers not written in English.

The last step of the process included IC5 and IC6, which helped ensure that the paper was insightful and relevant to the literature review and did not present itself on a different database search. In turn, EC5 and EC6 excluded papers whose content was not significant for the literature review and duplicates. Ultimately, the search unravelled 25 papers, as presented in Table 8.

Table 8 - SLR Results

		Search String	IC1 & EC1 applied	IC2 & EC2 applied	IC3 & EC3 applied	IC4 & EC4 applied	IC5 & EC5 applied	IC6 & EC6 applied
Data Bases	Scopus	26788	185	115	71	67	23	16
	EBSCO	173 086	955	638	243	225	24	6
	IEEE	3729	26	17	16	16	7	2
	ACM	1365	4	1	0	0	0	0
	Web Of Science	350	54	32	26	26	13	1
	Total	205318	1224	803	356	334	66	25

In Table 9 it is represented the crossing of subjects with studies areas. This table summarizes a thorough investigation of several important domains that cross over into AI Solutions, PM and PMPD. The table draws boundaries around important topics that act as centres within these overlapping domains.

A range of important topics surface within the overlapping domains of AI solutions and PM, providing deep understandings. These topics encompass integrating advanced AI techniques and their implementation in the context of efficient PM and implementation. Some examples include well-known techniques such as "Text Mining in PM" and "Machine Learning in PM." These domains explore the depths of ML integration and the extraction of useful insights within PM frameworks, exemplifying how it is possible to infuse AI into PM.

Simultaneously, the field expands to include the applications of "AI Use Cases applied to PM" and "Intelligent PM Tools." These topics represent the real implementation of AI-powered instruments, bringing in a new set of intelligent PM techniques, from useful applications demonstrated by successful AI use cases. Topics like "Scrum Framework" and "Project Managers' Relationship with AI" provide a detailed look at how methodologies and the usual roles, as we know them, are changing and how human expertise and AI-driven systems interact. However, among these topics, one stands out by being the only one involving Performance Domains: "Gap Identification." This topic outlines the crucial area where AI-powered PM and performance domains collide. It acts as a way to discover research gaps in using AI tools in PMPD.

Taken as a whole, this grouping of subjects in areas provides a better perspective of how the papers drawn from the SLR connect with each other, what topics they study, and what areas they cover.

Table 9 – Crossing of subjects with study areas

Subject	Paper	AI Solutions	PM	PMPD
ML in PM	[8]; [38]	X	X	
Text Mining in PM	[39]	X	X	
Drivers, Barriers and Impacts of AI in PM	[1]; [25]	X	X	
Intelligent PM Tools	[23]; [24]; [36]; [40]; [41]	X	X	
AI Use Cases applied to PM	[42]	X	X	
IT in Business Processes	[43]	X	X	
Advanced Analytics on PM	[29]; [35]	X	X	
Project Managers relationship with AI	[27]; [44];	X	X	
Scrum Framework	[33]	X	X	
Gap Identification	[2]; [3]; [45]; [46]	X	X	X
Current AI role in PM	[30]; [32]; [18]; [47]	X	X	

3.3. Multivocal Literature Review

The primary objective of this MLR is to provide a comprehensive examination of AI in PM and its PD by synthesizing and analysing multiple perspectives from the literature. Given the multifaceted nature of IA, adopting a multivocal approach to this literature review is deemed essential. By embracing diverse perspectives and methodologies, this review aims to provide a nuanced understanding of AI, transcending disciplinary boundaries and enriching scholarly discourse.

As observed with the SLR, initially the search string included the performance domains, but considering that no relevant articles emerged from that search, a broader search was chosen.

There were four selection criteria applied to perform the MLR. The first criteria assured that the study was produced by a hedonic entity, such as standardization entities or universities. Following only papers written in English were selected, and their content had to be relevant in order to be selected. Lastly the study could not be duplicated. These criteria helped restrict the search outputs, according to the study needs.

The search string used is shown in Table 10 and used on Google Scholar. After applying the selection criteria, presented on Table 11, the resultant number of articles during the search came to a total of 7 studies.

Table 10 – Description of the Search String

Search String	“(“Artificial Intelligence” OR "ai") in (“Project Management”)”
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Table 11 – MLR Selection Criteria

	Criteria
C1	The study was produced by a hedonic entity, such as standardization entities or universities
C2	The language used for writing was English
C3	The study contents are relevant to the literature review
C4	Study is not duplicated

3.4. Interviews and Sample Characterization

3.4.1. Chatbots Interviews

For this dissertation, an interview was prepared and conducted with AI chatbots. This interview aimed to ascertain how an AI chatbot views the application of AI in PM, and what specific usages were suggested, to compare it and confront it against the literature review and experts’ experiences and suggestions.

The structure followed was also a semi-structured, conducted with two chatbots, these being ChatGPT and PMOtto, an AI-powered assistant for specifically PM related topics. The reason for using two chatbots instead of one was to allow a comparison between their answers and try to understand their similarity and differences. Choosing specifically ChatGPT, among others, due to its popularity and recognition, since its appearance revolutionized human interaction with chatbots, and PMOtto was chosen for being a bot particularly oriented to PM. Both of these chatbots are of free use, which was also an important aspect when deciding which ones to use.

These AI systems were questioned directly about PMPD, being that it was ensured that they were familiarized with them, and what possible AI applications they could view for each PM domain. Attached in Appendix B is the set of questions asked and their respective answers regarding ChatGPT, and in Appendix C the same for PMOtto. The questions, were semi-structured and equal for both bots, and they aimed to explore what AI solutions oriented to PMPD an AI solution itself would mention, as well as, what disadvantages it suggests.

3.4.2. Experts Interviews

Furthermore, an interview, divided into two parts, was prepared and conducted with experts working within the context of projects, to validate what was raised in the literature review and discover new uses of AI in PM.

The interview was divided into two parts: the first part aimed to ascertain the existing knowledge that each participant had regarding the current use of AI in PM, such as AI techniques already used in their projects or projects they were aware of and the main benefits they bring, as well as, the challenges perceived for the future of AI adoption in PM; and on the other hand, the second part of the interview consisted of a semi-structured group of questions that attempted to understand if the interviewees corroborated and agreed with some of the suggestions made by the chatbots, as well as, encourage them to think about further AI applications to PM. This helped confirm that the chatbots recommendations were applicable and valid. The questions from this second part were formulated through the chatbots suggestions (given in the interviews with chatbots), and they were used with the purpose of, firstly validating that they were coherent and valuable recommendations and helping develop the experts' thoughts about the topic to achieve new suggestions. The questions served merely as a guide to lead the interviews where participants did not have a lot of suggestions. Not all questions were asked to all the experts, as they served as a way to aid the experts who did not have many suggestions to think more about the topic. Some experts did not need to be asked these questions as they had a lot of experience with AI in PM, or they had many suggestions for the integration. The interview guide is attached in Appendix A.

This interview targeted experts with experience on working in projects, not having to be necessarily project managers, as the usage of AI is destined to the project team, thus any project team member was an adequate respondent. With this being the criteria used for selecting the study participants was that the expert had to have experience working in a project context for over 6 months. The participants were contacted through LinkedIn, where they received an invitation to be a part of the study, explaining the context and what would be necessary.

The total number of participants was twelve, and the roles played by these includes CEO, Chief Technical Titan, project managers, software engineer and tech and business analysts as it is possible to observe in Table 12. Regarding the experts' experience, we can observe it ranged between 1 to more than 10 years of experience; where five interviewees have 1 year of experience, four interviewees have between 3 and 10, and three interviewees have more than 10 years of experience. The industry that was most present was consulting and audit, followed but automotive, infrastructure and transportation, software and financial.

Being that not every participant had a profound knowledge of PM and the PDs introduced in the 7th edition of PMBOK, during the interviews there was no specific mention to these domains, only questions that refer to the topics each domain covered. This type of structure was chosen since it allows flexibility on what areas of interest will be explored, being that each person has different views, opinions and experiences related to the theme.

Table 12 – Interviewees profiles

Job Title	Work Experience	Industry
CEO	> 10 years	Consulting
Chief Technical Titan	> 10 years	Automotive
Project Manager	10 years	Infrastructure and transportation
Software Engineer	7 years	Software Enterprise
Project Manager	> 10 years	Financial
IT SAP Advisor	1 year	IT Audit
Tech Analyst	1 year	IT Audit
Assurance Analyst	1 year	IT Audit
Tech Consultant	1 year	IT Consulting
Tech Analyst	1 year	IT Consulting
Business Analyst	5 years	IT Consulting
Assurance Associate	3 years	IT Audit

3.5. Interviews Saturation

The saturation level was achieved during the data retrieval process after conducting twelve interviews. After this point, participants' suggestions began to resemble previous ideas and topics, and very little significant new information emerged. According to, [48] saturation is an instrument that determines at what point observations become unnecessary since no relevant insights contribute to pertinent information from the data collection process. Therefore, it was considered that the twelve interviews conducted were sufficient to achieve the objectives identified in this dissertation.

In order to achieve this number, as identified by [49], we defined what categories we would be analysing and what concepts would better represent what is being investigated. Two categories were identified: AI based solutions to support PM, and challenges of AI adoption in PM. On the second step the interviews script was outlined.

Table 13 – Interview Script

Category	Script Questions
AI based solutions to support PM	<ol style="list-style-type: none">1. Have you ever used or heard of any AI techniques to support PM? If yes, can you provide examples2. Besides what you are familiar with what other utilizations to support PM can you think about?3. Different questions about the topics covered by each domain (Appendix A) <p>.</p> <p>.</p> <p>.</p>
Challenges of AI adoption in PM	<ol style="list-style-type: none">1. Are you familiar with any challenges or disadvantages this integration might originate?

As mentioned before these interviews were structured so, for the first category, the first two questions were the same for all the experts (presented in Table 13). However, the following questions (Table 13 Point 3) differ from expert to expert, considering their experiences and opinions. The reason for opting for this approach was due to the PMPDs a relatively recent concept and not everyone may be familiar with them, so from question 3 onwards, the questions asked had the goal of trying to understand for each domain component what possible AI use cases the experts could envision.

In order to find the optimal number of interviews to perform, the saturation of the collected answers was conducted. In Figure 3, it is possible to observe how throughout the interviews, the accumulated number of new answers started to stagnate, and eventually, there were no new contributes added to the study. When observing the figure, it is possible to conclude that the first five interviews had the greatest number of new contributions, whereas from that point to the eighth interview, the curve started to bend, showing less increase in new aspects. Arriving at the ninth interview, we can understand that from this interview on, there was no new additional suggestions.

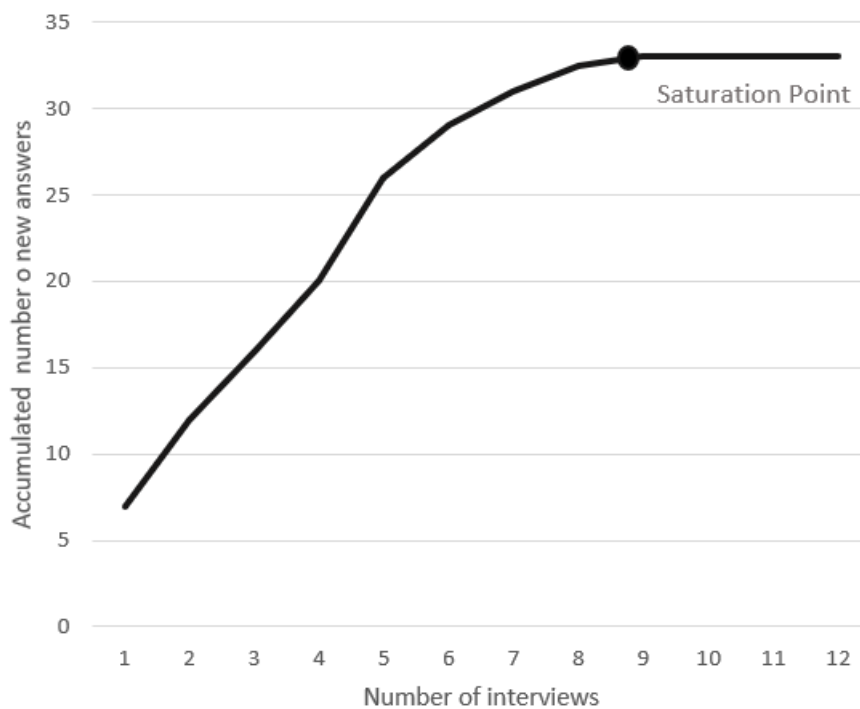


Figure 3 - Saturation Curve

Furthermore, this point of saturation is represented in Table 14, where it is possible to observe that the first interview to not bring any fresh contributions is the ninth interview. In this table, we have a binary representation of when a new contribution was collected during the interview.

