

**NOVA**

**IMS**

Information  
Management  
School

# MGI

Master Degree Program in  
**Information Management**

## **Applying Artificial Intelligence on Project Management Office Improvement**

Marcus Vinicius Fernandes de Almeida

Master Thesis

presented as partial requirement for obtaining the Master Degree in Information Management

**NOVA Information Management School**  
**Instituto Superior de Estatística e Gestão de Informação**

Universidade Nova de Lisboa

**NOVA Information Management School**  
**Instituto Superior de Estatística e Gestão de Informação**  
Universidade Nova de Lisboa

**Applying Artificial Intelligence on Project Management Office Improvement**

by

Marcus Vinicius Fernandes de Almeida

Master Thesis presented as partial requirement for obtaining the Master's degree in  
Information Management, with a specialization in Information Systems and Technologies Management

**Supervised by**

Vítor Duarte dos Santos, PhD.

November, 2024

## **STATEMENT OF INTEGRITY**

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

*Lisbon, November 30<sup>th</sup>, 2024*

## **DEDICATION**

This work is dedicated to my beloved wife, thank you for your unwavering support, endless patience, and belief in me throughout this journey. Your encouragement has been my source of strength and inspiration, lifting me through challenges and celebrating every achievement along the way. I am deeply grateful for your love and understanding, which made this accomplishment possible.

The memory of my parents, who are no longer with us, this work is a tribute to your guidance, sacrifices, and the values you instilled in me. Your memory has been a constant source of motivation, reminding me of the importance of perseverance, integrity, and the pursuit of knowledge. I hope this achievement makes you proud.

A special recognition to my friends and professional colleagues who contributed with their time and insights during the path and with the interviews, I am profoundly grateful for your generosity and expertise. Your input has enriched this work immensely, and your collaboration has been an invaluable part of this achievement.

Thank you all for sharing this journey with me.

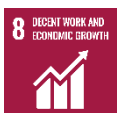
## ABSTRACT

The use of Artificial Intelligence (AI) in Project Management Offices (PMOs) represents an important step forward in project management approaches increasing efficiency, decision-making, and strategy alignment. PMOs serve an important role in project portfolio management, maximizing resource use and assuring alignment with organizational goals. Although they frequently experience some issues like resource allocation inefficiencies, reactive risk management, and lack of strategic alignment. This study investigates how AI can improve PMO effectiveness across their functions. The study builds a comprehensive framework that connects AI applications like predictive analytics, real-time project monitoring, natural language processing, and others to the main PMO activities. These include portfolio and project monitoring, risk management, resource allocation, and portfolio optimization. The framework was created through an extensive literature review and was demonstrated through a hypothetical case study, illustrating AI's capacity to address common PMO issues. Following that, it was evaluated through expert interviews, which confirmed its practical relevance and application while emphasizing crucial implementation factors such as the necessity of a large volume of historical high-quality data, organizational readiness, and change management. Despite constraints, this research establishes a basic mode for integrating AI into PMO operations. The study concludes that AI-driven PMOs are better equipped to navigate complex project environments, stimulate innovation, and achieve strategic goals, allowing organizations to stay relevant in an increasingly dynamic business market. This work provides an approach for the practical adoption and future research of AI's potential to transform project management practices.

## KEYWORDS

Project Management Office; Artificial Intelligence; Project Management; Predictive Analytics; Portfolio Management

### Sustainable Development Goals (SDG):



# TABLE OF CONTENTS

1. Introduction.....	1
1.1. Background and problem identification.....	1
1.2. Objectives .....	2
1.3. Study Importance and Relevance.....	2
2. Literature review .....	4
2.1. Project Management Office .....	4
2.1.1. Concept and Evolution .....	4
2.1.2. Benefits, Opportunities and Challenge .....	6
2.1.3. PMO Types.....	6
2.1.4. Processes and Methodologies.....	8
2.1.4.1. Waterfall Methodology.....	8
2.1.4.2. Agile Methodology.....	9
2.1.4.3. Hybrid Methodology .....	10
2.2. Artificial Intelligence.....	11
2.2.1. Concepts.....	11
2.2.2. Pathways to Build AI.....	12
2.2.3. Application Areas .....	13
2.3. Applications of AI Techniques in PMO .....	14
2.3.1. Systematic Literature Review - PRISMA.....	14
2.3.2. Systematic Literature Review - PRISMA Definitions .....	15
2.3.3. Systematic Literature Review - PRISMA Execution .....	17
2.3.4. Systematic Literature Review - PRISMA Results .....	20
3. Methodology .....	28
3.1. Design Science Research (DSR).....	28
3.2. Research Strategy.....	30
4. Framework for an Efficient Use of AI in PMO .....	33
4.1. Assumptions .....	33
4.2. Framework.....	35
4.3. Demonstration.....	41
4.3.1. Study Case: IT Corporation .....	41
4.4. Evaluation .....	47
5. Conclusions and future works .....	51
5.1. Limitation.....	51
5.2. Recommendations for Future Work .....	52

Bibliographical References .....53

## LIST OF FIGURES

Figure 1 – PRISMA Workflow .....	18
Figure 2 - DSR Process Model (adapted from Peffers et al., 2007).....	29
Figure 3 - DSR Research Strategy (adapted from Peffers et al., 2007) .....	32

## LIST OF TABLES

Table 1 - Systematic Literature Review Questions.....	15
Table 2 - Systematic Literature Review Databases .....	15
Table 3 - Systematic Literature Review Keywords .....	16
Table 4 - Systematic Literature Review inclusion and exclusion criteria .....	16
Table 5 – PRISMA Results .....	20
Table 6 – Proposed Framework .....	38

## LIST OF ABBREVIATIONS AND ACRONYMS

<b>AI</b>	Artificial Intelligence
<b>ANN</b>	Artificial Neural Networks
<b>DE</b>	Differential Evolution
<b>DSR</b>	Design Science Research
<b>DT</b>	Decision Tree
<b>EPMO</b>	Enterprise Project Management Office
<b>IT</b>	Information Technology
<b>KPI</b>	Key Performance Indicators
<b>ML</b>	Machine Learning
<b>NLP</b>	Natural Language Processing
<b>PMBOK</b>	Project Management Body of Knowledge
<b>PMO</b>	Project Management Office
<b>PPM</b>	Project Portfolio Management
<b>PRISMA</b>	Preferred Reporting Items for Systematic Reviews and META-Analysis
<b>PSO</b>	Particle Swarm Optimization
<b>ROI</b>	Return on Investment
<b>SLR</b>	Systematic Literature Review
<b>SLRQ</b>	Systematic Literature Review Question
<b>SVM</b>	Support Vector Machines

# 1. INTRODUCTION

## 1.1. BACKGROUND AND PROBLEM IDENTIFICATION

Project Management Offices (PMOs), in the lively world of modern business, stand out as reliable managers of corporate performance. PMOs act as a focal point of attention, coordinating and refining the complex dance of projects inside an organization. Their strategic ability is the strength that synchronizes initiatives with corporate goals and guarantees effective execution, making them indispensable in addition to their managerial oversight.

As enterprises navigate the complexity of project landscapes, PMOs provide a structured framework, fostering consistency, communication, and collaboration. These entities streamline processes, define best practices, and offer a centralized hub for project oversight. In essence, PMOs are like navigational beacons, helping projects navigate the frequently turbulent waters of business endeavors.

At the same time, the rise of Artificial Intelligence (AI) indicates that a new era for PMOs is emerging. AI becomes a useful friend in the search for efficiency and effectiveness due to its ability to process massive volumes of data, forecast outcomes, and automate operations. Aujla (2023) underlines the growing importance of AI tools to PMOs, highlighting their ability to improve productivity, reduce expenses, and give predictive analytics that aids decision-making processes.

Gartner (2019) anticipates a future landscape where AI will perform a major share of traditional project management duties. Their projection that AI will undertake 80 percent of today's project management tasks by 2030 highlights the significant change in the project management discipline. However, as Whitaker (2019) correctly points out, project management is not merely a collection of procedures techniques, and tools; it is a complex interaction of human abilities and experience.

The incorporation of AI tools into PMOs marks a paradigm shift, unlocking new levels of efficiency and insight. Holzmann et al. (2022) elaborate on the symbiotic nature of this relationship, mentioning that, while AI can accelerate decision-making processes and improve project management efficiency, it does not replace the critical function of human decision-making and communication inside PMOs.

It is critical to consider AI as a supplement to, rather than a replacement for, human skill. While AI improves project management procedures and decision-making, the complicated dance of project orchestration still necessitates the soft touch of human project managers and PMOs. The facilitation of decision-making processes, as highlighted by Holzmann et al. (2022), demonstrates that AI has the ability to enhance rather than replace the human element in project management.

Considering all that, we can interrogate ourselves about the challenge of determining how AI could be used on PMOs to improve productivity, decision-making, and overall PMO outcomes.

A significant research gap exists in understanding the nuanced ways in which AI can improve the performance of PMOs. The precise interactions between various PMO models and AI applications are still relatively unexplored. Addressing this research gap holds the promise of not only optimizing PMO operations but also fostering a more agile and intelligent approach to project management in the digital era.

Determining where AI may integrate to improve PMO productivity, decision-making, and overall outcomes drives us to the following Research Question: How and where AI can help the different types of PMOs used in companies to improve their work and results?

## 1.2. OBJECTIVES

In order to help answer the research question the main research objective is to create a set of frameworks for the most efficient use of AI in the different types of PMO used in companies.

To achieve this goal, the following intermediate steps will be taken:

- Understanding PMO types, processes, and methodologies.
- Understanding the main AI concepts and application areas.
- Make a comprehensive Literature Review on the applications of AI techniques in PMOs, namely, study the existent application of AI tools and techniques that can be applied to PMOs.
- Propose a framework that PMOs could use to find the better use of AI applications.
- Validate the proposed framework.

## 1.3. STUDY IMPORTANCE AND RELEVANCE

In an era dominated by technological breakthroughs, the importance of studies regarding the application of AI to PMO improvement goes beyond the academic world. This study project aims to contribute to the development of our society and business, while also expanding our scientific understanding.

This study can help transform organizational operations, influencing overall satisfaction and well-being. AI integration into PMOs improves productivity, reduces costs, and improves project outcomes, resulting in more efficient resource allocations. This can lead to cost savings that can be transferred to societal programs, infrastructure, or employee well-being. The ripple effect promotes economic growth, job creation, and increased individual satisfaction.

Furthermore, AI-driven insights increase project success rates, allowing organizations to deliver products more effectively, suit faster to market demands, stimulate innovation, and ensure long-term viability in a competitive sector.

This thesis contributes to the field extending our understanding and pushing our knowledge. The proposed framework explores the practical consequences of incorporating AI into PMOs, setting the base for future research and innovation. It reveals the complicated relationships between AI and human expertise, which not only contributes to academic debate but also can help the establishment of ethical rules, considering the current discussion of responsible AI adoption in our society.

## 2. LITERATURE REVIEW

### 2.1. PROJECT MANAGEMENT OFFICE

#### 2.1.1. Concept and Evolution

The PMO has transformed into an essential part of modern project management methodologies employed within organizations. The initial purpose of its establishment as an administrative function has developed into a strategic institution that now has a wider range of functions (Hobbs & Aubry, 2010). At first, PMOs offered assistance by managing project documentation, keeping track of project records, and ensuring compliance with deadlines. However, with the increasing complexity and strategic significance of project management, the scope of PMOs has considerably expanded (Artto et al., 2011).

Today, the main role of a PMO is to establish consistent and uniform procedures for managing projects and to facilitate the effective application of resources, methods, tools, and techniques across all projects in the organization (PMBOK Guide, 2017). PMOs play a vital role in governance and standardization by setting and maintaining project management standards across several projects throughout the organization. This involves the creation and enforcement of project processes, standards, and frameworks that are in line with the organization's objectives and strategy (Crawford, 2006).

PMOs provide a substantial contribution in the area of resource management. Their responsibility is to efficiently distribute and optimize the use of resources across multiple projects. This encompasses not only the assignment of staff but also the administration of financial resources, tools, and technological resources, enabling projects to be adequately equipped and staffed with efficiency (Kerzner, 2017). In addition to resource management, PMOs are involved in monitoring and reporting. They offer crucial supervision and observations on the advancement of projects, including key metrics such as adherence to budget, timeframes, and resource use. Continuous monitoring and reporting contribute to the early identification of potential issues and ensure that projects remain on schedule and within the defined scope (Kerzner, 2017).

Additionally, PMOs are progressively taking part in strategic planning and decision-making processes. They play a crucial role in determining the strategic direction of projects by ensuring their alignment with the organization's objectives and goals. Ensuring strategic alignment is crucial for projects to deliver value and achieve business success (Joslin & Müller, 2016). PMOs also have a responsibility in risk management, by identifying potential risks related to the project and formulating ways to mitigate them. This function is crucial for

ensuring the success of the project and protecting the company from possible delays and issues.

PMOs are making substantial contributions in the field of change management. They frequently take the lead in overseeing organizational change, ensuring that changes connected to projects are communicated, executed, and embraced throughout the business. This entails collaborating closely with diverse stakeholders to provide seamless transitions and mitigate resistance to change (Schwalbe, 2015).

In addition, PMOs play a crucial role in enhancing organizational capabilities and facilitating effective knowledge management. They frequently supervise training and development programs for project managers and team members, guaranteeing that they acquire the essential abilities and information to proficiently oversee projects. This includes providing training on new methodologies, tools, and technologies, as well as stimulating a culture of continuous learning and improvement in the organization (PMBOK Guide, 2017).

Agile methodologies have impacted PMO operations. They are increasingly adopting agile practices to enhance flexibility and responsiveness in project management. Agile PMOs prioritize the delivery of value, quick adaptation to change, and sustaining stakeholder satisfaction. This means a significant change from traditional PMO approaches that prioritize control and standardization. Agile PMOs enable a more collaborative and iterative method of managing projects, which better aligns with the dynamism of modern business environments (Pemsel & Wiewiora, 2013).

Digital transformation has further expanded the role of PMOs. During a time when digital initiatives have great significance, PMOs play a crucial role in guiding this kind of project. They have an essential purpose in aligning project results with digital strategy and assuring the most efficient utilization of digital technologies. This involves managing projects that frequently necessitate fast execution and iterative methodologies, which are commonly employed in digital initiatives (Vukadinović & Fabac, 2022). PMOs in the digital era are in charge of not only handling traditional project management tasks but also promoting innovation and digital transformation initiatives. This encompasses assisting with initiatives that involve the integration of new technologies, digital platforms, and innovative approaches.

The PMO has evolved into a crucial component of organizational project management, providing a diverse array of services that go well beyond its original administrative responsibilities. PMOs have a crucial role in assuring the success of projects and accomplishing corporate goals, including governance, standardization, strategic alignment, risk management, and capacity development. The functions and significance of the PMO will adapt and align with the evolving needs of businesses and the wider project management landscape as the field of project management progresses (Turner, 2016).