Table 14 - Saturation of the collected answers

Interviews												
Interview	1	2	3	4	5	6	7	8	9	10	11	12
New AI solution	1	1	1	1	1	1	1	1	0	0	0	0
New challenge	1	1	1	1	1	1	1	0	0	0	0	0

Data Analysis

4.1. Framework for using Artificial Intelligence in Project Management

4.1.1. Chatbots suggestions for integrating AI in PM

For each chatbot there were three questions and, as mentioned before, the questions for both were the same, these being:

1. An introductory question to make sure that the bot was familiar with the PMPDs according to PMBOK definition
2. Explaining briefly the topic and context and ask for AI applications in PM
3. Ask about the challenges and disadvantages of this integration

Following is a summarized version of **ChatGPT's answers** regarding ways of integrating AI in each one of PMPD, and each has provided three aspects.

1. Stakeholder Performance Domain

- "Sentiment Analysis: AI-driven sentiment analysis tools can analyze stakeholder communications (emails, meeting notes, etc.) to gauge their satisfaction, concerns, and overall sentiment, enabling proactive engagement strategies."
- "Chatbots: AI-powered chatbots can provide stakeholders with instant responses to queries and updates, improving communication and engagement."
- "Predictive Analytics: AI can predict stakeholder reactions and behavior based on historical data, helping to tailor communication and engagement plans."

2. Team Performance Domain

- "Talent Management: AI can assist in identifying the best team members for specific tasks by analyzing their skills, experience, and past performance."
- "Collaboration Tools: AI-enhanced collaboration platforms can suggest optimal meeting times, automatically assign tasks, and monitor team dynamics, providing insights to improve team cohesion and performance."
- "Performance Monitoring: AI can continuously monitor team performance, providing real-time feedback and identifying potential issues before they escalate."

3. Development Approach and Life Cycle Performance Domain

- "Optimization of Development Approaches: AI can analyze project requirements and constraints to recommend the most suitable development approach (e.g., Agile, Waterfall, Hybrid)."
- "Adaptive Planning: AI-driven tools can dynamically adjust project life cycles and development methodologies in response to changing project conditions or risks."

- “Scenario Analysis: AI can simulate various development approaches to determine the most efficient and effective path for project completion.”

4. Planning Performance Domain

- “Automated Planning: AI can automate the creation of project plans by analyzing historical data and predicting the most effective sequences of tasks.”
- “Resource Allocation: AI can optimize resource allocation by predicting resource availability, workloads, and potential bottlenecks.”
- “Risk Identification and Mitigation: AI can identify potential risks during the planning phase and suggest mitigation strategies based on historical project data and predictive models.”

5. Project Work Performance Domain

- “Task Automation: AI can automate routine tasks such as scheduling, reporting, and status updates, freeing up project managers to focus on strategic activities.”
- “Progress Tracking: AI-powered tools can monitor and track project work in real-time, providing updates and flagging potential issues.”
- “Quality Assurance: AI can assist in quality control by automatically checking work outputs against predefined standards and identifying any deviations.”

6. Delivery Performance Domain

- “AI-Driven Delivery Optimization: AI can optimize the delivery process by analysing real-time data to adjust delivery schedules, resource allocation, and supply chain logistics.”
- “Predictive Delivery Management: AI can predict potential delays or issues in the delivery process and suggest corrective actions to ensure on-time delivery.”
- “Automated Compliance Checks: AI can automatically verify that deliverables meet all regulatory and contractual requirements before final delivery.”

7. Measurement Performance Domain

- “Real-Time Analytics: AI can provide real-time analytics and dashboards that monitor project metrics, enabling more informed decision-making.”
- “Predictive Performance Metrics: AI can forecast project performance based on historical data, allowing project managers to take corrective actions before issues arise.”
- “Anomaly Detection: AI can detect anomalies in project performance data, signalling potential problems that may not be immediately apparent.”

8. Uncertainty Performance Domain

- “Risk Prediction and Management: AI can predict potential risks and uncertainties by analysing project data, market trends, and other external factors, helping to mitigate them proactively.”

- “Dynamic Risk Assessment: AI tools can continuously assess project risks and adjust risk management strategies in real-time.”
- “Scenario Planning: AI can simulate various "what-if" scenarios, helping project managers to prepare for potential uncertainties and develop contingency plans.”

Following is **PMOtto’s answers** regarding ways of integrating AI in each one of PMPD, and for each on it has provided two aspects.

1. Stakeholder Performance Domain

- “Sentiment Analysis: AI-driven sentiment analysis tools can analyze stakeholder communications (emails, surveys, social media) to gauge sentiment, helping project managers proactively address concerns or capitalize on positive feedback.”
- “Stakeholder Mapping: AI can map stakeholders based on their influence, interest, and involvement, providing insights into how to prioritize engagement strategies.”

2. Team Performance Domain

- “Virtual Assistants: AI-powered virtual assistants can help team members manage tasks, schedules, and deadlines, freeing up time for more strategic activities.”
- “Team Composition Optimization: AI can analyze skills, past performance, and team dynamics to recommend the best team composition for a project.”

3. Development Approach and Life Cycle Performance Domain

- “Predictive Analytics: AI can predict which development approaches (e.g., agile, waterfall, hybrid) will be most effective based on project characteristics, historical data, and team capabilities.”
- “Adaptive Planning: AI can continuously monitor project progress and automatically adjust the development approach or lifecycle phases to optimize outcomes based on real-time data.”

4. Planning Performance Domain

- “Automated Scheduling: AI tools can automate the creation of project schedules, optimizing resource allocation and timelines based on constraints and past project data.”
- “Risk Prediction: AI can identify potential risks during the planning phase by analyzing large datasets from similar projects, enabling proactive risk management.”

5. Project Work Performance Domain

- “Process Automation: AI can automate repetitive tasks such as data entry, reporting, and monitoring, allowing project teams to focus on high-value activities.”
- “Resource Optimization: AI algorithms can optimize the use of resources (e.g., materials, human resources) by predicting needs and minimizing waste.”

6. Delivery Performance Domain

- “Quality Control: AI-driven quality control systems can analyze data in real-time to ensure deliverables meet required standards, identifying defects or issues early.”
- “Predictive Maintenance: In projects involving physical assets, AI can predict when maintenance is needed, reducing downtime and ensuring timely delivery.”

7. Measurement Performance Domain

- “Performance Dashboards: AI-powered dashboards can provide real-time insights into project performance, highlighting key metrics, trends, and potential issues.”
- “Automated Reporting: AI can generate project reports automatically, pulling data from various sources, and presenting it in a clear, actionable format.”

8. Uncertainty Performance Domain

- “Risk Management: AI can enhance risk management by identifying emerging risks, quantifying their impact, and suggesting mitigation strategies based on data patterns and historical outcomes.”
- “Scenario Analysis: AI can run multiple project scenarios to evaluate the potential impact of different uncertainties, helping project managers make informed decisions.”

A summary of the proposed connections between PM and AI Techniques is presented in Table 15, where [C] refers to ChatGPT’s suggestions and [P] to PMOttos’.

Table 15 – Summary of solutions suggested by chatbots

Performance Domain	Potential Usages
Stakeholder	<ul style="list-style-type: none"> • <u>Sentiment Analysis</u>: AI-driven sentiment analysis tools can analyse stakeholder to gauge their overall sentiment [C] [P] • <u>Chatbots assistants</u>: AI-powered chatbots can provide stakeholders with instant responses [C] • <u>Predictive Analysis</u>: AI can predict stakeholder reactions and behaviour based on historical data [C] • <u>Stakeholder Mapping</u>: AI can map stakeholders based on their influence, providing insights into how to prioritize engagement strategies [P]
Team	<ul style="list-style-type: none"> • <u>Talent Management</u>: AI can assist in identifying the best team members for specific tasks [C] [P] • <u>Collaboration Tools</u>: AI-enhanced collaboration platforms can provide insights to improve team cohesion and performance. [C] • <u>Performance Monitoring</u>: AI can continuously monitor team performance [C] • <u>Virtual Assistants</u>: AI-powered virtual assistants can help team members manage duties [P]
Development Approach & Life Cycle	<ul style="list-style-type: none"> • <u>Development Approach Optimization</u>: AI can predict which development approaches will be most effective [C] [P] • <u>Adaptive Planning</u>: AI-driven tools can dynamically adjust project life cycles and development methodologies [C] [P] • <u>Scenario Analysis</u>: AI can simulate various development approaches [C]

Planning	<ul style="list-style-type: none"> • <u>Automated Planning/ Scheduling</u>: AI tools can automate the creation of project schedules and the creation of project plans [C] [P] • <u>Resource Allocation</u>: AI can optimize resource allocation [C] • <u>Risk Identification and Mitigation</u>: AI can identify potential risks during the planning phase [C] [P]
Project Work	<ul style="list-style-type: none"> • <u>Task Automation</u>: AI can automate repetitive tasks [C] [P] • <u>Progress Tracking</u>: AI-powered tools can monitor and track project work in real-time [C] • <u>Quality Assurance</u>: AI can assist in quality control by checking outputs [C] • <u>Resource Optimization</u>: AI algorithms can optimize the use of resources [P]
Delivery	<ul style="list-style-type: none"> • <u>AI-Driven Delivery Optimization</u>: AI can optimize the delivery process by analysing real-time data [C] • <u>Predictive Delivery Management</u>: AI can predict potential delays or issues in the delivery process [C] • <u>Automated Compliance Check & Quality Control</u>: AI can automatically verify that deliverables meet the requirements before final delivery [C] [P] • <u>Predictive Maintenance</u>: In projects involving physical assets, AI can predict when maintenance is needed [P]
Measurement	<ul style="list-style-type: none"> • <u>Predictive Performance Metrics</u>: AI can forecast project performance based on historical data [C] • <u>Anomaly Detection</u>: AI can detect anomalies in project performance data [C] • <u>Performance Dashboards</u>: AI-powered dashboards can provide real-time insights into project performance [C] [P] • <u>Automated Reporting</u>: AI can generate project reports automatically [P]
Uncertainty	<ul style="list-style-type: none"> • <u>Risk Prediction and Management</u>: AI can predict potential risks and uncertainties [C] [P] • <u>Dynamic Risk Assessment</u>: AI tools can continuously assess project risks [C] • <u>Scenario Planning</u>: AI can simulate various "what-if" scenarios [C] [P]

Through analysis of Table 15, we quickly understand that for each domain there is always, at least one, common suggestion given by ChatGPT and PMOtto. This aspect will be further discussed in chapter 5.

4.1.2. Chatbots views on disadvantages and challenges of said integration

ChatGPT Answers

Adopting AI in Project Management offers numerous advantages, but it also presents several challenges and potential disadvantages. These can affect how effectively AI tools are integrated into project management practices and how teams and organizations adapt to these new technologies.

1. Data Quality and Availability

- “Challenge: AI systems rely heavily on large volumes of high-quality data to function effectively. If the data is incomplete, inaccurate, or biased, the AI's recommendations and insights may be flawed.”
- “Disadvantage: Poor data quality can lead to incorrect predictions or suboptimal decisions, undermining trust in AI tools and potentially causing project failures.”

2. Integration with Existing Systems

- “Challenge: Integrating AI with existing project management tools and systems can be complex and resource intensive. It may require significant changes to current processes and technologies.”
- “Disadvantage: The integration process can be disruptive, leading to temporary inefficiencies, higher costs, and potential resistance from team members.”

3. Loss of Human Oversight

- “Challenge: Over-reliance on AI could result in reduced human oversight, where project managers and teams might depend too much on AI-driven decisions without critically evaluating them.”
- “Disadvantage: This could lead to a lack of accountability, where project teams may follow AI recommendations blindly, even when human intuition or experience might suggest a better course of action.”

4. Ethical Concerns and Bias

- “Challenge: AI systems can perpetuate or even amplify existing biases present in the data they are trained on, leading to unfair or unethical outcomes.”
- “Disadvantage: This can result in biased decision-making, such as in stakeholder management or team evaluations, which could damage relationships and harm the project's success.”

5. Resistance to Change

- “Challenge: Project teams and stakeholders may resist adopting AI due to fear of job displacement, lack of understanding, or discomfort with new technology.”
- “Disadvantage: Resistance can slow down the adoption process, reduce the effectiveness of AI tools, and create friction within teams, leading to a decline in overall project performance.”

6. Cost and Resource Requirements

- “Challenge: Implementing AI systems can be expensive, requiring significant investment in technology, training, and ongoing maintenance.”

- “Disadvantage: Smaller organizations or projects with limited budgets may find it challenging to justify or afford the costs associated with AI adoption, potentially widening the gap between resource-rich and resource-poor projects.”

7. Complexity and Usability

- “Challenge: AI systems can be complex and require specialized knowledge to operate effectively. Project managers and team members might need extensive training to use AI tools correctly.”
- “Disadvantage: The learning curve associated with AI tools can be steep, leading to potential misuses or underutilization of AI capabilities, reducing the anticipated benefits.”

8. Security and Privacy Risks

- “Challenge: AI systems often require access to sensitive project data, which raises concerns about data security and privacy.”
- “Disadvantage: If not properly managed, AI adoption could increase the risk of data breaches or unauthorized access to confidential project information, leading to significant legal and reputational consequences.”

9. Over-Promising and Under-Delivering

- “Challenge: There is often a hype around AI that can lead to unrealistic expectations. Project teams might expect AI to solve all problems, which is rarely the case.”
- “Disadvantage: If AI tools do not meet these high expectations, it could lead to disappointment, disillusionment, and skepticism towards future AI initiatives.”

10. Legal and Regulatory Compliance

- “Challenge: AI adoption in project management must comply with various legal and regulatory standards, which can be complex and vary across regions.”
- “Disadvantage: Non-compliance can result in legal penalties, project delays, and additional costs, especially if the AI systems unintentionally violate data protection laws or industry regulations.”

PMOtto’s Answers

1. Data Dependency and Quality

- “Challenge: AI systems require vast amounts of high-quality, structured data to function effectively. Incomplete, outdated, or biased data can lead to inaccurate predictions or insights.”
- “Impact: Poor data quality can result in flawed decision-making, undermining the effectiveness of AI tools in project management.”

2. Cost of Implementation

- “Challenge: Implementing AI technologies can be expensive, involving costs related to software acquisition, infrastructure, training, and ongoing maintenance.”
- “Impact: High costs can be prohibitive, especially for smaller organizations or projects with limited budgets, leading to a slow adoption rate.”

3. Complexity of AI Systems

- “Challenge: AI systems can be complex and require specialized knowledge to set up, manage, and interpret. Many project managers and teams may lack the necessary expertise.”
- “Impact: The complexity of AI can create a steep learning curve, increasing the risk of misapplication or underutilization of AI tools.”

4. Ethical and Privacy Concerns

- “Challenge: AI systems often rely on collecting and analyzing large amounts of data, which can raise ethical and privacy concerns, particularly with regard to stakeholder information.”
- “Impact: Mismanagement of sensitive data can lead to breaches of confidentiality and trust, potentially harming stakeholder relationships and the organization's reputation.”

5. Over-reliance on AI

- “Challenge: There is a risk that project managers may become overly reliant on AI tools, potentially overlooking the importance of human judgment and intuition.”
- “Impact: Over-reliance on AI can lead to a lack of critical thinking and creativity, which are essential for navigating complex, ambiguous project environments.”

6. Resistance to Change

- “Challenge: Introducing AI into project management may encounter resistance from team members and stakeholders who are uncomfortable with new technologies or fear job displacement.”
- “Impact: Resistance to AI adoption can hinder its effective implementation, leading to lower morale and potential disruptions in project workflows.”

7. Transparency and Accountability

- “Challenge: AI algorithms can sometimes be “black boxes,” meaning their decision-making processes are not always transparent or understandable to users.”
- “Impact: Lack of transparency can make it difficult to explain AI-driven decisions to stakeholders or hold the system accountable for errors, leading to trust issues.”

8. Integration with Existing Systems

- “Challenge: Integrating AI tools with existing project management systems and workflows can be challenging, requiring significant customization and potentially causing disruptions.”

- “Impact: Poor integration can lead to inefficiencies, data silos, or even system failures, reducing the overall effectiveness of AI.”

9. Job Displacement and Role Changes

- “Challenge: AI has the potential to automate many tasks traditionally performed by project managers and team members, leading to concerns about job displacement or the need for role redefinition.”
- “Impact: While AI can improve efficiency, it may also require significant retraining and role adjustments, which can be stressful and challenging for employees.”

10. Long-Term Maintenance and Evolution

- “Challenge: AI systems require continuous monitoring, updates, and evolution to remain effective, which can be resource-intensive and require ongoing investment.”
- “Impact: Failure to maintain and update AI systems can lead to degradation in performance and relevance, making them less useful over time.”

In Table 16 it is possible to find a summary of the identified challenges and disadvantages of adopting AI Techniques in PM, which were identified by chatbots.

Table 16 – Summarization of challenges identified by chatbots

Disadvantages and Challenges	
Data Dependency, Quality and Availability [C] [P]	Unrealistic promises and Expectations [C]
Loss of Human Oversight and Over-reliance [C] [P]	Security and Privacy risks [C]
Ethical Concerns [C] [P]	Legal Compliance [C]
Resistance to change [C] [P]	Job displacement [P]
Systems complexity [C] [P]	Maintenance and Evolution[P]
Integration with Existing Systems [C] [P]	Transparency and Accountability [P]
Cost of Implementation [C] [P]	

4.1.3. Experts’ suggestions for integrating AI in PM

During the interviews, experts were questioned about ways to use AI in PM, whether it was related to the tasks they perform at their jobs and they wish they were more automated, AI solutions that they already used on their projects, or even AI tools they had known of but did not use. When the experts shared their experiences and suggestions these were not segmented specifically according to the PMPD, and so they were analysed and organized considering which PMPD encompasses such activities and tasks.

Stakeholder PD: In the stakeholders' domain, an interviewee suggested that for their activities it would be useful if an AI tool could automate the creation of documents, such as weekly reports, to communicate the project status and updates to the stakeholders. The vast majority of the interviewees, approximately 85%, admitted to using chatbots, specifically ChatGPT, to write formal communication and to validate spelling errors, sometimes already submitting a baseline of the

message. Interviewees agreed that using AI to develop strategies for stakeholder engagement, either by creating new approaches or improving existing ones, would be helpful. Additionally, AI was mentioned as a potential solution to reduce administrative work, like preparing slides and to analyse correspondence with stakeholders, providing insights into their attitudes and the overall project status. Regarding this last topic two interviewees mentioned using the Microsoft software co-pilot to prepare reports and presentations for stakeholders. One of the interviewees believes that, for communicating with the stakeholder, AI would be only useful in routine communication rather than for ad-hoc interactions.

Team PD: For the team domain, interviewees suggested implementing techniques to reduce administrative burdens, such as drafting documents. Moreover, some proposed an application for storing and sharing documentation among team members, that could also store information about past projects to make information more accessible. One interviewee suggested conducting sentiment analysis to assess the team's motivation and generating suggestions to maintain a positive environment was another recommendation, to help the project manager understand and sustain motivational factors within the team.

Regarding team management and human resources engagement, one interviewee stated that everyone is different. Team management and motivation require the team to be committed to the project manager, and it is not possible to do this without the team trusting the project manager enough to share what they feel, a level of commitment that cannot be achieved without being by a human being. Alongside this opinion, another expert mentioned that having non-human beings manage a team is not moral.

Development Approach and Life Cycle: In this domain, the suggestion was to use dynamic simulations to help the project manager decide the best development approach and life cycle based on the project's characteristics. In accordance, approximately 78% of the participants suggested that an algorithm capable of identifying similar projects based on specific parameters and plans, gathering of historical data, risk records, plan variations, and prioritizing lessons learned during the initial phase of new projects, would be valuable.

Planning: Interviewees proposed the development of tools that utilize historical project data to make estimates and predictions for budget management, resource allocation, and scheduling. Additionally, one participant claimed that a positive use of AI would be an algorithm that could create a product roadmap based on product vision and user stories. Furthermore, one participant proposed a tool that could assist in calendar management through earned value management indicators and incorporate emerging requirements into the original plan.

Project Work: For project work management, an interviewee indicated that it would be useful for their job to have a tool that analyses an individual's to-do activities, organizing them by their deadlines

and priority, and identifying common points between tasks to save time. Another person mentioned having heard of a solution that automated task creation and definition, which was Jira's automation with OpenAI. Moreover, three people mentioned the usefulness of a tool that summarizes meetings, as it is seen as a way to reduce time wasted on producing meeting minutes, and out of those three, two of them mentioned using the Zoom feature to do so, even though this feature is flawed on certain aspects like when multiple people speaking, when there is more than one language being used, or when someone talks quietly.

In addition, one participant added that in the company they work for, multiple platforms are used for different things, such as slack for communication, zoom for meetings, and Jira for task management, among other applications, and how difficult it is to become familiar with a particular topic since they are required to check multiple systems to gather all information. This person believes that having one common platform for everything would be very helpful, or for example, having an AI-based system that could gather all information about a specific topic would reduce time wasted just acquiring information.

Delivery: In the delivery domain, algorithms were suggested to review theoretical documents, identifying errors and areas for improvement. Additionally, two participants, for IT projects with continuous code delivery, used an AI chatbot to assist in producing deliverables and believed it to be useful even though it is still necessary to verify the outcomes as these solutions are prone to error. Another person suggested a tool that would assess the quality of project outcomes based on stakeholder feedback. It was mentioned that there is a need for a tool to help project teams adjust their strategies and processes in case of new requirements.

Measurement: Suggestions for the measurement domain included algorithms capable of generating or improving KPIs based on project information, helping to choose the best indicators to measure performance according to project goals. A tool that could create dashboards comparing the project's status with the initial plan was also suggested, along with another that verifies whether the planned requirements and scope are being met, ensuring the project's success. For KPI generation and validation, interviewees thought a chatbot, like ChatGPT, or a virtual assistant, like MS Copilot, would be ideal for these activities.

Uncertainty: Finally, in the uncertainty domain, one interviewee mentioned that they had already used Monte Carlo techniques to simulate and quantify risks related to project deadlines and budgets. Additionally, they suggested dynamic simulations to evaluate potential risks and their impact on the project. They also suggested tools to identify risks and lessons learned from previous projects, drawing attention to external variables. Furthermore, an algorithm to predict risk management scenarios by analysing the probability and impact of each risk was also proposed, along with a tool based on historical information to help project managers prepare contingency plans according to foreseeable

risks in a given project. A summary of the proposed connections between PM and AI Techniques is presented in Table 17.