### **2.1.2. Benefits, Opportunities and Challenge**

As discussed before, the main benefit of a PMO resides in its capacity to offer a centralized framework for project management throughout an organization. PMOs guarantee uniformity and standardization in project management methodologies, resulting in more predictable project results and improved operational effectiveness (PMBOK Guide, 2017). They play a crucial role in optimizing resources and ensuring that human and financial resources are deployed efficiently to maximize the success of the project (Kerzner, 2017). Furthermore, PMOs have a vital function in improving the standard of project execution by providing governance and supervision, resulting in enhanced project performance and a greater likelihood of project success (Joslin & Müller, 2016).

PMOs offer a multitude of chances for enhancing and advancing an organization. An important opportunity lies in the PMO's capacity to facilitate strategic alignment. PMOs play a crucial role in ensuring that projects are in line with the strategic goals of the organization, hence enhancing the total business value (Artto et al., 2011). The PMO is able to promote a culture of ongoing learning and enhancement. PMOs can enhance the organization's project management capabilities by improving the skill levels of project managers and team members through training and development programs (Schwalbe, 2015).

Despite their advantages, PMOs encounter numerous challenges. An important obstacle that businesses often face is the reluctance to accept and adapt to change. Implementing standardized processes and methodologies often necessitates a substantial culture transformation, which may encounter opposition from project teams accustomed to specific work practices (Pemsel & Wiewiora, 2013). Another obstacle lies in effectively highlighting the worth of the PMO to stakeholders. PMOs must consistently demonstrate their value by showing their contributions to project success and the achievement of organizational objectives (Hill, 2022). Another big challenge that already implement PMOs face is that as organizations progressively embrace agile approaches, PMOs must modify their practices to accommodate a more adaptable and iterative approach to project management. This transition can be challenging, as it frequently necessitates a shift in perspective from conventional project management methodologies. Nevertheless, it also offers PMOs the chance to enhance their adaptability to changes and accelerate value delivery (Vukadinović & Fabac, 2022).

### **2.1.3. PMO Types**

In the domain of Information Technology (IT), PMOs are created to optimize project management, align IT projects with business strategy, and ensure the effective delivery of projects. It functions as a hub for sharing best practices, new methodologies, and developing technologies. In project management within the business, it frequently serves as an incentive for innovation and ongoing enhancement (Schwalbe, 2015).

The types of IT PMOs can differ depending on the extent of their responsibilities, the level of control they need, and the methodology utilized. The common types are:

- **Supportive PMO** – It functions as a repository of knowledge, providing guidance, best practices, templates, and access to project management information. Supportive PMOs fulfill only a consultative function and are typically favored in organizations that grant project teams a significant level of independence. They are characterized by a low degree of control over projects (Hill, 2022).
- **Controlling PMO** – It offers more supervision in contrast to supportive PMOs. They provide frameworks and procedures for project management and demand adherence to these standards. This type of PMO is well-suited for organizations with high levels of compliance, that demand strict adherence to standardized and precise project management methodologies, particularly in cases where there are regulatory obligations (Kerzner, 2017).
- **Directive PMO** – It assumes an active role in project management. It not only establishes the project management procedure but also manages the projects. This sort of PMO is commonly observed in organizations that deal with complex projects and demand uniform management procedures throughout all departments (Artto et al., 2011).
- **Project-specific PMO** – It is created for a singular significant project, especially when the project is too large or complex to be effectively managed within the regular operating structure. Upon the completion of the project, this type of PMO is often dissolved (Hobbs & Aubry, 2010).
- **Program PMO** – It is accountable for supervising a collection of interconnected projects, referred to as a program. The focus is on achieving strategic goals and benefits that may not be attained if the projects were handled separately (PMBOK Guide, 2017).
- **Portfolio PMO** - It is responsible for managing a group of projects or programs, to ensure they are in line with the strategic goals of the organization. The portfolio management function is responsible for managing project selection and prioritization, resource allocation, risk assessment, and benefits realization throughout the entire portfolio (PMBOK Guide, 2017).
- **Enterprise Project Management Office (EPMO)** – It is not only an IT PMO, as functions at the highest level in the organization and ensures that all project, program, and portfolio endeavors are in line with the organizational strategy. The presence of an EPMO typically exerts a substantial impact on the overall

project policies, practices, and techniques inside the organization (Hobbs & Aubry, 2010).

- **Agile PMO** – It is specifically designed to assist with projects that utilize agile approaches. This particular class of PMO places a strong emphasis on flexibility, quick delivery, continuous improvement, and the ability to adapt to change. These characteristics align with the concepts of Agile project management, as described by Kerzner in 2017.
- **Hybrid PMO** - It is an organizational structure that integrates components from both traditional and Agile PMOs. It provides support for projects that utilize both classic (waterfall) and Agile approaches, enabling a diverse array of project types and management styles (Kerzner, 2017).

Selecting the appropriate type of PMO in IT is crucial for an organization and should evolve as its maturity increases. The decision should be founded on the organization's culture, the level of maturity of its project management processes, and the specific requirements of its IT projects. The challenges involve integrating the functions of the PMO with the goals of the business, adjusting to evolving project requirements, and securing stakeholder support for the PMO's processes and methodologies.

The efficacy of an IT PMO relies on its capacity to adjust to the evolving organizational environment and its ability to enhance project deliverables.

#### **2.1.4. Processes and Methodologies**

When it comes to guaranteeing the success and efficiency of IT projects, the integration and successful execution of PMO procedures and methods are decisive. One significant approach in IT PMO is the customization of project management techniques to suit specific IT needs, particularly in development projects.

There are three techniques that are most often used: Waterfall, Agile, and Hybrid. Each of these approaches serves distinct project goals and objectives concerning the organization. The PMOs should build their process and roles within organizations considering these different approaches.

##### **2.1.4.1. Waterfall Methodology**

One of the most conventional approaches to project management is the Waterfall technique, which is distinguished by its sequential and phase-based approach. A linear progression is one of its main characteristics. This progression ensures that each step, including planning, design, implementation, and testing, is completed in a predetermined sequence (Royce, 1998). As

pointed out by Halani and Jhajharia (2022), the Waterfall model excels in environments where detailed planning and predictable outcomes are the priority.

A Waterfall-based PMO often has a structure that is more hierarchical and conventional. It is the responsibility of the PMO to ensure that projects adhere to a linear and sequential course, as well as to carry out substantial documentation and precise preparation ahead (Kerzner, 2017). As a gatekeeper, the PMO in this scenario is responsible for ensuring that each step of the project lifecycle is finished in its entirety before going on to the next phase.

The following are the main processes that are involved in Waterfall PMOs:

- Detailed Planning: The initial planning for the project is comprehensive, with a clear and defined scope and deliverables (Wysocki, 2013).
- Design and Development Phases: The execution process is carried out in a predetermined sequence, with each phase affecting the one that came after it.
- Testing and Deployment: As soon as the development process is complete, rigorous testing is carried out, and then deployment takes place.

#### **2.1.4.2. Agile Methodology**

According to Beck et al. (2001), the agile approach highlights the need for flexibility, cooperation, and adaptation to change. This technique was first proposed in the early 2000s. It has been brought to the attention of Venkatachalam et al. (2017) that the Agile SCRUM framework, which is a popular Agile methodology, can support quick product iterations and put an emphasis on frequent reflection and development. When it comes to project management, the Agile methodology takes an iterative and incremental approach, in contrast to the Waterfall methodology approach. It places a strong emphasis on adaptability, continual feedback, and flexibility in response to changing needs. It is suitable for projects in which the needs are not completely specified at the beginning or where it is anticipated that they may change over time.

In contrast to Waterfall PMOs, Agile PMOs are often more adaptable and less hierarchical in their organizational structure. According to Cohn (2010), the primary goals of these PMOs are to facilitate collaboration, create a culture of continuous improvement, and enable quick reactions to change. Agile PMOs foster iterative development, encourage frequent feedback, and provide support for cross-functional teams. They often take on the role of coaches or facilitators, helping teams to embrace Agile values and principles (Schwaber & Beedle, 2002).

The following are the main processes that Agile PMOs use:

- Iterative Development: Projects are divided into short iterations or sprints, each delivering a potentially shippable product increment (Schwaber & Beedle, 2002).

- Collaborative Planning and Review: Regular planning meetings, reviews, and retrospectives ensure continuous improvement and adaptation (Cohn, 2010).
- Backlog Management: Ongoing prioritization of tasks in the backlog is crucial for responding to changes.

#### **2.1.4.3. Hybrid Methodology**

Hybrid approaches utilize the qualities of both Waterfall and Agile techniques by combining the structured approach of Waterfall with the flexibility of Agile methodology. According to Boehm and Turner (2003), this method is suitable for projects that need a balance between meticulous preparation and the capacity to react to changed circumstances. In complex projects that demand both stability and flexibility, hybrid techniques are becoming an increasingly attractive choice over traditional approaches.

Hybrid PMO implements a balance between strict project phases and agile adaptability. According to Quist (2015), this model allows for upfront planning and design (Waterfall) and then moves to an iterative development and testing phase (Agile). The PMO is responsible for overseeing both the structured planning phase and the flexible execution phase in this setting. This ensures that the project stays true to its original goals while also being able to accommodate any modifications that may occur.

The following are the main processes that are involved in Hybrid PMOs:

- Initial Framework Definition: Starts with a broad plan under a Waterfall approach, establishing project scope and milestones.
- Iterative Execution: Agile practices are integrated during the execution phase, allowing for flexibility and responsiveness to change (Conforto et al., 2014).
- Regular Milestone Reviews: Combines Waterfall's milestone reviews with Agile's iterative assessments.

The choice of a methodology in an IT PMO has a considerable impact on the procedures and the outcomes of projects. The Waterfall methodology gives predictability and order, while the Agile methodology promotes flexibility and elevated customer satisfaction, and the Hybrid methodology offers a compromise between the two. The IT PMO's role is pivotal in ensuring that the chosen methodology is effectively applied to achieve the desired project outcomes.

## 2.2. ARTIFICIAL INTELLIGENCE

### 2.2.1. Concepts

AI is at the cutting edge of technological advancement, redefining what is achievable in a variety of fields. AI is concerned with the creation of computers capable of doing functions that need human intelligence, such as learning, thinking, and problem-solving. This field integrates computer science, mathematics, psychology, and linguistics, seeks to replicate or even improve human cognitive functions (Russell & Norvig, 2019; Poole & Mackworth, 2017).

AI ideas can be traced back centuries ago, although its contemporary form emerged around the mid-20th century. Alan Turing, a pioneer in the computer science area, created the Turing Test, which laid the groundwork for evaluating a machine's ability to demonstrate intelligent behavior (Turing, 1950). In this assessment, a human tester engages in a natural language discussion with a person as well as an artificially intelligent machine taught to respond in human-like ways. If the evaluator is unable to consistently distinguish between the machine and the human, the machine is deemed to have passed the test, demonstrating its ability to exhibit intelligent behavior that is indistinguishable from a human being.

During the 1950s and 1960s, AI research expanded dramatically, with notable advances such as Frank Rosenblatt's development of the first neural network computer, the Perceptron (Rosenblatt, 1958). Machine learning (ML) had substantial progress in the years that followed, which was highlighted by notable milestones such as the introduction of the backpropagation algorithm (Rumelhart et al., 1986) and the development of deep learning approaches (LeCun et al., 2015).

A lot of things are exciting and unknown about the future of AI. Researchers are investigating the integration of AI with emerging technologies such as quantum computing (Biamonte et al., 2017), as well as extending the boundaries of AI's capabilities in areas like general intelligence (Goertzel, 2014) and emotion recognition (Picard, 2000). Additionally, there is a rising concern about the creation of AI ethics that should be in accordance with human values and societal standards (Jobin et al., 2019).

The increasing integration of AI into daily life has resulted in substantial ethical concerns. Data privacy, monitoring, and the possibility of biased decision-making are some of the topics that are now at the forefront of discussions (Bostrom & Yudkowsky, 2014; O'Neil, 2016). The growing use of AI raises concerns about the future of employment and job displacement (Susskind & Susskind, 2015). As AI systems become more independent, determining accountability in decision-making becomes increasingly complex.

AI's evolution demonstrates human brilliance and the capacity to revolutionize society. As we navigate its future, we will need to strike a balance between innovation and ethics. AI's journey is far from over, and its continuing progress will undoubtedly change our understanding of intelligence and machine capabilities (Kaplan & Haenlein, 2018).

### **2.2.2. Pathways to Build AI**

The development of AI systems requires a comprehensive strategy that combines many technical, methodological, and theoretical frameworks. Examining the main routes to creating AI, we can consider that the main pathway passes through the following process.

The first stage requires systematic data collecting and preprocessing. AI systems are always built on top of high-quality data. It is crucial to collect and refine varied datasets from multiple sources to assure precision and relevance. Efficient data preparation approaches, such as normalization, transformation, and outlier identification, greatly improve the performance of the data set on the learning models. According to Niranjana (2023), thorough data preparation is especially critical for developing AI systems to handle real-world concerns.

After the data has been prepared, the second step process involves selecting and implementing ML algorithms. These algorithms are divided into three categories: supervised, unsupervised, and reinforcement learning. When labeled data is available, supervised learning algorithms such as deep learning have achieved significant accomplishments in several fields because of their capacity to acquire hierarchical representations from data. Unsupervised learning, including clustering and dimensionality reduction methods, can be used in situations when labeled data is not accessible. Goertzel (2014) demonstrates how integrating narrow AI methods with general AI approaches improves adaptability when handling complicated problems.

Next, the AI model is trained by feeding the preprocessed data into the specified algorithms and changing model parameters to reduce errors. Optimization techniques such as gradient descent are critical for achieving high accuracy and reliability. Septiandri et al. (2024) suggest that including ethical issues in the training process ensures that models are both accurate and trustworthy.

Following training, the validation and testing phase analyzes the model's performance on separate datasets. The test dataset was not used in model training to guarantee their effectiveness. The model's ability to generalize to new data is evaluated according to their accuracy, precision, and recall. This stage assures that the AI system meets performance requirements and is stable under a variety of scenarios.

The final step is deployment, which involves integrating the verified model into a production environment and performing real-time operations. Continuous monitoring is critical for

addressing issues such as model drift, in which changes in data distribution affect performance. Tobar and González (2021) underline the importance of regular updates to keep the model effective.

While technological steps are necessary, ethical considerations are vital in AI development. Concerns around data privacy, algorithmic bias, transparency, and social consequences must be addressed. Dronic (2018) proposes employing technological solutions such as distributed ledgers, paired with sociological insights, to align AI with human values.

To summarize, developing AI systems entails a methodical process of data preparation, algorithm selection, model training, validation, and implementation. On every path, balancing technical rigor with ethical responsibility is crucial to creating AI solutions that are not just efficient but also consistent with societal norms.

### **2.2.3. Application Areas**

AI has produced a major impact on a variety of fields, by enabling automation, improving decision-making, and encouraging inventive solutions.

In healthcare, AI offers disruptive promise in diagnoses and therapy. An example of that was provided by Gulshan et al. (2016) who created a deep learning system for detecting diabetic retinopathy that performed similarly to ophthalmologists. This result highlights AI's ability to improve accessibility and accuracy in medical imaging. Another example was given by Topol (2018), which emphasizes the significance of AI in genomics-tailored medical treatment, which will allow for customized therapies for complex diseases.

In education, AI-powered adaptive learning platforms adjust training to individual learning styles and needs. Zawacki-Richter et al. (2019) published a systematic review that emphasizes AI's role in enhancing educational results through customized mentoring and analytics. In transportation, autopilot cars use AI for navigation and collision avoidance, as demonstrated by Waymo (2020)'s autonomous vehicle innovations, which use AI to improve traffic safety and efficiency.

In business areas, AI applications emerged as an essential component in building the path to increase organizational efficiency, productivity, and innovation. Some examples of that are that AI improves customer interactions using chatbots and recommendation algorithms, as seen on retail or streaming platforms. Or as Davenport and Ronanki (2018) discuss how AI improves data-driven decision-making and operational efficiency in organizations, with a focus on the use of robotic process automation (RPA) to streamline repetitive operations. In marketing, AI-powered predictive analytics improve targeting techniques, allowing businesses to achieve higher client retention rates. Furthermore, AI integration in supply chain

management improves logistics and demand forecasts, reducing costs and increasing productivity.

While these applications demonstrate AI's transformative potential, difficulties such as ethical issues, data security, and regulatory requirements remain, necessitating ongoing innovation and monitoring to ensure responsible use.

## 2.3. APPLICATIONS OF AI TECHNIQUES IN PMO

### 2.3.1. Systematic Literature Review - PRISMA

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method is an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses. It aims to help improve the reporting of systematic reviews and meta-analyses, focusing on the review's transparency and completeness. The PRISMA statement consists of a four-phase flow diagram, which guides the selection and evaluation process of literature to be included in the review (Moher et al., 2009).

The main objectives of the PRISMA method are to enhance the transparency of systematic reviews, facilitate the critical appraisal and replication of reviews, and improve the integration of evidence for decision-making.

PRISMA's methodology is designed to ensure that systematic reviews and meta-analyses provide a high degree of evidence and clarity. By following the PRISMA guidelines, researchers can methodically search, appraise, and synthesize research findings to draw conclusions that are both reliable and replicable. The techniques involved in the PRISMA method include identifying relevant studies, selecting studies according to predefined eligibility criteria, assessing the quality of the studies, and systematically synthesizing the findings (Page et al., 2021).

This method's value in conducting rigorous and transparent systematic reviews, irrespective of the research domain. By adhering to the PRISMA guidelines, researchers can produce systematic reviews that are not only methodologically sound but also of great value to the wider research community.

**2.3.2. Systematic Literature Review - PRISMA Definitions**

Based on this theoretical foundation previously presented in this study, we are able to identify the important terms that were used in the search query created to locate the scientific articles that are pertinent to the research. The goal is to have a thorough comprehension of the current advancements in using AI in the PMO field.

The study Systematic Literature Review aims to address the following questions:

<b>SLRQ1</b>	What kind of AI techniques are currently useful in the PMO field?
<b>SLRQ2</b>	What are the most common PMO functions addressed by AI?
<b>SLRQ3</b>	What are the common challenges and barriers to AI adoption in PMOs?

Table 1 - Systematic Literature Review Questions

The Systematic Literature Review was conducted on the selected scientific information resource databases:

<b>Resource Database</b>	<b>Resource URL</b>
<b>Scopus</b>	<a href="https://www.scopus.com/home.uri">https://www.scopus.com/home.uri</a>
<b>Web of Science</b>	<a href="https://www.webofknowledge.com/">https://www.webofknowledge.com/</a>

Table 2 - Systematic Literature Review Databases

Following the PRISMA standards, the most relevant research in this area has been considered to address these issues. The search was performed with a meticulously selected collection of terms that are considered highly relevant, as determined by the examination of the theoretical framework. As most of the articles are written in the English language, exclusively English keywords were used. The searched keywords are:

Keywords	PMO	Artificial Intelligence
	Project Management Office	Artificial Intelligence
	Project Portfolio Management	Machine learning
	Project Governance	Predictive Analytics
	PMO	Artificial Neural Networks
		Natural Language Processing

Table 3 - Systematic Literature Review Keywords

The last step of the PRISMA technique before starting the execution of the systematic literature review, involves establishing specific criteria for inclusion and exclusion, which will be used to filter the article's search results.

The study was only interested in contemporary scientific papers since this field of study has progressed rapidly in the last few years. Therefore, only the most recent publications can guarantee current and pertinent information. To do this, one must apply a filter that displays only papers published between 2020 and 2024. The objective is to gather precise information on the latest advancements in the use of AI in the PMO field.

Inclusion Criteria	Exclusion Criteria
Any scientific article showing evidence of AI utilization in PMO	Papers focusing on PMO but without focusing on AI techniques utilization
The paper must be a peer-reviewed conference or journal paper written in English.	Articles not in English and duplicate papers
	Articles published before 2020
The paper is published between 2020 and 2024	Non-academic or non-scientific papers
	Papers with titles outside the scope of this work

Table 4 - Systematic Literature Review inclusion and exclusion criteria

### **2.3.3. Systematic Literature Review - PRISMA Execution**

This Systematic Literature Review was conducted in September 2024. It was constructed a customized search query to ensure that the PRISMA results only return material that is relevant to this study's subjects. This search query includes the previously mentioned keywords and aims to locate them inside the abstracts, titles, or article's keywords and other academic papers.

The search query employed was: ("Project Management Office" OR "Project Portfolio Management" OR "Project Governance" OR "PMO") AND ("Artificial Intelligence" OR "Machine learning" OR "Predictive Analytics" OR "Artificial Neural Networks" OR "Natural Language Processing").

The identification phase initiates inputting the search query into 2 pre-selected database websites, we obtain a collection of articles recognized by a database search. The search returns a total of 2221 articles (2182 articles from Scopus and 39 articles from Web of Science).

Upon transitioning to the screening phase, the first step is eliminating any duplicate entries of both databases, when 18 items have been excluded, resulting in 2203 entries that went to the second stage of the screening process.

During this second stage of the screening process, we apply the inclusion and exclusion criteria. We excluded papers published before 2020 (85 articles), articles not written in English (31 articles), articles not in PDF format or inaccessible articles (336 articles), and any other exclusion criteria that were specified as papers with titles outside the scope or non-academic/-scientific papers (1015 articles). Consequently, 1467 articles were excluded, with the remaining 736 articles for the eligibility phase.

During the eligibility phase, the abstracts of articles were subjected to deeper analysis, and those that lacked a direct connection to the research were discarded. Articles focused on a single specific project management area and not minimally related to AI techniques have been removed as well (698 articles), leaving a total of 38 articles.

These articles demonstrate the utilization of several AI techniques that can be used in several PMO functions and address the topics of the research questions. This process is represented in the following workflow:

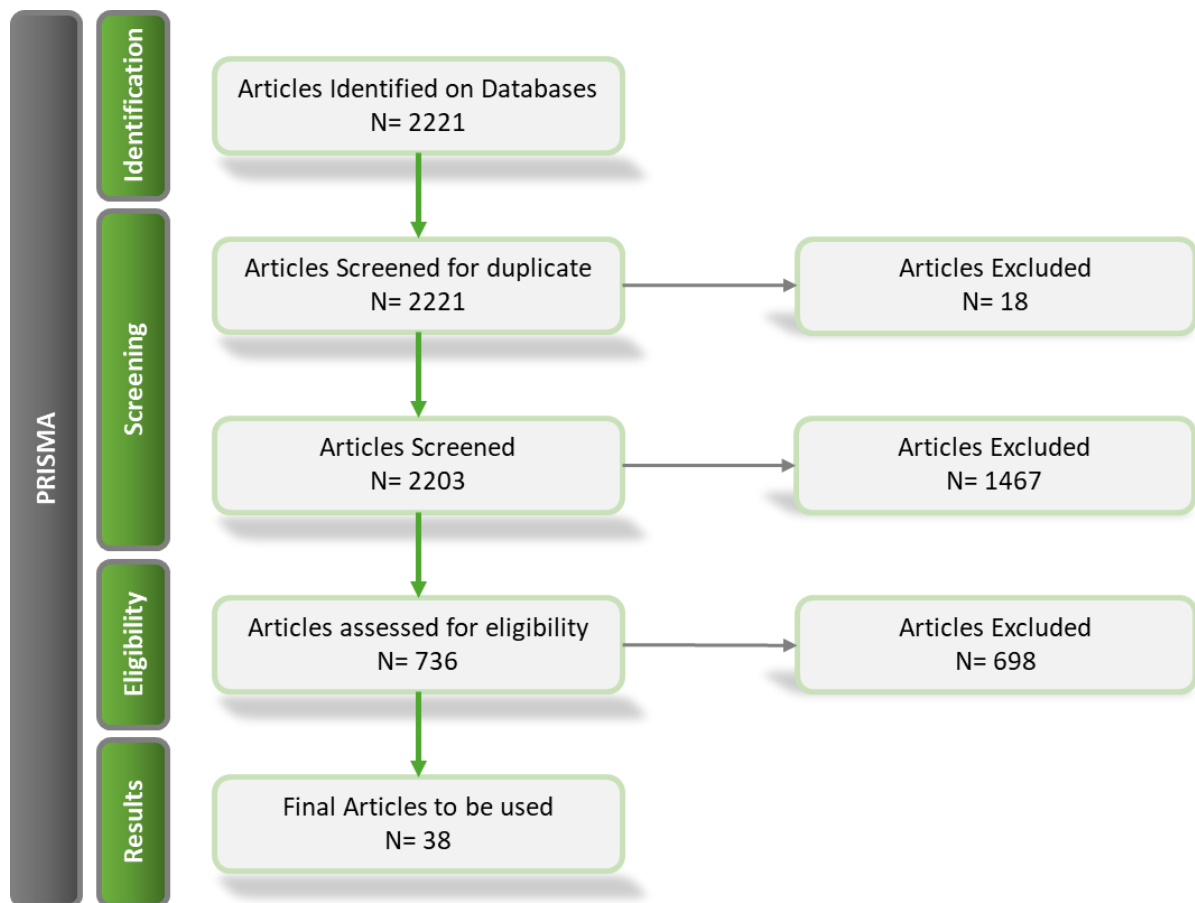


Figure 1 – PRISMA Workflow

As a result of this PRISMA research, we have the articles listed in the following table:

#	Authors	Article
1	(Abbing & Linssen, 2023)	Requirements for a Decision Support System for Managing Complexity of Multidimensional IT Project Assessments in the Context of IT Portfolio Management
2	(Agbese et al., 2023)	Implementing AI Ethics: Making Sense of the Ethical Requirements
3	(Albogami et al., 2021)	A new hybrid ahp and dempster—Shafer theory of evidence method for project risk assessment problem
4	(Bang et al., 2022)	Application of machine learning to limited datasets: prediction of project success
5	(Barrocas et al., 2023)	Exploring Data Analysis and Visualization Techniques for Project Tracking: Insights from the ITC
6	(Bilgin et al., 2022)	A Decision Support System for Project Portfolio Management in Construction Companies

7	(Boiko et al., 2024)	Intelligent project portfolio development of IT companies
8	(Bushuyeva et al., 2024)	"Clip" thinking as the tool of Agile project management in an artificial intelligence environment
9	(David & Gelbard, 2024)	Using sentiment analysis to assess PMBOK knowledge areas' compatibility with agile methodology
10	(Dremel et al., 2020)	Management of analytics-as-a-service - results from an action design research project
11	(Duff et al., 2024)	A Model-Driven Framework to Support Portfolio Management Under Uncertainties
12	(Faraji, 2021)	Neuro-fuzzy system-based model for prediction of project performance in downstream sector of petroleum industry in Iran
13	(Fronte et al., 2022)	Importance-Performance Analysis in Project Portfolio Management Using an IOWA Operator
14	(Gil et al., 2021)	The application of artificial intelligence in project management research: A review
15	(Gobov & Huchenko, 2021)	Software requirements elicitation techniques selection method for the project scope management
16	(Harani et al., 2023)	Optimization Model PPM for Financial Goals with Machine Learning Literature Review
17	(Holzmann et al., 2022)	The Expectations of Project Managers from Artificial Intelligence: A Delphi Study
18	(Kanakaris et al., 2019)	Combining Machine Learning and Operations Research Methods to Advance the Project Management Practice
19	(Karrenbauer & Breitner, 2023)	Value-driven IT Project Portfolio Management: Process Model, Evaluation Framework, and Decision Support
20	(Makaula et al., 2021)	Impact of artificial intelligence in South African construction project management industry
21	(Maphosa & Maphosa, 2022)	Artificial Intelligence in Project Management Research: A Bibliometric Analysis
22	(Marchinares & Aguilar-Alonso, 2020)	Project portfolio management studies based on machine learning and critical success factors
23	(Marchinares & Rodriguez, 2021)	Online Solution Based on Machine Learning for IT Project Management in Software Factory Companies
24	(Miller, 2022)	Artificial Intelligence Project Success Factors—Beyond the Ethical Principles
25	(Mishra et al., 2022)	A Proposal for Research on the Application of AI/ML in ITPM: Intelligent Project Management

26	(Mitrovic et al., 2020)	Systems Thinking in Software Projects-an Artificial Neural Network Approach
27	(Morozov et al., 2019)	Investigation of Forecasting Methods of the State of Complex IT-Projects with the Use of Deep Learning Neural Networks
28	(Niederman, 2021)	Project management: openings for disruption from AI and advanced analytics
29	(Pappert & Kusanke, 2024)	Modern Project Portfolio Management– Analyzing the Potential of Artificial Intelligence
30	(Shafiabady et al., 2023)	Using Artificial Intelligence (AI) to predict organizational agility
31	(Taboada et al., 2023)	Artificial Intelligence Enabled Project Management: A Systematic Literature Review
32	(Tarawneh et al., 2024)	Innovating Project Management: AI Applications for Success Prediction and Resource Optimization
33	(Uddin et al., 2023)	Integrating machine learning and network analytics to model project cost, time and quality performance
34	(Urata et al., 2022)	Early-stage Project Outcome Prediction Considering Human Factors
35	(Wach & Chomiak-Orsa, 2022)	Determinants of the use of predictive models in the management of investment portfolios, on the example of KGHM Polska Miedz S.A.
36	(Wachnik, 2022)	Analysis of the use of artificial intelligence in the management of Industry 4.0 projects. the perspective of Polish industry
37	(Yehorchenkova & Yehorchenkov, 2021)	Modeling of project portfolio management process by cart algorithm
38	(Yehorchenkova et al., 2022)	Modeling of Project Portfolio Management Process in Banking

Table 5 – PRISMA Results

#### 2.3.4. Systematic Literature Review - PRISMA Results

After ending the research for the study, adhering to the PRISMA methodology detailed in the preceding section, the analysis of the results is conducted. This involves examining each included article to identify the main findings of each work and to address the systematic literature research questions.

## **SLRQ 1 - What kind of AI techniques are currently useful in the PMO field?**

The integration of AI into PMO operations is changing the way projects are managed, monitored, and optimized. AI techniques facilitate the automation of routine tasks, assist decision-making processes, and deliver predictive insights that increase project results. Diverse AI approaches have proven to be immensely beneficial in the PMO sector, applicable to resource allocation, risk management, project selection, performance monitoring, and others.