Table 17 – Experts view of AI Techniques utilization PM

Performance Domain	Potential Usages
Stakeholder	<ul style="list-style-type: none"> • Tool capable of writing a document, for instance weekly, concerning the changes and the project status to communicate to stakeholders; • Use of chatbots to communicate with stakeholders, whether to write the whole message or to help certify that a message is correctly written, without mistakes and with appropriate formal writing; • A tool, most likely a chatbot, to provide strategies for engaging stakeholders, whether it is new ways or help to improve existing ones; • Use of a tool to help reduce administrative work related to stakeholders, such as slide preparation for example with the co-pilot software • An algorithm capable of analysing correspondence with stakeholders and providing insights about their attitude towards a certain matter and the general status of a project
Team	<ul style="list-style-type: none"> • A technique, depending on the nature of the activity, that could help remove administrative burden • An application that could store documentation, sharing information within the team • A technique that could perform a sentiment analysis of the team, to ascertain if they are motivated or frustrated, and provide suggestions according to the results of the analysis, to maintain a stimulated environment • A chatbot that could help the project manager keep the team motivated, by helping to understand what factors motivate the team and how to maintain positive environment
Development Approach & Life Cycle	<ul style="list-style-type: none"> • Use dynamic simulation to help the project manager decide the best development approach and life cycle according to the project's characteristics. • In the initial phase of a project, using a series of parameters, use an algorithm able to detect which project is most similar to the current one and what lessons must be prioritized in the planning and design of the project methodology. Gather historical data, lessons learned, risk register and plan deviations from past projects for future planning
Planning	<ul style="list-style-type: none"> • Tool able to gather information through historical project data and perform estimates and predictions for budget management, resource allocation and scheduling • An algorithm that, through the product vision and stories, could create a roadmap for the product • A tool that, through earned value management indicators, could perform calendar management • A technique that could analyse the project plan and help incorporate emerging requirements into the original process

Project Work	<ul style="list-style-type: none"> • A tool that could analyse the various activities someone has and from that could identify deadlines, organize them according to priority and identify common points between tasks in order to save time • Automate the process of task creation and definition. For example, use Atlassian Jira's automation with OpenAI for stories creation • Using a tool that could summarize meetings providing summary about the covered topics, for example zoom transcripts • A tool that could centralize and analyse information about a certain matter and provide a synthesis, eliminating time wasted with information gathering and familiarizing with the matter
Delivery	<ul style="list-style-type: none"> • An algorithm that could perform document delivery review: spelling errors, inconsistencies, points for improvement • A tool that could analyse the quality of the project outcomes, taking into consideration stakeholder feedback • A tool that could help project teams adjust their strategy and processes in case of the appearance of new requirements • In IT projects where there is a continuous delivery of code, use, for example an AI chatbot to help produce the deliverable
Measurement	<ul style="list-style-type: none"> • An algorithm that could generate or improve KPIs according to a project's information • A tool that could help understand how to measure and quantify success, new metrics, and indicators • An algorithm that could help choose what are the best KPIs to measure project's performance according to its target and objectives • An algorithm that could create dashboards containing a comparison between project's status and what had been planned • A tool that could ascertain if the initial planned requirements and scope of a project are being met and compare them to the resultant deliverables to ensure success
Uncertainty	<ul style="list-style-type: none"> • Monte Carlo Techniques: Simulation Analysis of Project risks. Quantitatively assesses the risk of the project deadline and budget, that is, whether it is feasible given the project requirements/constraints • Use dynamic simulation to help the project manager assess feasible risks and their influence on the project • A tool that could help with the identification of risks and detection of lessons learned, from other projects, that would be reused in projects with similar characteristics as well as raise attention to outside variables • An algorithm to help with the prediction of risk management scenarios, determining probability, and impact of each risk, i.e. quantitative analysis of each risk based on a trained algorithm • A tool that based on historical information could help a project manager prepare a contingency plan according to what risks are foreseeable in a certain project

4.1.4. Experts' views on disadvantages and challenges of said integration

The interviews with experts led to the identification of several challenges and disadvantages that they believed must be carefully considered. The aspect that most experts identified was related to data quality and data availability. They highlighted that, to apply AI to PM, and use historical data, we need to make sure said data has quality and it is not missing, to be able to train models correctly. Unfortunately, many experts explained how this is not usually seen in projects, and many do not preserve and store the data correctly, which makes it impossible to reuse this information for future predictions, which translates to poor quality of data and lack of information.

Additionally, still concerning the data aspect, one expert mentioned how AI could use data sources that might be unreliable and how users may not even understand it, which could lead to inaccurate information and incorrect decision-making.

One of the experts expressed that AI lacks intuition, a crucial human ability for decision-making in complex situations. They explained how the absence of intuition can limit AI's effectiveness, particularly in contexts where human experience is indispensable, and how only humans can intuitively identify a possible risk even though data and past experiences may point in a different direction. Moreover, this expert explained how we always need someone assuming responsibilities; whether things succeed or not, there is always the need to have someone accountable for the outcomes.

Additionally, some experts mentioned how adopting AI imposes high requirements, which can be a barrier for companies needing more infrastructures or expertise, and how expensive this technological transition can be. Besides already being identified as highly expensive, concerning resources and equipment, and time-consuming, another challenge identified by experts is how, even though we are experiencing significant technological advancements in multiple disciplines, some companies are still resistant to change and do not want to embrace this adoption.

Many experts mentioned that users of AI technologies are increasingly over-reliant on AI, leading to a decline in critical thinking, with people becoming excessively dependent on the technology. One expert indicated an OCDE report that shows that new generations, for the first time, present a lower QI than previous generations. Over-trusting AI models can result in critical errors. Additionally, two experts pointed out that AI is not error-proof, as it makes many mistakes and sometimes cannot solve simple problems. Additionally, on a similar note, another expert mentioned how trusting AI may be working, still, generally, in the future, the quality of the outputs will be progressively lower as we trust AI with the aspects that we need to be more comfortable with or skilled. This expert gave a specific example of their work is technical, and so they use AI for more functional tasks, such as communicating, where they do not feel as comfortable as with technical activities. Moreover, the expert manifested their opinion that when we are not sure of the output we need, and we are not

capable of defining precisely what we are looking for, AI is not reliable. Additionally, one expert mentioned that AI lacks PM knowledge when compared to humans.

Regarding aspects concerning a project team, two experts, who work as team leaders, explained how they view AI integration as something that presents significant ethical challenges. They explain how AI is not morally subjective, so having AI communicating and/or trying to motivate a team, or evaluating a team's performance would not be correct or moral. In this context, experts consider it is essential that responsibility for engaging or assessing a team remains with humans, who can consider aspects that AI might not even comprehend and the context of actions.

Additionally, one expert explained how data protection is crucial, particularly when handling sensitive information, and how before rules and policies arose concerning this topic, data storage enterprises used their client's information to train their own models. Moreover, this expert explained how concerning it is that as of right now we have a monopoly in the data storage market, where a small number of companies control a vast amount of information, making it very difficult to insert new players in the market.

Another challenge raised by an expert was the sustainability of AI. For example, prompts are a concern, as they may only be viable in the long term with efficient management.

Finally, one expert mentioned how sometimes systems fail and AI can be unavailable for a certain period of time, which would deeply affect AI-powered solutions.

A summary of the presented challenges and disadvantages in adopting AI Techniques in PM is presented in Table 18.

Table 18 – Summarization of challenges identified by experts

Disadvantages and Challenges	
Availability of data	Overall lower output quality
Quality of data	AI is not reliable when there is uncertainty
Unreliable data sources	Ethical and moral aspects
AI does not have intuition	Data protection
Need to attribute responsibilities	Market monopolies
AI's level of demand	Sustainability
Resistance to change	AI can be unavailable
Overreliance on AI and loss of human oversight	AI lacks PM knowledge compared to humans
AI makes mistakes	

Discussion and Findings

5.1. Artificial Intelligence solutions supporting Project Management

After collecting the data through the Literature Review and the research methodology, it is possible to confront the results obtained and draw conclusions, to answer the research questions. Revisiting the first research question “*What AI solutions are available to support PM and its benefits, considering the structuring by performance domains?*” we are now able to answer the question and confront the three information sources explored: the literature review, the experts’ reviews and the AI chatbots reviews.

For the **Stakeholder PD**, simultaneously, the literature, the interviewees with experts and the interviews with chatbots highlighted solutions with potential and current applications of AI technologies, although with some differences. According to [2], multiple AI techniques such as ML, NLP, and NN have already been applied to this domain. [27] emphasizes the application of AI in assessing stakeholder communication and monitoring involvement to ensure high satisfaction levels. Additionally, both [27] and [29] suggest that AI can be used to identify the potential stakeholders of a project, their characteristics and needs. In summary, AI is seen as valuable in creating communication plans tailored to keep stakeholders informed about emerging concerns, which is crucial for maintaining engagement and satisfaction.

The insights from the experts’ interviews align with the aspects mentioned in the literature regarding communication, as a significant number of interviewees admitted to already using AI chatbots like ChatGPT to draft formal communication and validate the accuracy of messages, focusing on grammatical correctness, which was also suggested by the chatbots but with a different goal. Experts suggested algorithms capable of analysing stakeholder correspondence to comprehend their feelings towards the project providing insights. Similarly, ChatGPT suggested using sentiment analysis tools and predictive analysis on the stakeholder’s behaviour to help tailor communication and improve stakeholder interaction, thus reflecting the literatures conclusion that AI can improve communication with stakeholders.

Furthermore, ChatGPT suggests using chatbots to provide answers to stakeholders instantly regarding projects, thus aiming to improve stakeholder communication. Moreover, experts agreed that AI could be beneficial in developing strategies for stakeholder engagement, either by creating new approaches or refining existing ones, and PMOtto’s suggested creating a mapping of stakeholders translating their involvement and priorities, to provide insights about engagement strategies. Both contributions line up with the literature’s view on AI’s role in stakeholder commitment.

However, expert interviews brought new perspectives and some specific applications that have not been found neither in literature nor in chatbot suggestions. For instance, interviewees mentioned the potential of AI to automate the creation of routine documents, such as weekly reports, to update stakeholders on project status. Additionally, the experts explained how they have been using AI as a tool to reduce administrative burdens, such as preparing slides or review stakeholder correspondence.

On the other hand, chatbots suggestions sound more complex, even though the main objective is to gain knowledge about stakeholders' opinions and morale, exactly like literature and experts, their tactics are more advanced, involving predictive analysis and stakeholder mapping.

In the **Team PD** the literature review emphasizes the potential of AI to strengthen team performance through improved communication and task management. Authors in [2] note that AI-assisted communication, particularly using ML, can significantly boost team performance by facilitating interactions. Additionally, [30] highlights how AI can relieve administrative burden on project managers by automating simple yet repetitive tasks and, [18] together with [27] suggest that AI can aid prioritizing tasks. Moreover, authors in [1] mention specific tools such as Rescoper, that automates various PM tasks, assisting in task assignment, and provide real-time data visualization to aid decision-making processes.

Experts suggested implementing AI techniques to automate document drafting and manage documentation storage and sharing, which corresponds with the literature's view on AI's role in automating administrative tasks. In addition, expert interviews also highlight the potential of AI for conducting sentiment analysis to assess team motivation and generate suggestions for maintaining a positive environment. Additionally, one expert mentioned that it would be useful to have an application, available to all team members, that allowed sharing and updating documentation, which aligns with the many applications suggested by researchers in [1]. Moreover, unique suggestions were made by several experts, who proposed using AI techniques to perform sentiment analysis of the team's spirit and utilizing chatbots to brainstorm ways for the project manager to keep a good organization atmosphere and the team inspired.

Concerning the chatbots, their suggestions differ a bit from what experts mentioned, as they suggested that AI could be used to manage talent according to skills and task characteristics. However, they propose the use of virtual assistants to help team members manage their activities, which is in line with the experts' interviewees and literature. Contrarily to the experts, AI chatbots also mentioned that AI could analyse team dynamics and performance to help build the perfect team for a certain project according to its characteristics, which, according to some experts is not ethical and morally incorrect.

Comparing the literature review and interviews findings, concerning the **Development Approach & Life Cycle PD** revealed a research gap and some insights from experts arise, highlighting the potential

that AI can have on this area. The literature, in [2], indicates that there is limited direct research on how AI can specifically influence this domain and the processes it includes. However, [10] suggests the broader potential of AI to impact project methodologies, and deliverables. For instance, [27] presents the possibility of applying AI in creating and verifying deliverables, and additionally, author [23] speculates on the concept of a “digital project manager” capable of selecting the appropriate methodology based on a project's specific features.