### Machine Learning

One of the most prominent AI techniques in the PMO field is ML. The ML concept consists of a training algorithm to recognize data patterns. The process begins with feeding the algorithm with a dataset, which includes known input and outcomes. The algorithm learns the relationships between these inputs and outputs during the training phase. Once trained, the model can then make predictions or decisions on new unseen data using the identified logical pattern.

ML methods, such as Support Vector Machines (SVM), Decision Trees (DT), and Artificial Neural Networks (ANN), have been considered essential for Project Portfolio Management (PPM) (Holzmann et al., 2022). These algorithms are trained using historical project data to anticipate project outcomes, such as success probability, cost overruns, risks, schedule delays, and generate real-time forecasts.

These predictive insights enable project managers to make data-informed decisions, reduce project failure probability, and enhance overall success rates. For example, in Yehorchenkova and Yehorchenkov (2021), a Decision Tree algorithm is used to model the PPM process, showing an impressive 99% accuracy in predicting project success.

Based on that we can say that the adoption of ML into PPM enables organizations to detect possible bottlenecks, improve resource allocation, and define project priorities. The study by Marchinares & Rodriguez (2021) presents an online ML solution for IT Project Management, aimed at automating data processing and identifying trends in extensive datasets for software factory companies.

### Natural Language Processing

Another AI technique applied in the PMO is Natural Language Processing (NLP). NLP is the method that allows machines to generate human language, understand, and interpret. Usually involving a few phases, these techniques are Text preparation (Cleaning and translating the text into an analyzable format), Feature extraction (Converting words into numerical representations), and modeling (Built algorithms to execute tasks like translation, sentiment analysis, or text generation).

In the PMO field, NLP can be employed to scrutinize extensive quantities of project documentation, including proposals, contracts, and reports, to extract essential information that facilitates decision-making. Project managers can employ NLP tools to automate the analysis of unstructured text, thereby discovering trends, hazards, and opportunities with greater efficiency. This functionality not only conserves time but also guarantees that critical ideas from large documents are not overlooked (Pappert & Kusanke, 2022).

NLP can improve project selection and prioritization by evaluating the wording of project proposals to assess their compatibility with organizational goals. Consequently, AI-driven NLP systems assist project managers in making assisted judgments on project selection, utilizing both qualitative and quantitative data.

### Optimization Algorithms

AI-driven optimization algorithms methods are algorithms built to solve specific issues and consider multiple and different scenarios and constraints. Some optimization algorithms methods as Particle Swarm Optimization (PSO) and Differential Evolution (DE) are frequently utilized to optimize project portfolios, enabling project managers to allocate resources more effectively and align projects with strategic goals (Holzmann et al., 2022).

These optimization algorithms can simultaneously assess many criteria—such as maximizing Return on Investment (ROI), minimizing risk, and assuring timely project completion—to propose the most effective project configurations. Utilizing AI to simulate various portfolio scenarios enables PMOs to enhance decision-making on project prioritization and optimal resource allocation to achieve strategic goals. After ending the research for the study, adhering to the PRISMA methodology detailed in the preceding section, the analysis of the results is conducted. This involves examining each included article to identify the main findings of each work and to address the systematic literature research questions.

All things considered, these AI techniques are changing PMO field management project portfolios, resource optimization, and outcome prediction. PMOs can greatly simplify their decision-making process, allocate resources better, and reduce risks by using ML, NLP, and optimization techniques. As AI develops, its adoption into PMO procedures will probably increase and provide even more sophisticated tools for handling complex project portfolios.

### **SLRQ 2 - What are the most common PMO functions addressed by AI?**

Key PMO functions including portfolio management, key performance indicators (KPI) tracking, resource allocation, and risk management are addressed by AI techniques. These tools simplify decision-making and let project portfolio managers concentrate on strategic activities while AI handles data-driven insights and process efficiencies. Based on PRISMA findings, the most often PMO tasks that can be handled by AI are:

## Portfolio Management

Portfolio Management is the most important function of a PMO. AI techniques can help evaluate and select the most appropriate projects from a portfolio, ensuring alignment with business goals. By simulating several project configurations and market situations, AI systems help managers prepare scenarios and so explore several possibilities. Optimization algorithms methods are commonly used in portfolio management to balance competing objectives like maximizing ROI and minimizing risk (Uddin et al., 2023). These systems analyze strategic relevance, budgetary restrictions, and resource constraints to enable PMOs to decide which projects to give top priority.

Furthermore, AI methods such as network analytics and ML can replicate intricate project dependencies, therefore enabling PMOs to forecast how project decisions would affect the whole portfolio. Fronte et al. (2022) propose a framework that integrates AI to assist in managing the uncertainties inherent in portfolio management. This method guarantees improved portfolio performance by allowing PMOs to react fast to evolving project requirements and outside events.

## KPIs Tracking and Predictive Analytics

Providing real-time data analytics and prediction insights, AI significantly contributes to performance monitoring. Performance monitoring in conventional PMO environments sometimes entails hand tracking of project milestones and KPIs. With AI, though, this function becomes automated and offers constant updates on project development and possible risks.

AI methods including predictive analytics and ML enable project managers to spot deviations from budget and timing expectations. In their study, Urata et al. (2022) utilize deep learning models to predict project outcomes early in the project lifecycle. Project managers with this predictive capacity can act early to reduce risks and guarantee project success.

Furthermore, real-time monitoring dashboards driven by AI provide project managers with a whole picture of project status, which enables them to make data-driven decisions enhancing project results. In the study of Marchinares & Rodriguez (2021), they emphasize the importance of AI-powered dashboards in managing IT project portfolios, especially in the face of large datasets. These instruments help PMOs to evaluate project performance constantly and modify their approach as necessary, hence improving agility and responsiveness.

## Resource Allocation and Optimization

The distribution of resources among several projects guarantees that the appropriate people and assets are ready at the appropriate moment to satisfy project deadlines and budgets, therefore serving one of the most important roles of a PMO.

AI-driven tools, particularly ML algorithms have automated resource allocation based on real-time data, so improving this process. For instance, Uddin et al. (2023) highlight how AI

techniques such as SVM and Random Forests are used to model resource requirements and optimize project performance. By enabling PMOs to forecast future resource needs and distribute them efficiently, these methods help to minimize bottlenecks and thereby enhance the general project results.

### Risk Management

Conventional risk-reducing strategies rely on subjective assessments and past data, which could lead to mistakes. On the other hand, AI presents a more data-driven means of spotting and reducing risks. Project-related documents are analyzed using methods including sentiment analysis and NLP, therefore identifying potential risks depending on language patterns and concerns raised by stakeholders.

Sentiment analysis is used in David & Gelbard's (2024) article to evaluate project documentation for fit between project management frameworks. Early identification of possible problems made possible by this AI-driven risk management ensures that project managers may solve them before they impact the results of the project.

Furthermore, optimization algorithms like PSO and DE are used to model risk scenarios, which give PMOs an understanding of the possible outcomes of different risk factors. AI enables project managers to create mitigating methods that lower general project risk by modeling various project outcomes and therefore helping them to plan for contingency (Uddin et al., 2023).

From resource allocation and portfolio management to KPIs tracking and risk management, AI has evolved into a vital tool for handling fundamental PMO tasks. By leveraging multiple AI techniques, AI enables PMOs to operate more efficiently, make data-driven decisions, and adapt to changing project requirements with agility. Their integration with PMO processes will only deepen as AI technologies develop, providing even more advanced options for handling challenging project portfolios.

### **SLRQ 3 - What are the common challenges and barriers to AI adoption in PMOs?**

Given these potential benefits, the implementation of AI technologies in PMOs is not without challenges. From data quality issues and resistance to change to integration complexity and ethical considerations, PMOs have various obstacles to effectively adopting AI into their activities. Supported by PRISMA studies and data, this study analyzes the most often occurring challenges to AI implementation in PMOs.

### Data Availability and Quality

The quality and availability of data determine mostly how effective AI is in PMOs. To train ML models and generate consistent predictions, AI algorithms need an enormous amount of

accurate, pertinent data. Data quality presents difficulties for many PMOs, though, including incomplete, inconsistent, or obsolete data. Bang et al. (2022) underline the challenges of using AI methods in sectors where fragmented or restricted datasets could be present. Under such circumstances, AI models could generate incorrect findings, leading to bad project decisions.

Additionally challenging to consolidate and guarantee consistent data standards is PMO data collecting, which is sometimes dispersed and segregated across several departments. AI technologies cannot provide the insights required to enhance project management without standardized, high-quality data.

### AI Integration's Complexity

The difficulty of embedding AI technology into current project management systems adds even another major obstacle to AI adoption in PMOs. Often not suited for the dynamic, data-driven character of AI systems are conventional project management approaches such as those described in the PMBOK framework. Particularly in settings with great degrees of unpredictability and complexity, Duff et al. (2024) paper emphasizes the challenges of including AI in portfolio management.

Using AI systems calls for not only technical support but also organizational process adjustments that can be expensive and time-consuming. Furthermore, impeding the effective acceptance of AI in PMOs is the dearth of qualified individuals knowledgeable in both AI technologies and project management approaches. AI systems may find it difficult to fully perform in optimizing project management operations without appropriate integration.

### Resistance to Change and Organizational Culture

Many companies have a common obstacle in resistance to change; PMOs are no exception. Project managers and other stakeholders used to conventional approaches may be skeptical about the inclusion of AI into project management systems. Fears about job displacement, a lack of knowledge of AI technologies, or worries about the reliability and transparency of AI-driven choices could all contribute to this reluctance.

According to David & Gelbard (2024), sentiment analysis can help project management stakeholders evaluate their opinions about AI and other innovative technologies. Understanding these attitudes is crucial for dealing with resistance and fostering a culture that is open to technological innovations. Organizations that neglect to remove cultural barriers could find it challenging to have general AI adoption within their PMOs.

### Ethical and Transparency Concerns

Particularly concerning PMO decision-making, ethical issues are progressively acting as a barrier to AI acceptance. Concerns regarding justice, responsibility, and accountability are growing as AI technologies find an increasing presence in project management systems. Agbese et al. (2023) examine the ethical ramifications of AI use in project management,

especially risk management and resource allocation. They stress the importance of unambiguous ethical rules to make sure that choices motivated by AI complement business goals and do not support discrimination or bias.

Moreover, generally considered a "black box," the opacity of AI systems seriously compromises transparency. If project managers and stakeholders cannot fully comprehend or justify the logic behind AI-driven recommendations, they could be reluctant to embrace AI solutions. Lack of transparency in AI systems may reduce confidence in them, therefore restricting their application in important decision-making procedures.

### Cost and Resource Constraints

Another frequent obstacle for PMOs is the financial investment needed to embrace AI technologies. Using AI tools sometimes requires large upfront expenses including staff training, hardware and software acquisition, and integration of AI with current project management tools. Many companies find these expenses excessive, particularly for smaller PMOs who might lack the means to invest in modern technologies.

In addition, AI platforms need constant maintenance and updates to be effective, especially as fresh data emerges or project conditions change. Dremel et al. (2024) go over the difficulties of running analytics and AI tools in large organizations. The paper emphasizes the need for socio-technical alignment and continuous resource allocation to guarantee the success of AI initiatives.

Adopting and sustaining AI technology may prove more expensive than the possible advantages for PMOs with limited budgets and resources, therefore making it challenging to justify the investment.

### Skill Gaps and Workforce Readiness

Urata et al. (2022) show the need to recognize human factors while using AI in project management. Effective use of AI in PMOs demands a staff skilled in project management as well as in AI technologies. Many companies, meanwhile, have notable shortages of skills in both sectors. The adoption of AI is much hampered by a lack of qualified experts able to close the gap between AI and project management approaches.

Both time-consuming and expensive are training current personnel or recruiting new ones with the required AI knowledge. Companies who neglect to invest in the AI capacity of their team members could find it difficult to properly use AI technologies, producing less-than-ideal results.

Including AI in PMO activities presents several challenges. Significant obstacles to the effective application of AI technology in project management are data quality problems, integration complexity, reluctance to change, ethical questions, cost restrictions, and talent gaps. Organizations that want to overcome these obstacles must adopt a strategic approach to AI

adoption, investing in data management, workforce training, and ethical frameworks to guarantee that AI-driven decisions line with business goals and values.

### 3. METHODOLOGY

Design Science Research (DSR) is generally seen as one of the most appropriate research approaches for creating artifacts, especially within disciplines such as information systems, computer science, and engineering. DSR's systematic approach to the creation and evaluation of artifacts is one the best to address complex problems (Peppers et al., 2007).

DSR is very efficient at mixing practical applicability with academic rigor. It calls for the created artifact to be both practical and relevant in use as well as based on existing theoretical understanding. Gregor and Hevner (2013) underline that the combination makes DSR quite appropriate for studies aiming at both theory and practice contribution.

The primary purpose of DSR is the design and creation of artifacts. DSR's artifacts are not limited to physical objects but rather include theoretical constructions of value and usefulness. Hevner et al. (2004) contend that objects are things designed to address certain problems; a framework satisfies this function by providing a methodical methodology for understanding and handling complex issues.

A framework constitutes an artifact since it was intentionally created to serve practical needs and address research. It serves as a tool that organizes knowledge and guides decision-making processes. Thus, by using DSR, researchers guarantee that the framework is methodically created, empirically proved, and theoretically grounded, so making it both innovative and practical.

#### 3.1. DESIGN SCIENCE RESEARCH (DSR)

As Peppers et al. (2007) conceptualize, DSR is a research methodology that provides a structured approach to creating and evaluating artifacts built to handle real issues or improve existing solutions. Peppers et al. (2007) provide the following framework for DSR based on their six-step process approach that directs studies in progressively building and assessing their artifacts.

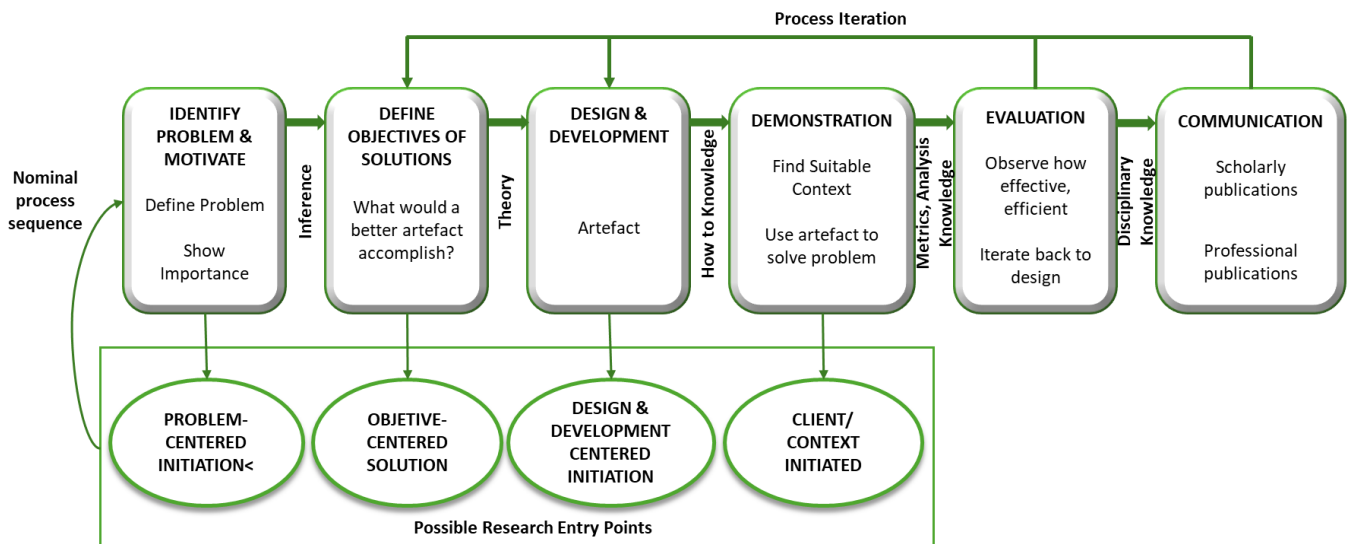


Figure 2 - DSR Process Model (adapted from Peffers et al., 2007)

The framework processes are:

### Problem Identification and Motivation

The first process in the DSR approach is clearly identifying the research problem and demonstrating its significance. Researchers must explain why the issue must be resolved and what drives the research. This means understanding current solutions limitations or knowledge gaps. Establishing the relevance of the problem guarantees that the created artifact will have a significant influence on the field or practice.

### Define the Objectives of a Solution

Researchers have to specify what a good solution might look like once they have found the issue. This involves establishing the criteria the artifact must reach, maybe regarding certain performance standards or desired results. Derived from the problem analysis, the goals should indicate how the artifact will either solve the found issues or create value.

### Design and Development

This process consists of the real construction of the artifact, maybe a model, a framework, a method, or a software. The goals specified in the previous step guide the researchers' design of the artifact. Often to produce a unique or improved item, the design process draws on already-existing theories, models, or technology. Documenting the design choices and underlying ideas guiding the development is essential.

### Demonstration

Once the artifact is built, it must be shown in a pertinent setting to explain how it addresses the problem. This may involve doing experiments, simulating its use, or putting the artifact in a real-world environment. The demonstration should offer proof that the artifact can accomplish the specified results and operate as expected.

### Evaluation

This stage is a comprehensive assessment of the artifact to determine if it offers value and satisfies the objectives set. Among the several approaches used in the evaluation process are empirical testing, case studies, simulations, or expert reviews. Often referencing current solutions or benchmarks, researchers evaluate the performance, utility, and efficiency of the artifact. If the artifact does not meet the objectives, researchers may need to refine or redesign it.

### Communication

The last process of the DSR framework involves communicating the research findings to both communities: academic and practitioner. This covers presenting the issue, the artifact, the design process, the evaluation findings, and the improvements to knowledge. Good communication guarantees that others may comprehend, criticize, and maybe use the artifact in their own contexts.

Finally, we can see that Peffers et al. (2007) DSR proposal offers researchers a methodical way to create and assess artifacts with accuracy and relevance. It underlines iterative feedback and improvement to guarantee that the artifact develops to become a validated and powerful solution. Following this method ensures that the produced artifacts are both theoretically based and practically valuable, therefore supporting both academic research and functional problem-solving.

## **3.2. RESEARCH STRATEGY**

This research strategy employs the DSR framework as delineated by Peffers et al. (2007), encompassing all their processes: the identification of a relevant problem, defining the objectives to be accomplished to develop a satisfactory solution to that problem, design, and development of an appropriate artifact that satisfies these objectives, perform the artifact demonstration, the evaluation of this artifact to verify its usability and viability and the artifact communication by publishing the research results.

**Problem Identification and Motivation:** as discussed in Section 1.1. PMOs provide a crucial role in organizations, functioning as centralized entities for project coordination and alignment with strategic goals. They optimize procedures, promote uniformity, and offer essential

guidance, assisting organizations in managing the complexity of project management. AI's capacity to analyze vast datasets, predict results, and automate repetitive processes presents considerable promise for improving PMO efficacy by enhancing efficiency, lowering expenses, and facilitating data-driven insights. Given these dynamics, a crucial research gap exists to comprehend how AI can improve PMO effectiveness, promote efficiency, and facilitate decision-making while preserving the human element.

Define the Objectives: The objectives of this study are described in section 1.2 and cover a comprehensive examination of PMO types, processes, methodologies, as well as AI concepts and application areas. This should convert into the main objective of designing a framework that PMOs may utilize to optimize their main activities by applying AI tools.

Design and Development: At this phase, the artifact will be constructed. A key need for developing an effective and efficient assessment tool is a comprehensive understanding of the intended solution outcomes.

Consequently, a comprehensive analysis of the latest research on PMO and AI is essential. Thus, the literature review detailed in Chapter 2 was structured in two phases. In the first step, an initial review will be conducted to identify the relevant concepts of PMO and AI (sections 2.1 and 2.2). In the second step, an SLR (PRISMA) was performed (section 2.3). This summarizes the current understanding in this scientific area and on common assessment models, as well as the intersection of both in scientific literature. This research will be qualitative, as it involves gathering characteristics rather than testing hypotheses.

Applying a systematic search strategy guarantees a comprehensive examination of relevant material, hence augmenting the credibility and scientific merit of the work undertaken to develop the proposed framework.

Demonstration: A theoretical example is shown to illustrate the validity and applicability of the created framework, detailing the anticipated execution of the model's steps. This work does not encompass a true case study, it is not practicable to demonstrate the thorough development and use of a maturity model, which requires a detailed adoption to a specific company setting and strategy. Consequently, only examples are selected to illustrate the application of the framework within a hypothetical use case to assess and verify its functionality.

Evaluation: Following preliminary testing in a hypothetical scenario, the artifact will be scrutinized through discussions with specialists from pertinent scientific and practical domains, including project managers and PMOs. This assessment is crucial to verify that the research outcomes effectively met the intended objectives and can facilitate necessary enhancements while identifying limits. Utilizing interviews as an evaluative method is a prevalent approach to evaluate the artifact's design and gather input on its efficiency and effectiveness. This will enhance the validation of the artifact about its accuracy and usability. Should it be practicable within the scope of this study, insights from the interviews will be

utilized to produce a modified iteration of the artifact. The completed artifact will meet all requisite criteria for testing in actual companies, contributing to both practice and society in general. However, as mentioned previously, a real case application of the framework remains outside the scope of this work.

Communication: Ultimately, the findings of this research and its contributions will be disseminated to the public through publication and presentation to an academic committee for assessment. Disseminating the research to other researchers is essential to realize the theoretical contribution aimed for in this work and encourages others to build upon the findings reported in this study.

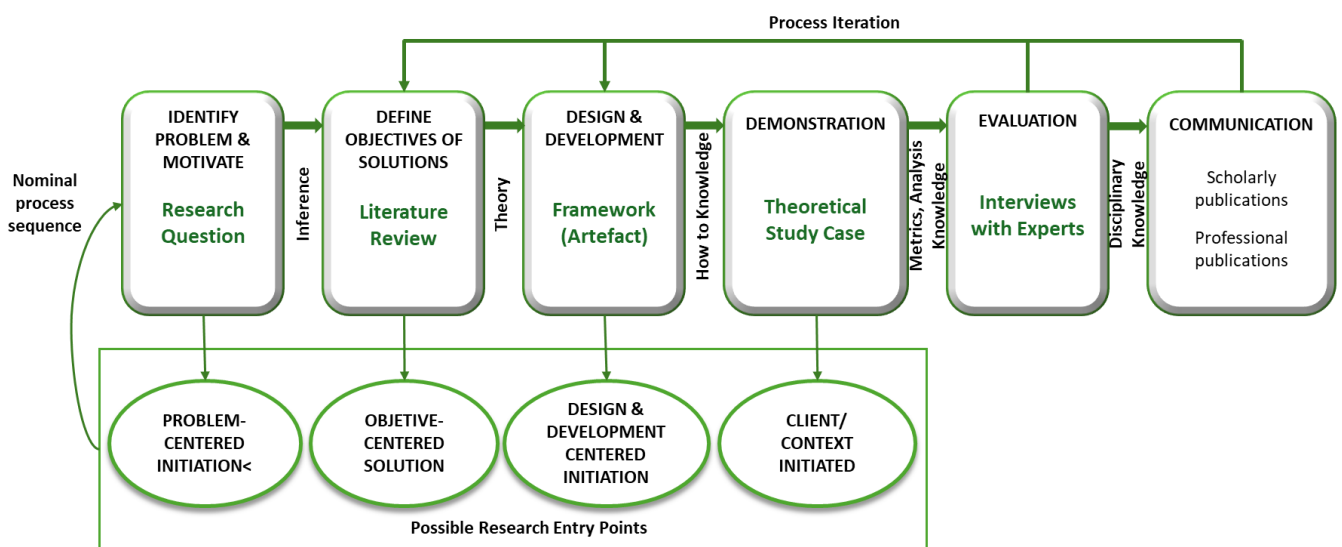


Figure 3 - DSR Research Strategy (adapted from Peffers et al., 2007)

## 4. FRAMEWORK FOR AN EFFICIENT USE OF AI IN PMO

As a result of the Literature Review, we can see that the increasing complexity and dynamic nature of project environments have driven PMOs to explore innovative tools to enhance efficiency and achieve organizational strategic goals. AI has emerged as a disruptive force in project management, providing tools and technology for automating processes, predicting outcomes, improving decision-making, and optimizing resource allocation. That gives us back to our research question, "How and where AI can help the different types of PMOs used in companies to improve their work and results?"

This can be answered by identifying how PMOs can use AI applications to address long-standing difficulties such as project performance monitoring, risk management, strategic goal alignment, and stakeholder engagement. The proposed framework is intended to give PMOs a practical roadmap on how to incorporate AI into their operations.

### 4.1. ASSUMPTIONS

This chapter describes the key assumptions that support the development of a framework that connects AI applications with PMO functions. These assumptions are based on the literature review and reflect AI's ability to transform PMO operations. By linking AI technology with essential PMO duties, the framework aims to give a road map for efficiently employing AI in PMO operations.

- Project management organizational maturity. The successful integration of AI into PMO activities is determined by the organization's project management maturity. Hobbs and Aubry (2007) said that more mature PMOs adopt more sophisticated tools and methodologies. AI solutions must be scalable and adaptable to satisfy the diverse maturity stages of businesses (Uddin et al., 2023). This maturity can facilitate AI application implementation and provide the maximum historical and accurate data set available, which will permit AI applications to reach a good precision level sooner.
- PMOs are the core of the project management organizational area and serve as centralized entities in charge of aligning projects with strategic goals, managing resources, and assuring standardization of project management practices. Hobbs and Aubry (2007) underline the importance of PMOs in project coordination across organizations. AI's ability to task automation and provide insights improves the PMO's ability to efficiently manage complex portfolios (Fronte et al., 2022).

- AI provides data-driven decision-making support. PMOs' efficacy is determined by their capacity to make informed decisions using reliable and up-to-date information. AI solutions, like predictive analytics and real-time monitoring, enable PMOs to foresee project outcomes, analyze risks, and effectively allocate resources (Bang et al., 2022; Uddin et al., 2023). This changes portfolio decision-making from reactive to proactive, ensuring better alignment with organizational goals.
- Automation improves PMO activities efficiency. Frequent PMO tasks like resource allocation, KPI tracking, and performance reporting are time-consuming and susceptible to errors when handled manually. AI-powered automation systems reduce manual workloads, allowing PMOs to focus on other tasks. As well, automated dashboards and resource allocation technologies, for example, have shown considerable improvements in project efficiency (Fronte et al., 2022).
- Strategic alignment is a PMO's key function. They must guarantee that project portfolios contribute to the organization's strategic objectives. AI solutions, such as multi-objective optimization and project prioritization algorithms, help PMOs find projects that maximize ROI while mitigating risks (Hobbs & Aubry, 2007; Fronte et al., 2022). This strategic alignment aims to ensure that organization resources are focused on the most high-value projects.
- Active risk management is essential. Risk management is a basic PMO function, but most common approaches tend to be subjective and/or reactive. AI applications, that use predictive models and simulations, combining real-time data, allow PMOs to identify risks early in the project lifecycle and act more effectively on risk mitigation plans (Urata et al., 2022).
- Stakeholder engagement is critical to project success. Effective communication and collaboration with stakeholders are essential to ensure project deliverable expectation alignment. According to Yehorchenkova & Yehorchenkov (2021), PMOs can use AI techniques like sentiment analysis and NLP to evaluate feedback, identify concerns, and adapt communication strategies. These applications ensure that stakeholders and team members are kept properly informed throughout the project's lifecycle.
- Knowledge management enables continuous improvement. Gathering lessons learned and disseminating best practices are essential for refining and improving PMO processes and methodology. A knowledge management application based on AI can examine technologies and past project data to discover patterns,

suggest process improvements, and load repositories with actionable insights (Bang et al., 2022; Hobbs & Aubry, 2007).

## 4.2. FRAMEWORK

This framework establishes a structured approach for utilizing AI in PMO by connecting the fundamental functions with AI applications. The PMO functions, as defined by Hobbs and Aubry (2007), represent the key tasks that PMOs must perform to drive project success and guarantee organizational alignment. AI applications improve data-driven insights, automate repetitive operations, and support strategic planning by serving as facilitators.

By applying AI to PMO processes, the framework addresses common issues such as inefficiencies in project monitoring and management, difficulties in aligning portfolios with strategic goals, and stakeholder engagement constraints. Moreover, the framework allows PMOs to react dynamically to changes in project portfolios, enabling increased resilience and agility.

Grounded in the work of Hobbs and Aubry (2007), who defined the key roles and responsibilities of PMOs, the PMO functions incorporated in this framework focus on operational, tactical, and strategic aspects, these functions reflect the various ways that PMOs support organizational success:

- Monitoring and Controlling Project Performance: This function guarantees that projects comply with scope, quality standards, budgets, and schedules. PMOs are responsible for tracking key performance indicators (KPIs) and addressing deviations as they occur.
- Development of Project Management Methodologies: It is essential to standardize and refine project management methods to ensure project portfolio consistency and efficiency. PMOs establish methodologies that are consistent with organizational goals and can be customized to meet the needs of individual projects.
- Strategic Alignment: PMOs are responsible for guaranteeing that initiatives and portfolios are following the organization's goals. This includes identifying and prioritizing high-value initiatives and assessing risks and benefits.
- Portfolio Management: PMOs optimize balance competing demands and resource allocation across multiple projects. This involves assessing project performance and adapting portfolios to maximize strategic value.
- Project Planning: Effective planning is required to establish realistic schedules, resource requirements, and budgets. PMOs serve an important role in

developing detailed project plans that correspond with organizational objectives.

- Resource Management: Allocating and optimizing resources across projects is crucial for maintaining efficiency and avoiding bottlenecks. PMOs must balance resource needs while avoiding conflicts and inefficiencies.
- Risk Management: PMOs identify, evaluate, and mitigate risks to minimize uncertainties that could affect project outcomes. Effective risk management made projects more resilient to potential disturbances.
- Knowledge Management: Capturing lessons learned and sharing best practices is critical for continual progress. PMOs help to create knowledge repositories, which increase organizational learning.
- Project Governance: Implementing governance systems improves accountability, transparency, and adherence to organizational policies. PMOs implement governance standards to ensure project success.
- Stakeholder Engagement: Maintaining open communication with stakeholders and managing their expectations is critical to project adoption and success.
- Training and Development: PMOs identify skill gaps and conduct training programs to improve team capabilities, ensuring that project teams are ready to handle project challenges.