The experts’ insights not only align with the concepts from the literature, but they also extend the discussion by providing more detailed examples of how AI could be practically implemented in this domain. The focus on dynamic simulations and historical data analysis demonstrates the opportunity for AI to have a critical part in refining project methodologies and life cycle management, which the literature only mentions on a high level. Similarly to the experts’ interviews, chatbots also suggested using scenario analysis to simulate the multiple available approaches for a project and choose the best fit. Experts proposed the use of an algorithm capable of identifying similar projects, through specific parameters, would be highly valuable, since such algorithm could facilitate planning by gathering historical data, risk records, and plan variations, as well as, prioritize lessons learned during the initial phases of new projects.

Furthermore, ChatGPT proposed adaptive planning, which consist of having an AI-driven solutions with the capacity of adjust a projects life cycle and/or development approach when responding to emerging concerns or unplanned changes. There was no indication of any similar suggestion on literature review or experts’ recommendation. We can understand how while literature acknowledges the potential of AI to influence project methodologies and deliverables, it lacks detailed studies on its direct impact on this domain, and experts and chatbots provide a more practical view on the matter.

In the **Planning PD**, [2], [18], and [27] emphasize the importance and impact of AI in project planning, particularly in budgeting, resource allocation, and scheduling. These authors propose that AI can be utilized to create initial drafts of project budgets and continuously update them to account for emerging concerns and minimize human errors and biases in financial planning. This aligns with an expert who highlighted the potential of AI to assist in calendar management through EVM indicators. Regarding budgeting, a distinctive suggestion was made by [24] recommending a "complete AI solution," a chatbot that conveys AI-based budget projections. Additionally, AI's role in resource allocation is widely recognized in the literature, indicating strategies that optimize the use of resources and improve scheduling management.

AI chatbots highlighted the exact same aspects as the literature and complemented them with the possibility of having an AI identify possible risks during planning, from overiewing similar projects data and indicate how to develop mitigation strategies. While the interviews findings match with the literature’s theoretical insights, since both experts and chatbots suggested developing of AI tools that

leverage historical project data to make estimates and predictions for budget management, resource allocation, scheduling, and planning, it was only the experts that had more specific and practical recommendations. One expert talked about the possibility of having an AI tool that could create a product roadmap based on product vision and user stories. This idea, while related to the literature's discussion of AI in budgeting and resource management, extends the application of AI into more specific product planning.

For the **Project Work PD**, the literature review identifies several AI technologies that are already being applied or proposed to support project work. The authors in [2] mention the use of AI technologies like fuzzy ES, ML, NLP, and NN, to strengthen project work processes, such as an already existing AI chatbot designed for PM and implemented through several platforms and applications.

The experts' proposals echo the literature emphasis on AI's role in optimizing project work but provide more detailed examples. One expert mentioned hearing about the Atlassian Jira's automation with OpenAI to develop product stories. Additionally, an expert expressed a desire for tools that could navigate through an individual's to-do list, prioritize tasks by deadlines, and identify commonalities between tasks, to save time. This idea aligns with the literature discussion on the time-saving potential. On the same note, chatbots implied how AI can help free project managers time by performing task automation and experts highlighted the need for AI tools that could summarize meetings, a feature that three participants found particularly useful. These insights highlight the need for more advanced AI solutions that can handle the challenges of real-world project work environments, which for now, is something that the literature does not specifically address.

Another significant point raised in the experts' interviews is the challenge of managing information spread across multiple platforms. One participant mentioned the difficulty of gathering information from different systems and explained how an AI-based system capable of consolidating information from various sources would be extremely beneficial.

Additionally, chatbots mentioned how AI-powered tools can monitor and track in real time the updates and advances. Furthermore, ChatGPT proposed a quality assurance based on AI where a system can compare outputs against what had been planned initially to identify potential concerns.

In the **Delivery PD**, the literature emphasizes the role of AI in automating project quality management. Authors in [2] discuss using AI-powered techniques, such as fuzzy logic, ML, and NN, to increase project delivery efficiency. Moreover [27] indicates that AI can play a critical role ensuring that projects meet their initial scope and quality objectives by monitoring for scope creep, deviations from the plan, and investigating the repercussions of these deviations. The interview findings resonate as experts suggested the use of algorithms to review theoretical documents, identifying errors and areas for improvement, which aligns with PMOtto's suggestion of quality control allowing to validate that deliverables meet their requirements before they are finalized.

One expert proposed the development of a tool that could assess the quality of project outcomes based on stakeholder feedback. Additionally, other interviewees expressed the need for a tool that could help project teams adjust their strategies and processes in response to new requirements. Similarly, ChatGPT proposes AI-Driven Delivery Optimization for adjustments based on real-time data and their implications for the project. These ideas relate to the literature's discussion of AI's potential to monitor the scope and detect deviations from the plan.

Furthermore, chatbots consider that AI could predict delivery by assessing potential schedule setbacks and suggesting corrective actions that would guarantee accurate deliveries.

Concerning the **Measurement PD**, authors in [2] identify several ways AI can be leveraged to improve project measurement processes, addressing the application of AI techniques to evaluate project performance metrics, monitor activities, and implement suitable responses to any detected delays. The study emphasizes the effectiveness of AI in forecasting and examining EVM techniques, noting that AI techniques excel when the training and test sets are similar. Additionally, [23] indicates that AI-based quality management is aimed at classifying and evaluating project outputs, which helps identify and prevent quality issues at an early stage. Holzmann et al. [27] suggested that AI can be used for quality assessment, creating reports, examining product quality, and process oversight. Furthermore, the authors propose that AI could play a role in creating or improving existing KPIs that are used for quality control.

On a similar note, the expert findings coincide with these insights, as they proposed a tool that could help select the most appropriate indicators to measure performance according to project goals. Another significant suggestion from experts and chatbots was the creation of dashboards that compare the project's status with the initial plan, providing insights and highlighting important aspects. Experts also mentioned the usefulness of AI tools, such as chatbots like ChatGPT or virtual assistants like Copilot, for generating and validating KPIs. Chatbots emphasized the usefulness of having anomaly detection through predictive performance metrics to signal upcoming challenges and help project managers act accordingly, which is in accordance with the research [2] where authors. These ideas provided by experts and chatbots deeply align with the literature discussion on AI's this domain, adding a more practical application.

Regarding the **Uncertainty PD**, authors [30] and [32] suggest applying AI tools to perform risk management, and [29] proposes utilizing AI to create and update checklists with possible emerging risk by comparing what was planned and really what happened. These researchers explore how using AI solutions as enablers can lead to efficient response to high-priority situations by predicting and preventing negative impacts, as well as, developing appropriate mitigation strategies. Moreover, [24] pointed out how ML has been already and successfully applied to monitor the level of risk and calculate its impact prior to its concretization, and additionally, the usage of NLP to identify risks.

The experts' findings provide a complementary perspective as one interviewee mentioned the studying and using Monte Carlo simulations to quantify risks related to project deadlines and budgets, highlighting the practical application of established risk management techniques enhanced by AI. In line with this idea, the chatbot interviews also provided answers mentioning scenario analysis and planning to help project managers. Furthermore, experts suggested the use of dynamic simulations to evaluate potential risks and their impact on projects, and proposed tools for identifying risks and drawing lessons from previous projects, paying particular attention to external variables. Likewise, chatbots suggested applying AI techniques for risk management and prediction through factor analysis to help project managers mitigate them. All these suggestions are similar with the literature's emphasis on AI's role in risk identification and response planning, while adding a layer of practical.

Additionally, the experts proposed an algorithm to predict risk management scenarios by evaluating the probability and impact of each risk. This idea closely mirrors the literature's discussion on ML techniques for risk assessment.

As a result of this discussion, we can observe in Table 19 the aggregated findings concerning AI solutions supporting PM structured by PDs, where we confront the inputs from all three information sources to gain insights about these connections. The [number] represent the literature references, the [E] stands for the experts' suggestions and the [C] and [P] represent ChatGPT and PMOttos recommendations, accordingly. This Table provides a clear vision regarding which contributions are shared by all the information and which ones are unique.

Table 19 – Summarization of findings regarding AI solutions supporting PM

Domains	Literature	Experts	Chatbots	Common Points
Stakeholder	<ul style="list-style-type: none"> - ML, NLP, and NN for Stakeholder Management [2] [27]; - Fuzzy Inference System for Stakeholder Identification [27] [25] [29]; 	<ul style="list-style-type: none"> - Program to reduce administrative work related to stakeholders - Use chatbots to check grammar when corresponding with stakeholders - Using an AI program to update stakeholders concerning a project status 	<ul style="list-style-type: none"> - Use chatbots to provide instant responses about the project [C] - Use AI to predict stakeholder reactions based on historical data [C] 	<ul style="list-style-type: none"> - Stakeholder Engagement and Communication [E] [C] [P] - Correspondence [E] and Stakeholder Sentiment [C] [P] Analysis (ML & NLP)
Team	<ul style="list-style-type: none"> - Use ML assisted communication to improve Team Performance [2]; 	<ul style="list-style-type: none"> - Application to store documentation, streamlining sharing information within the team; - Team Sentiment Analysis - Use chatbots suggestions to up morale 	<ul style="list-style-type: none"> - Use AI for talent Management [C] [P] - Use AI to monitor team performance [C] 	<ul style="list-style-type: none"> - Remove administrative burden [1] [27] [18] [E] [P]; - Team Management [2] [27] [29] [E] [C];
Development Approach and Life Cycle	<ul style="list-style-type: none"> - AI can be applied to create and verify deliverables [10] [27]; - Digital Project Manager [23] 	<ul style="list-style-type: none"> - Use an algorithm to detect which project is most similar to the current one and what lessons must be prioritized in the planning and design of the project methodology. Gather historical data, lessons learned, risk register, and plan deviations from past projects for future planning 	<ul style="list-style-type: none"> - AI-driven tools can dynamically adjust project life cycles and development methodologies [C] [P] 	<ul style="list-style-type: none"> - Deciding the best project methodology with dynamic simulation and scenario analysis [10] [23] [E] [C] [P]; - Deciding the best life cycle for the project [10] [E] [C] [P];
Planning	<ul style="list-style-type: none"> - Use AI for forecasting to use resources at optimum capacity [32]; 	<ul style="list-style-type: none"> - Creation of product roadmap through the product vision and stories - Perform calendar management through EVM indicators - Analysis of the project plan to incorporate emerging requirements into the original process 	<ul style="list-style-type: none"> - Use AI to identify potential risks during the planning phase [C] [P] 	<ul style="list-style-type: none"> - Automating Project Scheduling [1] [2] [18] [E] [C] [P]; - Optimize Resource Allocation [18] [32] [43] [C] - Budgeting [23] [24] [27] [32] [E];
Project Work	<u>Project Processes</u> [2],[33];	<ul style="list-style-type: none"> - Automate the process of task creation and definition - Summarization of meetings - Application to centralize and analyse information about specific topics 	<ul style="list-style-type: none"> - Automate repetitive tasks [C] [P] - Optimize the use of resources [P] 	<ul style="list-style-type: none"> - Quality control [2] [C]; - Progress Tracking [E] [C];
Delivery PD	<ul style="list-style-type: none"> - Scope Definition & Management [27]; - Apply AI to manage scope creep [10] [27]; 	<ul style="list-style-type: none"> - Strategy and process adjustment when new requirements emerge - In IT projects use AI chatbots to help produce the deliverable 	<ul style="list-style-type: none"> - AI can predict when maintenance is needed [P] 	<ul style="list-style-type: none"> - Project Quality Management [2] [E] [C] [P]; - Deliverables Management [10] [27] [E] [C]; - Delivery Optimization [E][C]
Measurement	<ul style="list-style-type: none"> - Risk Monitoring [2] [23] [24] 	<ul style="list-style-type: none"> - Solution to compare initial planned requirements and scope of a project to the resultant deliverables to ensure success 	<ul style="list-style-type: none"> - Automated Reporting [P] - Anomaly detection [C] 	<ul style="list-style-type: none"> - Earned Value Methods [2] [24] [E]; - Quality Assessment and KPIs [1] [27] [47] [E]; - Dashboard Creation [E] [C] [P];
Uncertainty	<ul style="list-style-type: none"> - Implement intelligent sorting and grouping anticipate and mitigate the risk associated costs [29]; 	<ul style="list-style-type: none"> - Monte Carlo Techniques to quantitatively assess the risk of the project deadline and budget, that is, whether it is feasible given the project requirements/constraints 	<ul style="list-style-type: none"> - Dynamic Risk Assessment: AI tools can continuously assess project risks [C] 	<ul style="list-style-type: none"> - Risk Simulation [E] [C] [P] - Risk Management [30] [24] [27] [E] [C] [P]; - Response to Risk [24] [E];

5.2. Challenges of Artificial Intelligence integration in Project Management

When revisiting the second the question “*What are the challenges and difficulties of AI integration in PM?*” it is possible to answer the question and address the three information sources explored: the literature review, the expert reviews, and the AI chatbot reviews.