The AI applications embedded into this framework reflect technology that directly addresses PMO concerns, according to the Literature review. These applications take advantage of data analytics, automation, ML, and other AI techniques to improve PMO activities.

- Predictive Analytics: Forecasts project outcomes including delays, cost overruns, and lack of resources. Predictive analytics analyzes historical and real-time data and allows PMOs to make proactive adjustments and mitigate risks before they escalate Bang et al. (2022) show how ML models can be used to predict project success and detect the earliest signs of project failure. This capability enables PMOs to address issues proactively rather than reactively.
- Real-time Project Monitoring: AI-powered dashboards deliver ongoing updates on project performance metrics such as schedules, budgets, and resource use. Real-time monitoring improves PMOs' capacity to detect and correct irregularities promptly. Uddin et al. (2023) underline the necessity of real-time tracking KPIs for maintaining project agility and enabling immediate responses to emerging issues.
- AI Document Analysis: NLP collects information from project documents, including risk factors, stakeholder concerns, and knowledge repositories.

Sentiment analysis assesses stakeholder perception to help drive communication strategies and increase stakeholder engagement. In their studies, Yehorchenkova and Yehorchenkov (2021) explain how sentiment analysis methods can evaluate stakeholder satisfaction and highlight areas of concern in communication records. Similarly, NLP programs have been shown to handle vast amounts of project documentation to extract critical insights while decreasing manual effort.

- Project Selection and Prioritization: AI-driven algorithms enhance project selection by evaluating proposals based on strategic alignment, expected ROI, and risk profiles. This ensures that resources are directed toward high-value projects that are consistent with organizational goals. Fronte et al. (2022) discuss the use of multi-objective optimization models for project selection, emphasizing their capacity to balance competing criteria like cost, ROI, and risk. PMOs can use these tools to guarantee that resources are allocated to high-impact initiatives.
- Portfolio and Project Simulation: Scenario planning tools model multiple project and portfolio scenarios to support PMOs in balancing competing objectives, mitigating risks, and maximizing strategic value. Portfolio optimization employs AI to simulate various configurations and determine the best approach to meeting organizational goals. Uddin et al. (2023) demonstrate how scenario planning tools enable PMOs to examine "what-if" scenarios, ensuring portfolios remain robust under varying conditions. These methods are particularly useful for controlling resource needs and balancing risks across portfolios.
- AI-Enhanced Decision Support: By evaluating vast datasets, AI generates actionable recommendations for project planning, resource allocation, and portfolio adjustments. This enhances the strategic decision-making capacity of PMOs. Agbese et al. (2023) point out the relevance of AI decision assistance in guaranteeing transparency, accountability, and alignment with organizational standards.

Based on this concept of PMO function and AI application and grounded on the literature review the following framework was proposed:

		AI Application					
		Predictive Analytics	Real-Time Project Monitoring	AI Document Analysis	Project Selection and Prioritization	Portfolio and Project Simulation	AI-Enhanced Decision Support
PMO Function	Monitoring and Controlling Project Performance	a)	b)	c)		d)	e)
	Development Project Management Methodologies	f)		g)	h)	i)	j)
	Strategic Alignment	k)	b) l)	m)	n)	o)	
	Portfolio Management	p)	b) l)	m)	q)	q)	r)
	Project Planning	s)	b)	t)	u)	v)	w)
	Resource Management	x)	b)	y)	z)		
	Risk Management	aa)	bb)		cc)	dd)	r)
	Knowledge Management	ee)		ff)			
	Project Governance	gg)	hh)	ii)	jj)		kk)
	Stakeholder Engagement		ll)	mm)			

Table 6 – Proposed Framework

a) Predictive analytics can forecast potential KPI deviations, such as delays, cost overruns, and underperformance, enabling early interventions.

b) Tracks performance metrics like Progress, timelines, budgets, and resource utilization, alerting managers to deviations.

c) Extracts performance insights from reports and updates, enabling better project monitoring and Control.

d) Simulates different project execution paths, helping identify optimal performance strategies.

e) Offers real-time recommendations for corrective actions when deviations occur.

f) Predictive analytics can identify gaps in current methodologies by analyzing historical success and failure rates, helping refine methodologies.

- g) Analyze project documentation to evaluate compatibility with existing methodologies.
- h) Recommends methodologies tailored to selected projects by analyzing past project success factors and aligning them with objectives.
- i) Adjusts methodologies dynamically based on simulated scenarios.
- j) Recommends optimal methodologies based on project type, team composition, and past success rates.
- k) Predictive analytics can assess how ongoing projects align with long-term organizational goals, predicting the impact of projects on strategic outcomes. And avoiding overinvestment in low-priority areas.
- l) Monitors project progress to ensure alignment with strategic goals and portfolio.
- m) Review strategic documents to ensure projects and Portfolios align with organizational goals.
- n) Optimizes project prioritization to ensure they directly support strategic goals and long-term organizational value.
- o) Evaluate multiple portfolio scenarios to ensure better alignment with strategic objectives under different conditions.
- p) Predicts portfolio trends, such as financial performance and resource demand, ensuring portfolios remain balanced and optimized.
- q) Optimize and balance projects' competing demands in the portfolio by ranking projects based on their strategic alignment, expected ROI, and risk profiles.
- r) Recommends portfolio adjustments to maximize strategic value and minimize risks.
- s) Forecasts project success probabilities and resource requirements, helping refine project plans, costs, resources, timelines, and deliverables.
- t) Analyze planning documents to identify inconsistencies and potential improvements.
- u) Refines planning for high-priority projects by allocating resources and setting realistic timelines.
- v) Evaluate planning scenarios to identify the most efficient and effective approaches for project execution.
- w) Propose recommendations for project plans, including resource allocation, timeline adjustments, and risk mitigations.

- x) Predictive analytics can be used to assign resources to tasks based on availability, skills, and workload, minimizing conflicts and inefficiencies. as well as forecasting potential bottlenecks in resource availability and workload imbalances allocation.
- y) Identifies resource needs and allocation gaps from project documentation.
- z) Assesses resource needs during the selection process, ensuring only feasible projects are prioritized.
- aa) Predict patterns of recurring risks in similar projects, allowing proactive mitigation measures.
- bb) Tracks risk indicators in real-time, allowing for proactive and immediate mitigation or response action.
- cc) Evaluate potential project risk and use this for prioritization considering risk-adjusted ROI.
- dd) Models risk scenarios to prepare mitigation/response strategies to reduce project uncertainties.
- ee) Predictive analytics can Identify patterns from past projects to recommend best practices and lessons learned for knowledge repositories.
- ff) Processes lessons learned and best practice documents to populate knowledge repositories.
- gg) Highlights potential gaps in governance processes that could lead to project mismanagement.
- hh) Monitors compliance with governance policies dynamically, ensuring adherence to processes.
- ii) Validate documentation governance requirements to ensure compliance.
- jj) Ensures projects meet governance criteria, before selection.
- kk) Support that Governance rules will be considered in the Decision
- ll) Allows to engage stakeholders dynamically, enabling real-time communication and feedback.
- mm) Analyzes communication records to extract insights into stakeholder concerns.
- nn) Identifies skill gaps and predicts future training needs based on project trends.
- oo) Tracks training effectiveness by monitoring performance improvements in trained personnel.
- pp) Analyze training materials and feedback to identify improvement opportunities.

### 4.3. DEMONSTRATION

To illustrate the use of the presented framework, a fictional case is described. Due to the fictitious nature of this use case, only a few examples are shown and are not intended to represent complete and valid inputs or outputs. Therefore, also not each step of the framework is documented at the level of detail it would be required for a real application of the framework.

However, in line with the DSR methodology, this fictional case study should be considered as a first iteration to test the applicability of the framework and can then be tested in future work as part of a real-world case study. Furthermore, the expert interviews to be conducted in the next step should also confirm the validity of the framework in its entirety.

#### 4.3.1. Study Case: IT Corporation

An IT Corporation that is a global leader in software development and IT services, managing a vast portfolio of projects ranging from custom software solutions to large-scale digital transformations. As the tech industry evolves rapidly, this corporation faces intense competition and increasing demands for innovative solutions. To maintain its market position, the company invests heavily in research and development, continuously expanding its service offerings.

The company has a mature PMO, that was implemented and running over more than 10 years. The PMO plays a crucial role in ensuring projects align with strategic objectives, resource allocation, and projects delivered on time and within budget.

Despite its robust structure, this IT Corporation's PMO faces several challenges:

- **Inefficient Resource Allocation:** Difficulty in optimizing resource utilization across multiple concurrent projects, results in bottlenecks and underutilization.
- **Reactive Risk Management:** Risks are often identified late, causing delays and cost overruns.
- **Lack of Strategic Alignment:** It is tough to ensure that all projects are aligned with rapidly evolving organizational goals in a high-demand market.
- **Ineffective Knowledge Management:** Lessons learned are not systematically captured or utilized, leading to repeated mistakes.
- **Stakeholder Engagement Issues:** Communication gaps with stakeholders result in misaligned expectations and reduced client satisfaction.

The PMO recognizes that integrating AI into its operations will enhance their effectiveness and results. For that, they decided to integrate AI applications according to the proposed framework. The goals are:

- Optimize Resource Allocation
- Shift to Proactive Risk Management
- Ensure a better Strategic Alignment of Projects
- Improve Knowledge Management Practices
- Enhance Stakeholder Engagement

The implementation process involves mapping AI applications to PMO functions, aligning with the proposed framework, and systematically integrating these technologies into existing processes.

Below is a detailed mapping of how specific AI applications are related to each PMO function aim to solve the presented PMOs challenges:

Monitoring and Controlling Project Performance: Implementation of Predictive Analytics (a), Real-Time Project Monitoring (b), and AI Document Analysis (c) applications. This aim is to enhance PMO's ability to detect and address performance issues proactively, leading to improved project outcomes as it allows timely interventions, reducing delays and cost overruns.

- Predictive Analytics (a): Implement an AI tool that analyzes historical project data to forecast potential schedule delays and budget overruns. For example, the AI predicts that Project A is likely to exceed its budget by 15% due to underestimated resource needs. This allows the PMO to adjust the project plan, reallocate resources, and communicate new timelines to stakeholders.
- Real-Time Project Monitoring (b): Deploy dashboards powered by AI that provide real-time updates on project KPIs, alerting managers to deviations. The dashboard notifies the PMO when Project KPIs achieve the planned threshold. This allows the project team to investigate the cause and act on issues promptly.
- AI Document Analysis (c): Use NLP to extract performance insights from weekly status reports, identifying recurring issues such as frequent scope changes affecting timelines.

Development of Project Management Methodologies: Implementation of AI Document Analysis (g) and AI-Enhanced Decision Support (j) to refine methodologies based on data-driven insights. PMO will be able to improve project outcomes and recommend methodology that is best suited to project specifics and needs.

- AI Document Analysis (g): Analyze existing project documentation to evaluate the effectiveness of current methodologies.
- AI-Enhanced Decision Support (j): Recommend optimal methodologies for upcoming projects based on project type, team composition, and past success rates. For instance, considering all these parameters the application can suggest adopting an agile, Waterfall, or hybrid Agile-Waterfall approach tailored for a specific Project.

Strategic Alignment: Implementation of Predictive Analytics (k), Project Selection and Prioritization (n), and AI-enhanced Decision Support (o) to ensure projects align with organizational goals to contribute meaningfully to the company's objectives.

- Predictive Analytics (k): Assess ongoing projects for alignment with strategic goals. For example, if an AI application predicts that Project B has low alignment with the company's goals, the PMO can reevaluate the project's relevance and decide to redirect resources.
- Project Selection and Prioritization (n): Use AI algorithms to prioritize projects that maximize ROI and strategic fit. The AI applications recommend prioritizing Projects, which align closely with strategic objectives and have a higher projected ROI.
- AI-Enhanced Decision Support (o): Provide recommendations for portfolio adjustments to better align with organizational goals.

Portfolio Management: Implementation of Predictive Analytics (p), Real-Time Project Monitoring (b), Project Selection and Prioritization (l), Portfolio and Project Simulation (q), and AI-enhanced Decision Support (r) to permit optimizing the project portfolio for maximum value balancing risk and return, enhancing overall performance.

- Predictive Analytics (p): Forecast portfolio trends, such as financial performance and resource demand, ensuring portfolios remain balanced.
- Portfolio and Project Simulation (q): Model different portfolio scenarios to optimize resource allocation and sequencing.
- AI-Enhanced Decision Support (r): Recommend portfolio adjustments to maximize strategic value and minimize risks.

Project Planning: Implementation of Predictive Analytics (s), Real-Time Project Monitoring (b), AI Document Analysis (t), Project Selection and Prioritization (u), Portfolio and Project Simulation (v), AI-enhanced Decision Support (w) to enhance the accuracy and feasibility of project plans. More accurate and realistic project plans, reducing the likelihood of schedule slips and budget overruns.

- Predictive Analytics (s): Forecast schedule and resource requirements and potential bottlenecks, helping refine project plans.

- AI Document Analysis (t): Analyze planning documents to identify inconsistencies and potential improvements.
- AI-Enhanced Decision Support (w): Provide recommendations for project plans, including resource allocation and timeline adjustments, according to specific project or portfolio demands.

Resource Management: Implementation of Predictive Analytics (x), Real-Time Project Monitoring (b), AI Document Analysis (y), Project Selection, and Prioritization (z) to optimize the allocation and utilization of resources, preventing overallocation or underutilization.

- Predictive Analytics (x): Assign resources to tasks based on availability, skills, and workload, minimizing conflicts.
- AI Document Analysis (y): Identify resource allocation gaps from project documentation.
- Project Selection and Prioritization (z): Assess resource needs during project selection to ensure feasibility.

Risk Management: Implementation of Predictive Analytics (aa), Real-Time Project Monitoring (bb), Project Selection and Prioritization (cc), Portfolio and Project Simulation (dd), and AI-enhanced Decision Support (r) to be more proactive risk management, enhancing resilience and avoid potential issues and disruptions

- Predictive Analytics (aa): Identify patterns of recurring risks, allowing proactive mitigation, and allowing PMO to apply risk mitigation strategies.
- Real-Time Project Monitoring (bb): Track risk indicators, enabling immediate response.
- Portfolio and Project Simulation (dd): Model risk scenarios to prepare effective mitigation strategies.

Knowledge Management: Implementation of Predictive Analytics (ee), and AI Document Analysis (ff) to improve organizational knowledge capture that helps in continuous improvement through effective knowledge sharing and application of lessons learned.

- Predictive Analytics (ee): Identify patterns from past projects to recommend best practices.
- AI Document Analysis (ff): Process lessons learned to populate knowledge repositories, that can be shared across the organization by knowledge repository.

Project Governance: Implementation of Predictive Analytics (gg), Real-Time Project Monitoring (hh), AI Document Analysis (ii), Project Selection and Prioritization (jj), AI-enhanced Decision Support (kk) to strengthen governance and compliance, improving accountability and transparency, ensuring projects comply with organizational policies.