When examining the disadvantages of integrating AI into PM, based on the literature review and the interviews conducted (with experts and chatbots), several barriers were identified, varying according to the perspective of each source. While there are areas of convergence, each group highlights unique concerns.

Data availability and quality is a major concern shared across all three sources. Both experts and chatbots emphasize the issue of data availability and quality as a critical challenge to overcome. Simultaneously authors in [1], [20], [25], and [31] support this by showing that AI's effectiveness is heavily dependent on large, high-quality datasets, which are often difficult to obtain and maintain [35]. Additionally, when the experts gave their suggestions, specifically about AI-solutions that use historical data, they always mentioned how it would have to be guaranteed that there were sufficient data and that this data was high-quality. Without accomplishing these requirements, adopting AI for these types of solutions would not be possible. Moreover, one expert mentioned how AI can use unreliable data sources. Additionally, chatbots alert to that incomplete, outdated, or biased data can lead to inaccurate outputs.

Other challenges that were identified by the three sources are AI overreliance and the importance of human oversight. Authors in [20] explain how using AI without critical judgement can be risky. Experts add a similar perspective by emphasizing the importance of maintaining human relationships, as people cannot connect to a machine as they do with humans, and AI does not possess intuition, a which is strictly human and fundamental when making important decisions. Authors in [31] and [30] express the same thought, human touch is crucial. In addition, some experts expressed concerns about the potential decline in critical thinking and the loss of human oversight as AI becomes more integrated into PM. Moreover, they manifested the belief that we can become overly depend on AI, and similarly chatbots highlight the risk of overreliance, noting that it could lead to errors if AI systems are not rigorously validated or if users become too dependent on them. One expert explained how AI lacks the intuition required for making decisions in complex and ambiguous situations, a capability that is crucial in PM, and inherent to humans. This point is not as prominently discussed by chatbots, although in the literature, there is an author that describes how the human touch is crucial.

Ethical concerns and resistance to change are two other difficulties discussed by all the different sources, although with different nuances. Regarding ethics, literature in [29] and [36] mentions that AI biases can lead to ethical and legal concerns, and similarly chatbots raise ethical concerns related to AI bias, and the moral implications of using AI for tasks traditionally managed by humans, such as mishandling of information. The experts manifested how AI is not morally subjective and how using AI for analysing team performance is not moral and could lead to ethical issues.

As for change resistance, [20] explains how AI undoubtedly changes an organization, creating uncertainty and resistance, which is in accordance with experts, who mention how some organizations

are interested in digital transformation, and chatbots that explain how by introducing AI into PM may result in resistance from people who are uncomfortable with new technologies.

Furthermore, cost and complexity are another aspect discussed by all information sources. Both [1] and [25] highlight the high costs associated with implementing and maintaining AI systems. ChatGPT and PMOtto explain how they view the integration of AI with existing PM tools as a technical challenge, and how the complexity of systems requires specialized knowledge to set up, manage, and interpret, which many professionals lack. This last aspect is mentioned by several authors, [1], [19], [25], and [34], where they draw attention to the fact that most project managers lack knowledge, skills and training regarding AI systems.

Experts and [31] both agreed that AI is not bullet proof. Experts bring attention to how AI is not failure-proof, by identifying multiple situations where AI can fail, such as, acknowledging that AI makes mistakes and can be wrong, raising attention to how it is possible that there is some kind of availability problem and it stops working (one expert referenced for example if ChatGPT is unavailable, which is something that has happened before), and explain how if someone uses AI without having established exactly what is the required outcomes the solution will not be effective and have quality. In accordance, [31] identifies how AI models performance can be unstable.

Additionally, [1], [19] and [25] talk about how AI implementation and maintenance can be expensive, time-consuming and tough, and PMOtto similarly identified that “AI systems require continuous monitoring, updates, and evolution to remain effective, which can be resource-intensive and require ongoing investment”.

Cubric [25] explains how unrealistic expectations of AI could result in significant challenges if users lack the necessary technical skills to properly utilize these systems, which was also noted by ChatGPT. ChatGPT explained that over relying on AI can lead to unrealistic expectations, and when these expectations are not met, it could lead to disappointment and disregard of future AI initiatives.

Additionally, and curiously, none of the experts mentioned having a fear of job displacement or even the discussed how AI could affect employment opportunities, but both the literature and chatbots mentioned how AI has created insecurity near employers and how they might feel threatened to lose their jobs over AI implementation.

Security and privacy risks involving the potential for data breaches and the ethical implications of handling sensitive information, highlighting the need for robust data protection measures.

This concludes the shared opinions on how AI adoption in PM can present various challenges, but it is possible to highlight challenges that were identified singularly by one of the data sources, these being the experts and the literature. For example, in addition to what was mentioned previously, the literature in [1] mentions how using AI could eventually lead to a more sedentary lifestyle.

As for the experts it is possible to gather more information related to difficulties that neither literature nor chatbots identified. One expert articulated how overall, in the future, we will start using and using AI systems with more frequency and the overall quality of outputs we produce will be lower than before. Finally, we can mention two more concerns, these being how the data storing companies have such a closed monopoly market, with three or four main players, and how difficult it becomes for other enterprises to raise to this level, and how AI has an impact on sustainability, giving one example provided by one expert that approximately one prompt is equivalent to discard one drinkable bottle of water, and manifested how processing has an alarming energy consume.

At last, we can confirm that all suggestions provided by chatbots were also mentioned on either literature or by experts, and that these challenges matched the literature more than it did the experts opinions on the matter, which was expectable as chatbots base their answers on existing documented information. The experts were the information group that provided more distinct information when comparing the three data sources. It is possible to observe on Table 20 the summarization of findings regarding the challenges identified and what common/unique points they have.

Table 20 - Summarization of findings regarding the challenges for AI integration in PM

Challenges and Disadvantages	
Common Points	Unique Points
<ul style="list-style-type: none"> - Data availability [1] [20] [25] [31] [C] [P] [E] - Data Quality [1] [20] [25] [35] [31] [E] [C] [P] - Human touch is crucial [31] [32] [E] - Overreliance and unrealistic expectations [1] [20] [C] [P] [E] - Fear of job displacement [22] [28] [34] [P] - AI adoption and maintenance are hard, expensive and time-consuming [1] [25] [C] [P] - AI models are hard to use/reuse [19] [25] [C] [P] - Lack of knowledge about AI [1] [19] [25] [E] - Performance instability [31] [E] - Bias and ethical concerns [20] [29] [31] [36] [C] [P] [E] - Security and Privacy [20] [31] [C] [E] - Resistance to change [20] [C] [P] [E] - Lack of trained staff and technical skills [1] [19] [34] 	<ul style="list-style-type: none"> - Unreliable Data Sources [E] - Need to attribute responsibilities [E] - Overall lower output quality [E] - AI is not reliable when there is uncertainty [E] - Data protection [E] - Market monopolies [E] - Sustainability [E] - Legal Compliances [C] - Need to attribute responsibilities [E] - Sustainability [E] - Sedentary Lifestyle [1] - AI lacks PM knowledge compared to humans[E]

5.3. Additional Findings Regarding Interviews Patterns and Aspects

While conducting the interviews it was possible to identify some curious aspects regarding the experts' opinions and ideas and the roles the perform on their companies. Concerning the years of experience it was possible to ascertain that the more experienced the experts were the more connections they

knew or heard for using AI in PM, as for less experienced experts had more propositions. This being, the less experience participants suggested more ideas and applications that they could see be used in PM as where more experienced participants already heard or used solutions. This is comprehensible as experience provides knowledge about many tools and techniques, so it is expected that the more contact you have with a subject you can deepen your knowledge concerning it.

Additionally, it is possible to identify a pattern between the experts' jobs and their suggestions. As mentioned before, experts tend to suggest practical use cases, whether they have already been applied previously or they are proposing them, but we can understand how their suggestions related with their profiles, jobs and characteristics. For example, one of the experts was a project manager who was skilled in communicating and so for this person using AI for communicating was not seen as something fruitful and worth investing in, whereas other experts, such as the software engineer and the tech consultant explained how for them using AI for communication is very helpful as they recognised that they were not as efficient in terms of communication, as they are in other skills. It is true that ultimately the majority of the participants mentioned using AI to write communication for stakeholders but the more technical an expert's profile was the more they intensified how they use AI in communicating.

Regarding interviews with chatbots, it was possible to observe that both ChatGPT and PMOtto, for each domain, suggested at least one equivalent response, for adopting AI in PM and its' challenges. From this pattern we are able to draw the conclusion that probably these two systems might share an information base, by using the same data sources. Moreover, this can indicate that the systems may be trained with similar datasets. Even though there were similarities we can also observe how ChatGPT, when asked the same questions, always provided for each domain one more answer than PMOtto. This may happen due to multiple reasons. Their data sources may be similar, nevertheless ChatGPT could have been trained with a large set of data or it can be related to how the chatbot was programmed and what models were used.

Furthermore, we can ascertain which domains are more developed, in terms of possible utilizations for adopting AI, by comparing the experts' interviews and the literature. As we compare, we can understand that they match. For the experts interviews the stakeholder, measurement and uncertainty PD were the ones with the most suggestions, each having 5, followed by the domains of the team, planning, project work and delivery with 4 propositions each, and lastly the development and life cycle approach with only two suggestions. As for the literature review the domains with the most use cases are the planning domain and the uncertainty, and the one with less is the development approach and life cycle.

Conclusion

6.1. Conclusion and Significant Findings

The purpose of this dissertation was to understand what are the available AI tools to support PM and other foreseeable usages and their benefits, as well as, the difficulties of joining AI to PM, considering the PMPDs mentioned in the 7th edition of the PMBOK. It was clear to the moment of the literature review there was no study covering particular topic.

The study applies both a Systematic Literature Review and a Multivocal Literature Analysis (MLR), aiming to gain a general understanding of the influence of AI on PMPDs, considering the theme under investigation and all of its issues, employing a DSRM, which allows the creation of an artifact, and continuous iterations to said artifact as more has more was discovered about the gap in question.

After conducting the Literature Review, the interviews with experts and chatbots, and discussing the results, it is possible to understand how the results originated throughout the interviews are deeply in accordance with the literature review. We can understand how literature and chatbots interviews tend to suggest more theoretically applications and idealized concepts, as for experts tend to propose more practical applications to real-life concerns where AI can be utilised, on a PM context. Therefore, we are able to answer to the two main research questions presented on subchapter 1.2.

Regarding the question *“What AI solutions are available to support PM and their benefits, considering the structuring by performance domains?”* we were able to identify multiple ways of integrating AI in PM and its benefits, for each domain. The domain with more applications, whether existing or foreseeable, was the uncertainty domain, both for experts as for the literature review, and the one with less, again in line with both data sources, was the development approach and life cycle domain. This can imply how the development approach and life cycle might be underexplored compared to the other domains and how the uncertainty domain is one where AI adoption would be more beneficial. Concerning chatbots, their number of contributions was exactly the same for each domain, being that ChatGPT, when asked exactly the same question (the first question) as PMOtto, provided on more answer for each domain.

Being that literature and chatbots possess a more conceptual view on how to apply AI techniques and experts presented more technical and practical points of view it is hard to say with certainty what are the most used, or expected to be used, techniques, even though it is possible to identify more general aspects. Regarding the stakeholder domain we can conclude that stakeholder communication and engagement is the aspect that was addressed the most for AI adoption. As for the team PD the component that matches all data sources is related to task management and AI tools that improve overall activity governance. Concerning the development Approach and life cycle PD, we are able to

identify that using AI-solutions for optimising the development methodology was the most mentioned aspect, even though this domain was the least explored by all data sources. Concerning the planning domain, resource allocation and schedule planning were the most covered aspects, by all information sources, where there were identified several opportunities for AI integration. In the project work domain, according to the data sources, a project's processes and tasks are the areas most expected to be supported by AI integration. As for the delivery PD the main aspect explored was having AI managing deliveries, whether it was their quality or their optimization. Concerning the measurement PD, the common theme under observation was how AI can help assess quality, by defining metrics and providing insights regarding performance. Lastly, in the uncertainty PD it is possible to notice that the most frequent topic was related to proactive risk management.

Additionally, to the question *“What are the challenges and difficulties of AI integration in PM?”* it was possible to collect various challenges and adversities the world needs to overcome in order to successfully adopt AI in PM. The discussion helps us highlight that the most common challenges are related to data, whether it is data quality, data availability or data dependency, ethical concerns and moral aspects, and over-reliance, over-trust and over-dependency on AI which are caused by unrealistic expectations. It was possible to assess that there were many similarities between literature and interviews on this topic, but the strongest connections were between the literature and the chatbots interviews, which was predictable, being that chatbots' answers were very similar between them, which could indicate that they share the knowledge base, which consists of the challenges already presented on the literature, hence the chatbots did not possess one challenge or difficulty that had not been already covered by literatures and experts.

These results demonstrate how AI is already being used in PM and its advantages. They also forecast possible future applications where AI automation can make a meaningful impact. However, they also identify various challenges and possible disadvantages of this integration that will have to be surpassed in order to produce efficiency.

We can easily assess that on one hand, literature and chatbots interviews tend to suggest more theoretically applications, as on the other hand, interviews with experts tend to propose more practical applications to real-life concerns where AI can be utilised, on a PM context.

6.2. Study Limitations and Future Work

This research, while offering significant insights into the existing and the expected role of AI in PM across the PMPDs is submitted to various limitations. Starting with the literature review, while extensive, it is possible that it may have failed to capture all relevant studies and research previously conducted due to the quick expansion and growing popularity of the subject. Additionally, due to time and resources constraints the number of interviews conducted was limited. So, the general perspective approximately might not have been able to capture the different opinions and experiences within the topic fully. With this being, 66% of the experts' interviews encompass participants working on audit or consulting and from these 66% approximately 63% only have one year of experience, which may not fully represent multiple disciplines nor explore various perspectives.

Another limitation to take into consideration is the fact that no studies have been found that specifically analysed the impact of AI in PMPDs, which represented a challenge to be able to cross the various AI solutions with the domains. Regarding future studies I would suggest broadening the sample size to include a larger number of participants and possibly gather more insights. Additionally, I would recommend using this research to perform a quantitative study to test the findings of this research.

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APPENDIX A: Experts Interview Guide

First Part of the Interview - General Questions

1. Have you ever used or heard of any AI techniques to support PM? If yes, can you provide examples.
2. Besides what you are familiar with what other utilizations to support PM can you think about?
3. Different questions about the topics covered by each domain (second part of the interview)

Second Part of the Interview – Guide based on ChatGPT’s suggestions

Stakeholder Domain Questions

1. Do you think AI would be useful to manage stakeholders? If so, how?
2. Do you think it would be useful to have a chatbot provide answers regarding a project’s status to stakeholders?
3. Do you think it would be useful to perform sentimental analysis, through AI algorithms, to understand and analyse stakeholders’ feelings towards a project?
4. Do you think it would be useful to perform a predictive analysis that could analyse historical data from similar projects to identify patterns and common characteristics of stakeholders, helping predict stakeholder behaviour?

Team Domain Questions

1. Do you think AI would be useful to manage a project’s team? If so, how?
2. Do you think it would be useful to have AI tools monitor and analyse team performance data, identifying areas for improvement?
3. Do you think it would be useful to have collaboration tools that allow teams to manage tasks, share workload in order to improve performance?
4. What do you think about using AI to optimize task allocation according to each team member's skills?
5. Do you think it would be insightful to have a virtual assistant that could help team members manage their tasks?

Development Approach Domain Questions

1. Do you think it would be useful to use AI to analyse historical project data and recommend more efficient development approaches and life cycles?
2. What about implementing AI models to simulate different development approaches and predict their impacts on the project? Do you think it could be helpful?
3. Do you believe that AI-based solutions could dynamically adjust a project's life cycle/development methodology by closely monitoring a project and making decisions based on real-time data?

Planning Domain Questions

1. Do you think AI would be useful aid in project planning? If so, how?
2. Do you think AI could impact resource allocation? How? For example, in resource allocation, using AI to predict resource needs based on historical data and planning optimized resource allocation.
3. Do you think it would be useful to have a tool that allows you to create detailed schedules, based on previous similar projects and constraints?
4. Do you think it would be useful to perform risk prediction using AI?

Project Work Domain Questions

1. Do you think AI techniques could aid in task automation? For example, using AI to automate monotonous and administrative activities, saving time for the team to concentrate on valuable activities?
2. What are your thoughts on using AI to track projects progress in real-time while providing updates and raising awareness to future complications?
3. What about using AI to perform quality assessment by comparing outputs against predefined standards?

Delivery Domain Questions

1. Do you think that using AI to perform automated quality and compliance checks, ensuring deliverables meet established requirements could be useful?
2. Feedback and Continuous Improvement: Applying AI analysis to collect and analyse stakeholder feedback on deliverables, identifying areas for continuous improvement.

Measurement Performance Domain Questions

1. Do you think AI could impact how success is measured? How?
2. Do you think it would be useful to have a tool that helps identify potential anomalies a project might face?
3. What are your thoughts on having AI-powered dashboards that aggregate and analyse project data, providing insights and forecasts on project performance?
4. What about using AI techniques to analyse historical project data, identifying patterns and trends that inform decision-making?

Uncertainty Performance Domain Questions

1. What is your opinion concerning implementing AI systems to identify potential risks based on data and early warning signs, improving proactive risk management?
2. Do you think using AI to simulate risk scenarios and develop more robust contingency plans, enhancing project resilience would be useful?
3. What about assessing risks dynamically by monitoring project data in real-time?

APPENDIX B: CHATGPT Interview Responses

1.

Interviewer

Q: “Are you familiar with the concept of the eight Project Management Performance Domains presented in the 7th edition of the PMBOK guide?”

ChatGPT

A: “Yes, I'm familiar with the concept of the eight Project Management Performance Domains introduced in the 7th edition of the PMBOK (Project Management Body of Knowledge) Guide. The 7th edition represents a significant shift from the previous editions, moving away from a process-based approach to a more principles-driven framework. The eight performance domains are part of this shift, focusing on key areas that drive project performance and success.

Here's a brief overview of the eight Project Management Performance Domains:

Stakeholder Performance Domain: This domain focuses on engaging and managing relationships with all stakeholders involved in the project. It emphasizes understanding stakeholders' needs and expectations, and ensuring their engagement throughout the project lifecycle.

Team Performance Domain: This domain addresses the formation, development, and management of project teams. It includes fostering a collaborative environment, facilitating communication, and ensuring that the team has the necessary skills and resources to succeed.

Development Approach and Life Cycle Performance Domain: This domain covers the selection and implementation of the appropriate development approach (e.g., Agile, Waterfall, Hybrid) and project life cycle. It ensures that the chosen approach aligns with project objectives and organizational needs.

Planning Performance Domain: The Planning domain focuses on the processes and activities required to define the course of action needed to achieve project objectives. It involves developing and maintaining a feasible project plan that is adaptable to changes.

Project Work Performance Domain: This domain involves the execution and coordination of project activities to meet project objectives. It covers managing resources, delivering project outcomes, and ensuring that the work aligns with the project plan.

Delivery Performance Domain: The Delivery domain is about delivering the project's intended outcomes, including products, services, or results. It emphasizes the importance of aligning project outcomes with stakeholder expectations and organizational goals.

Measurement Performance Domain: This domain focuses on assessing project performance and progress against agreed-upon metrics. It involves setting up systems to measure, analyze, and report on project performance throughout its lifecycle.

Uncertainty Performance Domain: The Uncertainty domain addresses managing risks, opportunities, and uncertainties that may impact the project. It emphasizes proactive identification, assessment, and response to uncertainties to minimize negative impacts and capitalize on potential opportunities.

These performance domains collectively provide a holistic framework for managing projects, emphasizing adaptability, stakeholder engagement, and a focus on delivering value. The PMBOK 7th edition's approach is more flexible and better suited for the diverse and dynamic nature of modern projects."

2.

Interviewer

Q: "I'm writing my master's thesis on the influence of artificial intelligence in these domains. Can you name, for each one of these domains, ways of integrating AI?"

ChatGPT

A: "Integrating Artificial Intelligence (AI) into the eight Project Management Performance Domains can significantly enhance project management practices, improving efficiency, decision-making, and overall project outcomes. Below are ways AI can be integrated into each of these domains:

1. Stakeholder Performance Domain

- Sentiment Analysis: AI-driven sentiment analysis tools can analyze stakeholder communications (emails, meeting notes, etc.) to gauge their satisfaction, concerns, and overall sentiment, enabling proactive engagement strategies.
- Chatbots: AI-powered chatbots can provide stakeholders with instant responses to queries and updates, improving communication and engagement.
- Predictive Analytics: AI can predict stakeholder reactions and behavior based on historical data, helping to tailor communication and engagement plans.

2. Team Performance Domain

- Talent Management: AI can assist in identifying the best team members for specific tasks by analyzing their skills, experience, and past performance.
- Collaboration Tools: AI-enhanced collaboration platforms can suggest optimal meeting times, automatically assign tasks, and monitor team dynamics, providing insights to improve team cohesion and performance.
- Performance Monitoring: AI can continuously monitor team performance, providing real-time feedback and identifying potential issues before they escalate.

3. Development Approach and Life Cycle Performance Domain

- Optimization of Development Approaches: AI can analyze project requirements and constraints to recommend the most suitable development approach (e.g., Agile, Waterfall, Hybrid).
- Adaptive Planning: AI-driven tools can dynamically adjust project life cycles and development methodologies in response to changing project conditions or risks.
- Scenario Analysis: AI can simulate various development approaches to determine the most efficient and effective path for project completion.

4. Planning Performance Domain

- Automated Planning: AI can automate the creation of project plans by analyzing historical data and predicting the most effective sequences of tasks.

- Resource Allocation: AI can optimize resource allocation by predicting resource availability, workloads, and potential bottlenecks.
- Risk Identification and Mitigation: AI can identify potential risks during the planning phase and suggest mitigation strategies based on historical project data and predictive models.

5. Project Work Performance Domain

- Task Automation: AI can automate routine tasks such as scheduling, reporting, and status updates, freeing up project managers to focus on strategic activities.
- Progress Tracking: AI-powered tools can monitor and track project work in real-time, providing updates and flagging potential issues.
- Quality Assurance: AI can assist in quality control by automatically checking work outputs against predefined standards and identifying any deviations.

6. Delivery Performance Domain

- AI-Driven Delivery Optimization: AI can optimize the delivery process by analyzing real-time data to adjust delivery schedules, resource allocation, and supply chain logistics.
- Predictive Delivery Management: AI can predict potential delays or issues in the delivery process and suggest corrective actions to ensure on-time delivery.
- Automated Compliance Checks: AI can automatically verify that deliverables meet all regulatory and contractual requirements before final delivery.

7. Measurement Performance Domain

- Real-Time Analytics: AI can provide real-time analytics and dashboards that monitor project metrics, enabling more informed decision-making.
- Predictive Performance Metrics: AI can forecast project performance based on historical data, allowing project managers to take corrective actions before issues arise.
- Anomaly Detection: AI can detect anomalies in project performance data, signaling potential problems that may not be immediately apparent.