- Predictive Analytics (gg): Highlight potential gaps in governance processes.
- Real-Time Project Monitoring (hh): Ensure compliance with governance policies.
- AI-Enhanced Decision Support (kk): Support governance adherence in decision-making.

Stakeholder Engagement: Implementation of Real-Time Project Monitoring (ll), and AI Document Analysis (mm) to enhance stakeholder satisfaction through better communication and expectation management.

- Real-Time Project Monitoring (ll): Engage stakeholders dynamically with up-to-date information.
- AI Document Analysis (mm): Analyze communication records to extract insights into stakeholder concerns.

Training and Development: Implementation of Predictive Analytics (nn), Real-Time Project Monitoring (oo), and AI Document Analysis (pp) to build a skilled and capable project member, capable of handling complex project challenges.

- Predictive Analytics (nn): Identify skill gaps and predict future training needs.
- Real-Time Project Monitoring (oo): Track training effectiveness by monitoring performance improvements.
- AI Document Analysis (pp): Analyze training materials and feedback to improve programs.

The PMO planned to execute the integration of AI in a structured manner, ensuring a smooth transition and maximizing benefits. The execution is set in 5 steps:

#### Step 1: Data Preparation

- Data Collect and Cleaning: Gather historical project data, resource utilization records, risk registers, financial records, communication platforms, stakeholder feedback, and training records to consolidate a clean dataset ready for AI processing
- Establish Data Governance: Implement policies to ensure data accuracy, security, and compliance. Define data ownership, access rights, and

security protocols to keep data integrity and compliance with regulations like GDPR.

### Step 2: AI Tools Selection

- Evaluate AI Platforms: Conduct trials and demos with vendors to choose AI tools that align with the PMO's needs and technical capabilities.
- Ensure Scalability and Integration: Work with the IT team to ensure that selected solutions can be integrated with existing project management systems, building a cohesive technology ecosystem

### Step 3: Implementation Planning

- Pilot Projects: Begin with a few projects to test the AI applications. Select projects that are representative and have available data to test AI application adoption in a controlled environment.
- Staff Training: Prepare the team for new tools and processes, and provide training for PMO staff on using AI tools effectively.
- Change Management: Communicate the benefits to teams and stakeholders to gain buy-in.

### Step 4: Execution and Monitoring

- Deploy AI Applications: Implement the AI tools across selected PMO functions.
- Monitor Performance: Use KPIs to measure improvements in efficiency, alignment, risk management, etc.
- Iterative Improvement: Adjust strategies based on feedback and performance data.

### Step 5: Scaling and Continuous Improvement

- Roll-outs: After the Pilot phase, roll out AI applications across all PMO functions.
- Methodologies Update: Refine project management methodologies based on AI insights. Create more efficient and effective processes
- Adopt a Data-Driven Decision-Making Culture: Encourage continuous learning and adaptation. Share success stories and provide ongoing education.

To ensure the objectives are met, the PMO sets specific KPIs targets to measure AI implementation success:

- Project Delivery Metrics: Reduction in delays and budget overruns. Compare baseline data with post-implementation results.

- Resource Utilization Rates: Improved efficiency in resource allocation. Track utilization rates and balance across teams.
- Risk Management Effectiveness: Decrease in the number of risks materializing. Monitor risk incidence and impact.
- Strategic Alignment: Increased percentage of projects aligning with strategic goals. Evaluate project portfolios against strategic objectives.
- Stakeholder Satisfaction: Improvement in stakeholder feedback scores. Conduct regular surveys and analyze sentiment.
- Knowledge Sharing: Increased utilization of knowledge repositories. Track access metrics and contribution rates.

By integrating AI into its PMO functions, IT Corporation anticipates significant improvements in efficiency, strategic alignment, and stakeholder satisfaction. The structured approach ensures that AI applications are effectively mapped to PMO functions, addressing specific challenges. The anticipated execution of the model's steps demonstrates a practical and systematic plan for transformation.

The PMO's commitment to embracing AI positions in IT Corporation as a forward-thinking organization, ready to meet the demands of a rapidly evolving industry. This integration not only solves current challenges but also sets the foundation for continuous innovation and competitive advantage.

#### 4.4. EVALUATION

Following a preliminary framework demonstration using a hypothetical case study scenario, the artifact will be evaluated through discussions with specialists in interviews. The objective of the interviews is to understand if the proposed framework would be helpful or inspiring to help interviewers implement AI on PMOs.

After an introduction and presentation of the proposed framework, to validate and refine the proposal, the interviews focused on three main questions:

1. Do you consider the proposed framework useful, and why?
2. Do you have any criticisms of the proposed framework? Do you have any suggestions for further improvements? Please explain.
3. Would you consider implementing the proposed framework? Please explain.

The interviews were conducted with 3 experienced Project Management / PMO professionals and occurred presential from November 24th to 26th, 2024. The interviewers' profile is:

Expert 1 is a Project Management Professional with over 20 years of experience managing complex projects and leading PMOs in the technology, telecommunications, and finance

industries. Holding a bachelor's degree in computer science and certifications such as PMP and PMO-CP.

Expert 2 has over 15 years of experience leading PMOs and managing projects in the technology and manufacturing sectors. He holds a bachelor's degree in economics science and an MBA in Project Management. Certified as a Scrum Fundamental (SFC), ITIL, and Lean Six Sigma Yellow Belt.

Expert 3 is a PMO leader and project manager with over 30 years of experience, involved in implementing and optimizing PMOs and managing large-scale projects within the technology, energy, and telecommunications industries. He holds a bachelor's degree in computer science and a PhD in project management. Certified as PMP, PMI-ACP, PMO-CP, and scrum master (SMC).

Considering the interview's main question, we were able to collect the following insights:

### **1. Do you consider the proposed framework useful, and why?**

All three experts affirmed the usefulness of the proposed framework:

*“Definitely. I think it's a solid approach. Mapping AI applications directly to PMO functions makes it practical and easy to understand. Incorporating predictive analytics, real-time monitoring, and decision support handles some of the biggest challenges we face. Plus, it helps PMOs become more proactive.” (Expert 1)*

*“I find the proposed framework quite useful. It offers a structured approach, not treating AI as just a buzzword but as a practical tool that can be used to improve PMO's efficiency. I can see the main challenges we have to treat in this framework as monitoring activities, risk, planning, and balancing portfolios. Something that highlights to me is the use of predictive analyses that can support all PMO areas.” (Expert 2)*

*“I find it quite good. It addresses critical areas like risk management, resource allocation, and strategic alignment, which are essential for successful project outcomes. In a Data world aligning AI use with specific PMO activities is important and can take PMOs to another level. I consider this framework provides a clear path to that.” (Expert 3)*

**2. Do you have any criticisms of the proposed framework? Do you have any suggestions for further improvements? Please explain.**

The experts provided valuable input on the suggested framework, identifying crucial areas for improvement to ensure its successful implementation and application in a variety of organizational scenarios. Unfortunately, most of this input is not pertinent to the framework itself, but rather to concerns and attention points that need to be addressed throughout the framework implementation. The main suggestions are:

Data Quality and Management: Emphasize the establishment of robust data governance practices to ensure the accuracy, consistency, and security of data used in AI applications.

*"All AI tools are only as good as the data they are built, so to be effective the organization needs to have good data governance practices. They need to ensure data accuracy and consistency in a big volume of data. And do not forget about data security." (Expert 1)*

Change Management: Incorporate strategies for managing organizational process change, including training programs, clear communication, and cultural alignment to facilitate acceptance and adoption of AI technologies.

*"Change management is critical when introducing new tools. Providing strategies for managing process change, training, and encouraging adoption would make the framework more robust." (Expert 3)*

*"This process changes requires a lot of acceptance by the teams. Training and clear communication about the benefits of the change can facilitate the adoption." (Expert 1)*

Scalability and Adaptability: Provide guidelines for tailoring the framework to suit different organizational contexts, ensuring its applicability across various industries, sizes, and maturity levels.

*"The PMOs and organizations vary so much because it will be helpful to have some guidance on tailoring the framework to different PMO types and sizes and industries would be helpful." (Expert 1)*

**3. Would you consider implementing the proposed framework? Please explain.**

All experts expressed interest in implementing the framework, and recognize its alignment with their organizational goals:

*"Absolutely. In fact, some elements of this framework are aligned with initiatives we're currently evaluating. As I can see, this framework can help us analyze the better applications we can adopt." (Expert 1)*

*"Yes, I would consider using this framework in my organization, as it aligns well with our strategy to have the best project management approach to support our work and increase our efficiency. Adopting this kind of tools can enhance a lot our project management process." (Expert 2)*

*"Yes, I would consider implementing the framework. Of course, we would need to customize it to our specific context, considering some organizational factors and internal limitations. But overall, it provides a good foundation to support PMO improvements" (Expert 3)*

As a result of this evaluation, the experts' response indicates that, while the framework adequately describes the integration of AI applications into PMO, its success depends on handling key factors during the implementation phase. So, to maximize the benefits, of implementing this framework successfully we should be focusing on data quality to guarantee the accuracy of AI Applications, change management to assure the proper adoption and use of the new process, and customization of the framework according to organization side and PMO type.

These enhancement recommendations do not change the framework itself but rather guide a careful and strategic approach to its use. Organizations adopting the framework should incorporate these considerations into their implementation plans, as described in the Case Study, ensuring that AI application serves as a powerful tool to enhance PMO functions while aligning with each organizational values, culture, and objectives.

## 5. CONCLUSIONS AND FUTURE WORKS

To conclude this work, it is important to start by mentioning that the previously defined objectives were achieved. The integration of AI into PMO functions represents a significant advancement in project management practices. This study establishes a basic framework that bridges the gap between AI applications and PMO functions, providing both theoretical insights and concrete guidance and answering the study Research question “How and where AI can help the different types of PMO used in companies to improve their works and results?”.

The framework highlights how AI may improve PMO activities by offering data-driven insights, automating routine tasks, optimizing resources, improving risk management, and increasing strategic alignment.

However, successful adoption necessitates a comprehensive examination of data quality, organizational readiness, and ethical implications. Organizations must approach AI integration holistically, ensuring that it aligns with their strategic goals, culture, and values. Change management appears as an important element since the implementation of AI involves changes in procedures, attitudes, and skill sets.

The benefits of incorporating AI into PMOs are significant, including increased efficiency, better decision-making, improved project outcomes, and higher stakeholder satisfaction. As the business environment evolves, PMOs with AI applications will be more capable of negotiating difficulties, recognizing opportunities, and driving organizational success.

### 5.1. LIMITATION

While the study offers significant contributions, several limitations should be considered.

The main limitation of this is that the framework was demonstrated using a fictional scenario rather than a real-world application. Without empirical testing in real organizational settings, the practical effectiveness and implementation challenges remain unknown.

The successful application of the framework relies heavily on the availability and quality of data. In order to use the framework, the development team must obtain datasets to implement the framework application. Datasets are one of the issues in project management because of the unstructured data saved in different structures and software over the years. Organizations with insufficient or poor-quality data may face difficulties in leveraging AI effectively. Also, project portfolio database patterns can be quite different between organizations as project performance is affected by the corporate environment and culture. So, this does not allow a shared database between companies. In that way, most of the research is done on small datasets.

The framework focuses on specific AI applications identified in the literature review. There may be other emerging AI technologies and methods that could further enhance PMO functions but were not considered.

The framework assumes that organizations have a certain level of maturity and readiness for AI integration. Cultural resistance, lack of technical expertise, and inadequate infrastructure can compromise implementation.

The study does not extensively address ethical issues related to AI adoption, such as data privacy, algorithmic bias, and transparency, which are critical for responsible AI integration.

## 5.2. RECOMMENDATIONS FOR FUTURE WORK

Future work recommendations are based on this study's limitations and expand on the findings.

- Validate the framework's effectiveness through case studies and pilot projects in real-world organizations and refine it with practical insights.
- Create guidelines for implementation and customizing the framework to diverse PMOs, industries, and organizational sizes, ensuring adaptability and scalability.
- Research and integrate emerging AI technologies to improve PMO capabilities.
- Investigate methods to improve project manager data quality and management for AI applications.
- Study ethical considerations for using AI in PMO, including data protection, security, transparency, and fairness algorithms.
- Conduct long-term studies to evaluate AI integration's impact on PMO performance and organizational success.

Finally, this study establishes the groundwork for future research and development in the field of AI-enhanced project management. By addressing the constraints and expanding on the recommendations, researchers and practitioners can improve the framework, adapt it to different circumstances, and contribute to the growth of PMOs in the digital era. The path to fully realizing the potential of AI in PMOs is ongoing, and this study is just one more step in that direction.

## BIBLIOGRAPHICAL REFERENCES

- Abbing, J., & Linssen, O. (2023). Requirements for a Decision Support System for Managing Complexity of Multidimensional IT Project Assessments in the Context of IT Portfolio Management: Vol. P-340 (Projektmanagement und Vorgehensmodelle 2023, PVM). Gesellschaft für Informatik (GI).
- Agbese, M., Mohanani, R., Khan, A., & Abrahamsson, P. (2023). Implementing AI Ethics: Making sense of the ethical requirements. <https://doi.org/10.1145/3593434.3593453>
- Albogami, S. M., Ariffin, M. K. a. B. M., Supeni, E. E. B., & Ahmad, K. A. (2021). A new hybrid AHP and Dempster—Shafer Theory of Evidence Method for Project Risk Assessment problem. *Mathematics*, 9(24), 3225. <https://doi.org/10.3390/math9243225>
- Artto, K., Kulvik, I., Poskela, J., & Turkulainen, V. (2011). The integrative role of the project management office in the front end of innovation. *International Journal of Project Management*, 29(4), 408–421. <https://doi.org/10.1016/j.ijproman.2011.01.008>
- Aujla, A. (2023, September 12). How Machine Learning will Change the World of Project Management. Birdview PSA. <https://birdviewpsa.com/blog/how-machine-learning-will-change-the-world-of-project-management/>
- Bang, S., Aarvold, M. O., Hartvig, W. J., Olsson, N. O. E., & Rauzy, A. (2022). Application of machine learning to limited datasets: prediction of project success. *Journal of Information Technology in Construction*, 27, 732–755. <https://doi.org/10.36680/j.itcon.2022.036>
- Barrocas, A., Da Silva, A. R., & Saraiva, J. (2023). Exploring Data Analysis and Visualization Techniques for Project Tracking: Insights from the ITC. In *Communications in computer and information science* (pp. 147–162). [https://doi.org/10.1007/978-3-031-43703-8\\_11](https://doi.org/10.1007/978-3-031-43703-8_11)
- Beck, K., Beedle, M., van Bennekum, A., et al. (2001). Manifesto for Agile Software Development. <http://agilemanifesto.org/>
- Biamonte, J., Wittek, P., Pancotti, N., Rebentrost, P., Wiebe, N., & Lloyd, S. (2017). Quantum machine learning. *Nature*, 549(7671), 195–202. <https://doi.org/10.1038/nature23474>
- Bilgin, G., Dikmen, I., Birgonul, M. T., & Ozorhon, B. (2022). A decision support system for project portfolio management in construction companies. *International Journal of Information Technology & Decision Making*, 22(02), 705–735. <https://doi.org/10.1142/s0219622022500821>
- Boehm, B., & Turner, R. N. (2003). *Balancing agility and discipline: A Guide for the Perplexed*. Addison-Wesley Professional.