8. Uncertainty Performance Domain

- Risk Prediction and Management: AI can predict potential risks and uncertainties by analyzing project data, market trends, and other external factors, helping to mitigate them proactively.
- Dynamic Risk Assessment: AI tools can continuously assess project risks and adjust risk management strategies in real-time.
- Scenario Planning: AI can simulate various "what-if" scenarios, helping project managers to prepare for potential uncertainties and develop contingency plans.

Summary

By integrating AI into these performance domains, project managers can leverage data-driven insights, automate routine tasks, enhance decision-making, and better manage uncertainties, ultimately leading to more successful project outcomes.”

3.

Interviewer

Q: “And could you name challenges or disadvantages that AI adoption might have on Project Management in general?”

ChatGPT

A: “Adopting AI in Project Management offers numerous advantages, but it also presents several challenges and potential disadvantages. These can affect how effectively AI tools are integrated into project management practices and how teams and organizations adapt to these new technologies.

1. Data Quality and Availability

- Challenge: AI systems rely heavily on large volumes of high-quality data to function effectively. If the data is incomplete, inaccurate, or biased, the AI's recommendations and insights may be flawed.
- Disadvantage: Poor data quality can lead to incorrect predictions or suboptimal decisions, undermining trust in AI tools and potentially causing project failures.

2. Integration with Existing Systems

- Challenge: Integrating AI with existing project management tools and systems can be complex and resource-intensive. It may require significant changes to current processes and technologies.
- Disadvantage: The integration process can be disruptive, leading to temporary inefficiencies, higher costs, and potential resistance from team members.

3. Loss of Human Oversight

- Challenge: Over-reliance on AI could result in reduced human oversight, where project managers and teams might depend too much on AI-driven decisions without critically evaluating them.
- Disadvantage: This could lead to a lack of accountability, where project teams may follow AI recommendations blindly, even when human intuition or experience might suggest a better course of action.

4. Ethical Concerns and Bias

- Challenge: AI systems can perpetuate or even amplify existing biases present in the data they are trained on, leading to unfair or unethical outcomes.
- Disadvantage: This can result in biased decision-making, such as in stakeholder management or team evaluations, which could damage relationships and harm the project's success.

5. Resistance to Change

- Challenge: Project teams and stakeholders may resist adopting AI due to fear of job displacement, lack of understanding, or discomfort with new technology.
- Disadvantage: Resistance can slow down the adoption process, reduce the effectiveness of AI tools, and create friction within teams, leading to a decline in overall project performance.

6. Cost and Resource Requirements

- Challenge: Implementing AI systems can be expensive, requiring significant investment in technology, training, and ongoing maintenance.
- Disadvantage: Smaller organizations or projects with limited budgets may find it challenging to justify or afford the costs associated with AI adoption, potentially widening the gap between resource-rich and resource-poor projects.

7. Complexity and Usability

- Challenge: AI systems can be complex and require specialized knowledge to operate effectively. Project managers and team members might need extensive training to use AI tools correctly.
- Disadvantage: The learning curve associated with AI tools can be steep, leading to potential misuses or underutilization of AI capabilities, reducing the anticipated benefits.

8. Security and Privacy Risks

- Challenge: AI systems often require access to sensitive project data, which raises concerns about data security and privacy.
- Disadvantage: If not properly managed, AI adoption could increase the risk of data breaches or unauthorized access to confidential project information, leading to significant legal and reputational consequences.

9. Over-Promising and Under-Delivering

- Challenge: There is often a hype around AI that can lead to unrealistic expectations. Project teams might expect AI to solve all problems, which is rarely the case.
- Disadvantage: If AI tools do not meet these high expectations, it could lead to disappointment, disillusionment, and skepticism towards future AI initiatives.

10. Legal and Regulatory Compliance

- Challenge: AI adoption in project management must comply with various legal and regulatory standards, which can be complex and vary across regions.
- Disadvantage: Non-compliance can result in legal penalties, project delays, and additional costs, especially if the AI systems unintentionally violate data protection laws or industry regulations.

Summary

While AI has the potential to revolutionize project management, its adoption is not without challenges. Addressing these issues requires careful planning, ongoing monitoring, and a balanced approach that combines AI's capabilities with human judgment and oversight. By being aware of these challenges and proactively managing them, organizations can maximize the benefits of AI while minimizing potential drawbacks."

APPENDIX C: PMOtto Interview responses

1.

Interviewer

Q: “Are you familiar with the concept of the eight Project Management Performance Domains presented in the 7th edition of the PMBOK guide?”

PMOtto

A: “Yes, I am familiar with the concept of the eight Project Management Performance Domains presented in the 7th edition of the PMBOK Guide. These domains represent groups of related activities that are critical to the delivery of project outcomes. Unlike traditional process groups, these domains are not prescriptive sequences but are meant to be used in an interactive, interdependent, and iterative manner across different project types and delivery approaches. Here are the eight performance domains:

Stakeholder Performance Domain: Focuses on activities related to stakeholder engagement to ensure productive working relationships and support for the project.

Team Performance Domain: Involves creating and maintaining a collaborative project team environment, ensuring team roles, responsibilities, and culture align with the project’s objectives.

Development Approach and Life Cycle Performance Domain: Concerns selecting the appropriate project development approach (predictive, iterative, hybrid) and defining the life cycle phases.

Planning Performance Domain: Includes the activities required to coordinate and organize the work necessary to deliver the project’s deliverables.

Project Work Performance Domain: Encompasses the actual execution of project activities, including managing physical resources, contracting, and change management.

Delivery Performance Domain: Involves ensuring that the project’s outputs (deliverables) meet quality requirements and satisfy stakeholder needs.

Measurement Performance Domain: Focuses on measuring project performance to ensure that the project is on track to deliver the desired outcomes.

Uncertainty Performance Domain: Addresses managing risks, uncertainties, and the Volatility, Uncertainty, Complexity, and Ambiguity (VUCA) aspects of the project environment.

These domains are designed to be adaptable and applicable to various project environments, ensuring that project management practices are flexible and relevant to the needs of each specific project.”

2.

Interviewer

Q: “I’m writing my master’s thesis on the influence of artificial intelligence in these domains. Can you name, for each one of these domains, ways of integrating AI?”

PMOtto

A: “Integrating AI into the Project Management Performance Domains can significantly enhance efficiency, decision-making, and overall project outcomes. Here’s how AI can be integrated into each of the eight domains:

1. Stakeholder Performance Domain

- Sentiment Analysis: AI-driven sentiment analysis tools can analyze stakeholder communications (emails, surveys, social media) to gauge sentiment, helping project managers proactively address concerns or capitalize on positive feedback.
- Stakeholder Mapping: AI can map stakeholders based on their influence, interest, and involvement, providing insights into how to prioritize engagement strategies.

2. Team Performance Domain

- Virtual Assistants: AI-powered virtual assistants can help team members manage tasks, schedules, and deadlines, freeing up time for more strategic activities.
- Team Composition Optimization: AI can analyze skills, past performance, and team dynamics to recommend the best team composition for a project.

3. Development Approach and Life Cycle Performance Domain

- Predictive Analytics: AI can predict which development approaches (e.g., agile, waterfall, hybrid) will be most effective based on project characteristics, historical data, and team capabilities.
- Adaptive Planning: AI can continuously monitor project progress and automatically adjust the development approach or lifecycle phases to optimize outcomes based on real-time data.

4. Planning Performance Domain

- Automated Scheduling: AI tools can automate the creation of project schedules, optimizing resource allocation and timelines based on constraints and past project data.
- Risk Prediction: AI can identify potential risks during the planning phase by analyzing large datasets from similar projects, enabling proactive risk management.

5. Project Work Performance Domain

- Process Automation: AI can automate repetitive tasks such as data entry, reporting, and monitoring, allowing project teams to focus on high-value activities.
- Resource Optimization: AI algorithms can optimize the use of resources (e.g., materials, human resources) by predicting needs and minimizing waste.

6. Delivery Performance Domain

- Quality Control: AI-driven quality control systems can analyze data in real-time to ensure deliverables meet required standards, identifying defects or issues early.

- Predictive Maintenance: In projects involving physical assets, AI can predict when maintenance is needed, reducing downtime and ensuring timely delivery.

7. Measurement Performance Domain

- Performance Dashboards: AI-powered dashboards can provide real-time insights into project performance, highlighting key metrics, trends, and potential issues.
- Automated Reporting: AI can generate project reports automatically, pulling data from various sources, and presenting it in a clear, actionable format.

8. Uncertainty Performance Domain

- Risk Management: AI can enhance risk management by identifying emerging risks, quantifying their impact, and suggesting mitigation strategies based on data patterns and historical outcomes.
- Scenario Analysis: AI can run multiple project scenarios to evaluate the potential impact of different uncertainties, helping project managers make informed decisions.

These AI integrations not only streamline project management processes but also enhance decision-making, risk management, and stakeholder engagement, making projects more adaptive and resilient.”

3.

Interviewer

Q: “And could you name challenges or disadvantages that AI adoption might have on Project Management in general?”

PMOtto

A: “Adopting AI in project management offers many benefits, but it also presents several challenges and potential disadvantages. Here are some key concerns:

1. Data Dependency and Quality

- Challenge: AI systems require vast amounts of high-quality, structured data to function effectively. Incomplete, outdated, or biased data can lead to inaccurate predictions or insights.
- Impact: Poor data quality can result in flawed decision-making, undermining the effectiveness of AI tools in project management.

2. Cost of Implementation

- Challenge: Implementing AI technologies can be expensive, involving costs related to software acquisition, infrastructure, training, and ongoing maintenance.
- Impact: High costs can be prohibitive, especially for smaller organizations or projects with limited budgets, leading to a slow adoption rate.

3. Complexity of AI Systems

- Challenge: AI systems can be complex and require specialized knowledge to set up, manage, and interpret. Many project managers and teams may lack the necessary expertise.
- Impact: The complexity of AI can create a steep learning curve, increasing the risk of misapplication or underutilization of AI tools.

4. Ethical and Privacy Concerns

- Challenge: AI systems often rely on collecting and analyzing large amounts of data, which can raise ethical and privacy concerns, particularly with regard to stakeholder information.
- Impact: Mismanagement of sensitive data can lead to breaches of confidentiality and trust, potentially harming stakeholder relationships and the organization's reputation.

5. Over-reliance on AI

- Challenge: There is a risk that project managers may become overly reliant on AI tools, potentially overlooking the importance of human judgment and intuition.
- Impact: Over-reliance on AI can lead to a lack of critical thinking and creativity, which are essential for navigating complex, ambiguous project environments.

6. Resistance to Change

- Challenge: Introducing AI into project management may encounter resistance from team members and stakeholders who are uncomfortable with new technologies or fear job displacement.
- Impact: Resistance to AI adoption can hinder its effective implementation, leading to lower morale and potential disruptions in project workflows.

7. Transparency and Accountability

- Challenge: AI algorithms can sometimes be "black boxes," meaning their decision-making processes are not always transparent or understandable to users.
- Impact: Lack of transparency can make it difficult to explain AI-driven decisions to stakeholders or hold the system accountable for errors, leading to trust issues.

8. Integration with Existing Systems

- Challenge: Integrating AI tools with existing project management systems and workflows can be challenging, requiring significant customization and potentially causing disruptions.
- Impact: Poor integration can lead to inefficiencies, data silos, or even system failures, reducing the overall effectiveness of AI.

9. Job Displacement and Role Changes

- Challenge: AI has the potential to automate many tasks traditionally performed by project managers and team members, leading to concerns about job displacement or the need for role redefinition.
- Impact: While AI can improve efficiency, it may also require significant retraining and role adjustments, which can be stressful and challenging for employees.

10. Long-Term Maintenance and Evolution

- Challenge: AI systems require continuous monitoring, updates, and evolution to remain effective, which can be resource-intensive and require ongoing investment.
- Impact: Failure to maintain and update AI systems can lead to degradation in performance and relevance, making them less useful over time.

These challenges highlight the need for careful planning, clear communication, and ongoing management when adopting AI in project management.”