- Boiko, Y., Diachenko, Y., Shandra, T., & Yakovenko, V. (Eds.). (2024). Intelligent project portfolio development of IT companies (5th International Workshop IT Project Management, ITPM, Vol. 3709). CEUR-WS.
- Bostrom, N., & Yudkowsky, E. (2014). The ethics of artificial intelligence. In Cambridge University Press eBooks(pp.316–334). <https://doi.org/10.1017/cbo9781139046855.020>
- Bushuyeva, N., Bushuieva, V., Bushuyev, S., Piliuhina, K., Tykchonovych, J., Zaprivoda, A., & Chernysh, O. (Eds.). (2024). “Clip” thinking as the tool of Agile project management in an artificial intelligence environment (5th International Workshop IT Project Management, ITPM, Vol. 3709). CEUR-WS.
- Cohn, M. (2010). Succeeding with Agile: Software development using Scrum. Addison-Wesley Professional.
- Conforto, E. C., Salum, F. A., Amaral, D. C., Da Silva, S. L., & De Almeida, L. F. M. (2014). Can Agile Project Management be Adopted by Industries Other than Software Development? Project Management Journal, 45(3), 21–34. <https://doi.org/10.1002/pmj.21410>
- Crawford, J. (2006). The Project Management Maturity model. Information Systems Management, 23(4), 50–58. <https://doi.org/10.1201/1078.10580530/46352.23.4.20060901/95113.7>
- Davenport, T. H., & Ronanki, R. (2018). Artificial intelligence for the real world. Harvard Business Review, 96(1), 108–116. <https://blockqai.com/wp-content/uploads/2021/01/analytics-hbr-ai-for-the-real-world.pdf>
- David, I., & Gelbard, R. (2024). Using sentiment analysis to assess PMBOK knowledge areas’ compatibility with agile methodology. Procedia Computer Science, 239, 381–395. <https://doi.org/10.1016/j.procs.2024.06.185>
- Dremel, C., Stoeckli, E., & Wulf, J. (2020). Management of analytics-as-a-service - results from an action design research project. Journal of Business Analytics, 3(1), 1–16. <https://doi.org/10.1080/2573234x.2020.1740616>
- Dronic, I. (2018). A path to artificial intelligence. In Advances in intelligent systems and computing (pp. 658–668). [https://doi.org/10.1007/978-3-030-01057-7\\_50](https://doi.org/10.1007/978-3-030-01057-7_50)
- Duff, C. L., Chasseray, Y., Fertier, A., Falco, R., Adrot, A., Montreuil, B., & Benaben, F. (2024). A Model-Driven framework to support portfolio management under uncertainties. In Lecture notes in computer science (pp. 596–611). [https://doi.org/10.1007/978-3-031-61057-8\\_35](https://doi.org/10.1007/978-3-031-61057-8_35)

- Faraji, A. (2021). Neuro-fuzzy system-based model for prediction of project performance in downstream sector of petroleum industry in Iran. *Journal of Engineering Design and Technology*, 19(6), 1268–1290. <https://doi.org/10.1108/jedt-06-2020-0241>
- Fronte, P., Agell, N., Torrens, M., & Brugarolas, D. (2022). Importance-Performance analysis in project portfolio management using an IOWA operator. In *Frontiers in artificial intelligence and applications*. <https://doi.org/10.3233/faia220312>
- Gartner (2019). Gartner Says 80 Percent of Today's Project Management Tasks Will Be Eliminated by 2030 as Artificial Intelligence Takes Over. <https://www.gartner.com/en/newsroom/press-releases/2019-03-20-gartner-says-80-percent-of-today-s-project-management>
- Gil, J., Torres, J. M., & González-Crespo, R. (2021). The Application of Artificial Intelligence in Project Management Research: A review. *International Journal of Interactive Multimedia and Artificial Intelligence*, 6(6), 54. <https://doi.org/10.9781/ijimai.2020.12.003>
- Gobov, D., & Huchenko, I. (2021). Software Requirements Elicitation Techniques Selection Method for the Project Scope Management. (2nd International Workshop IT Project Management, ITPM, Vol. 2851, pp. 1–10). CEUR-WS. <http://ceur-ws.org/Vol-2851/paper1.pdf>
- Goertzel, T. (2014). The path to more general artificial intelligence. *Journal of Experimental & Theoretical Artificial Intelligence*, 26(3), 343–354. <https://doi.org/10.1080/0952813x.2014.895106>
- Gregor, S., & Hevner, A. R. (2013). Positioning and presenting design science research for maximum impact. *MIS Quarterly*, 37(2), 337–355. <https://doi.org/10.25300/misq/2013/37.2.01>
- Gulshan, V., Peng, L., Coram, M., Stumpe, M. C., Wu, D., Narayanaswamy, A., Venugopalan, S., Widner, K., Madams, T., Cuadros, J., Kim, R., Raman, R., Nelson, P. C., Mega, J. L., & Webster, D. R. (2016). Development and validation of a deep learning algorithm for the detection of diabetic retinopathy in retinal Fundus photographs. *JAMA*, 316(22), 2402. <https://doi.org/10.1001/jama.2016.17216>
- Halani, K. R., & Jhajharia, K. (2022). A quantitative study of waterfall and agile methodologies with the perspective of project management. In *Advances in logistics, operations, and management science book series* (pp. 111–133). <https://doi.org/10.4018/978-1-7998-7872-8.ch007>
- Harani, N. H., Langi, A. Z. R., & Arman, A. A. (2023). Optimization Model PPM for Financial Goals with Machine Learning Literatur Review (pp. 1–7). <https://doi.org/10.1109/iciss59129.2023.10291364>

- Hevner, N., March, N., Park, N., & Ram, N. (2004). Design science in Information Systems Research. *MIS Quarterly*, 28(1), 75. <https://doi.org/10.2307/25148625>
- Hill, G. M. (2022). *The Complete Project Management Office Handbook*. Auerbach Publications.
- Hobbs, B., & Aubry, M. (2007). A Multi-Phase Research Program Investigating Project Management Offices (PMOS): The results of Phase 1. *Project Management Journal*, 38(1), 74–86. <https://doi.org/10.1177/875697280703800108>
- Hobbs, B., & Aubry, M. (2010). *The Project Management Office (PMO): A Quest for Understanding*.
- Holzmann, V., Zitter, D., & Peshkess, S. (2022). The expectations of project managers from artificial intelligence: A Delphi study. *Project Management Journal*, 53(5), 438–455. <https://doi.org/10.1177/87569728211061779>
- Jobin, A., Ienca, M., & Vayena, E. (2019). The global landscape of AI ethics guidelines. *Nature Machine Intelligence*, 1(9), 389–399. <https://doi.org/10.1038/s42256-019-0088-2>
- Joslin, R., & Müller, R. (2016). The relationship between project governance and project success. *International Journal of Project Management*, 34(4), 613–626. <https://doi.org/10.1016/j.ijproman.2016.01.008>
- Kanakaris, N., Karacapilidis, N., Kournetas, G., & Lazanas, A. (2019). Combining machine learning and operations research methods to advance the project management practice. In *Communications in computer and information science* (pp. 135–155). [https://doi.org/10.1007/978-3-030-37584-3\\_7](https://doi.org/10.1007/978-3-030-37584-3_7)
- Kaplan, A., & Haenlein, M. (2018). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. *Business Horizons*, 62(1), 15–25. <https://doi.org/10.1016/j.bushor.2018.08.004>
- Karrenbauer, C., & Breitner, M. (Eds.). (2023). *Value-driven IT Project Portfolio Management: Process Model, Evaluation Framework, and Decision Support* (43rd International Conference on Information Systems).
- Kerzner, H. (2017). *Project management metrics, KPIs, and dashboards: A guide to measuring and monitoring project performance*. John Wiley & Sons.
- Taylor, P. (2021). *AI and the project manager: How the rise of artificial intelligence will change your world*. Routledge.
- LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. *Nature*, 521(7553), 436–444. <https://doi.org/10.1038/nature14539>

- Makaula, S., Munsamy, M., & Telukdarie, A. (2021). Impact of Artificial Intelligence in South African Construction Project Management Industry (2nd South American Conference on Industrial Engineering and Operations Management, pp. 148–162). IEOM Society. <https://doi.org/10.46254/sa02.20210048>
- Maphosa, V., & Maphosa, M. (2022). ARTIFICIAL INTELLIGENCE IN PROJECT MANAGEMENT RESEARCH: A BIBLIOMETRIC ANALYSIS. Zenodo (CERN European Organization for Nuclear Research). <https://doi.org/10.5281/zenodo.7134074>
- Marchinares, A. H., & Aguilar-Alonso, I. (2020). Project Portfolio Management Studies Based on Machine Learning and Critical Success Factors (pp. 369–374). <https://doi.org/10.1109/pic50277.2020.9350787>
- Marchinares, A. H., & Rodriguez, C. R. (2021). Online Solution Based on Machine Learning for IT Project Management in Software Factory Companies. <https://doi.org/10.1109/cicn51697.2021.9574682>
- Miller, G. J. (2022). Artificial Intelligence Project Success Factors—Beyond the Ethical Principles. In Lecture notes in business information processing (pp. 65–96). [https://doi.org/10.1007/978-3-030-98997-2\\_4](https://doi.org/10.1007/978-3-030-98997-2_4)
- Mishra, A., Tripathi, A., & Khazanchi, D. (2022). A proposal for research on the application of AI/ML in ITPM. International Journal of Information Technology Project Management, 14(1), 1–9. <https://doi.org/10.4018/ijitpm.315290>
- Mitrovic, Z. M., Rakicevic, A. M., Petrovic, D. C., Mihic, M. M., Rakicevic, J. D., & Jelisic, E. T. (2020). Systems Thinking in Software Projects-an Artificial Neural Network approach. IEEE Access, 8, 213619–213635. <https://doi.org/10.1109/access.2020.3040169>
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ, 339(jul21 1), b2535. <https://doi.org/10.1136/bmj.b2535>
- Morozov, V., Kalnichenko, O., Proskurin, M., & Mezentseva, O. (2019). Investigation of Forecasting Methods of the State of Complex IT-Projects with the Use of Deep Learning Neural Networks. In Advances in intelligent systems and computing (pp. 261–280). [https://doi.org/10.1007/978-3-030-26474-1\\_19](https://doi.org/10.1007/978-3-030-26474-1_19)
- Niederman, F. (2021). Project management: openings for disruption from AI and advanced analytics. Information Technology and People, 34(6), 1570–1599. <https://doi.org/10.1108/itp-09-2020-0639>
- Niranjana, S.R. (2023). AI for sustainable development: assessing student interest, education, and career pathways. EPRA International Journal of Research & Development. (IJRD), 290–295. <https://doi.org/10.36713/epra14795>

- O'Neil, C. (2016). *Weapons of math destruction: How Big Data Increases Inequality and Threatens Democracy*. Crown Publishing Group (NY).
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., . . . Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, n71. <https://doi.org/10.1136/bmj.n71>
- Pappert, L., & Kusanke, K. (Eds.). (2024). *Modern Project Portfolio Management– Analyzing the Potential of Artificial Intelligence: Vol. P-340 (Projektmanagement und Vorgehensmodelle 2023, PVM)*. Gesellschaft für Informatik (GI).
- Peppers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A Design Science Research Methodology for Information Systems research. *Journal of Management Information Systems*, 24(3), 45–77. <https://doi.org/10.2753/mis0742-1222240302>
- Pemsel, S., & Wiewiora, A. (2013). Project management office a knowledge broker in project-based organizations. *International Journal of Project Management*, 31(1), 31–42. <https://doi.org/10.1016/j.ijproman.2012.03.004>
- Picard, R. W. (2000). *Affective computing*. MIT Press.
- Poole, D. L., & Mackworth, A. K. (2017). *Artificial intelligence*. <https://doi.org/10.1017/9781108164085>
- Project Management Institute. (2017). *A guide to the project management body of knowledge PMBOK guide*.
- Quist, C. (2015). *Benefits of Blending Agile and Waterfall Project Planning Methodologies*. University of Oregon.
- Rosenblatt, F. (1958). The perceptron: A probabilistic model for information storage and organization in the brain. *Psychological Review*, 65(6), 386–408. <https://doi.org/10.1037/h0042519>
- Royce, W. (1998). *Software Project Management: A Unified Framework*. Addison-Wesley Professional.
- Rumelhart, D. E., Hinton, G. E., & Williams, R. J. (1986). Learning representations by back-propagating errors. *Nature*, 323(6088), 533–536. <https://doi.org/10.1038/323533a0>
- Russell, S., & Norvig, P. (2019). *Artificial intelligence: A Modern Approach*. Pearson Higher Education.
- Schwaber, K., & Beedle, M. (2002). *Agile software development with Scrum*. Prentice Hall.

- Schwalbe, K. (2015). *Information technology project management*. Cengage Learning.
- Septiandri, A. A., Constantinides, M., & Quercia, D. (2024). The impact of responsible AI research on innovation and development. *arXiv* (Cornell University). <https://doi.org/10.48550/arxiv.2407.15647>
- Shafiabady, N., Hadjinicolaou, N., Din, F. U., Bhandari, B., Wu, R. M. X., & Vakilian, J. (2023). Using Artificial Intelligence (AI) to predict organizational agility. *PLoS ONE*, 18(5), e0283066. <https://doi.org/10.1371/journal.pone.0283066>
- Susskind, R., & Susskind, D. (2015). *The future of the professions*. In Oxford University Press eBooks. <https://doi.org/10.1093/oso/9780198713395.001.0001>
- Taboada, I., Daneshpajouh, A., Toledo, N., & De Vass, T. (2023). Artificial Intelligence Enabled Project Management: A Systematic Literature Review. *Applied Sciences*, 13(8), 5014. <https://doi.org/10.3390/app13085014>
- Tarawneh, M., AbdAlwahed, H., & AlZyoud, F. (2024). Innovating Project Management: AI applications for success prediction and resource optimization. In *Lecture notes in networks and systems* (pp. 382–391). [https://doi.org/10.1007/978-3-031-56950-0\\_32](https://doi.org/10.1007/978-3-031-56950-0_32)
- Tobar, F., & González, R. (2021). On machine learning and the replacement of human labour: anti-Cartesianism versus Babbage's path. *AI & Society*, 37(4), 1459–1471. <https://doi.org/10.1007/s00146-021-01264-3>
- Topol, E. J. (2018). High-performance medicine: the convergence of human and artificial intelligence. *Nature Medicine*, 25(1), 44–56. <https://doi.org/10.1038/s41591-018-0300-7>
- Turing, A. M. (1950). I.—COMPUTING MACHINERY AND INTELLIGENCE. *Mind*, LIX(236), 433–460. <https://doi.org/10.1093/mind/lix.236.433>
- Turner, R. (2016). *Gower handbook of project management*. Gower Publishing Ltd.
- Uddin, S., Ong, S., Lu, H., & Matous, P. (2023). Integrating machine learning and network analytics to model project cost, time and quality performance. *Production Planning & Control*, 1–15. <https://doi.org/10.1080/09537287.2023.2196256>
- Urata, S., Kawanaka, T., & Rokugawa, S. (2022). Early-stage project outcome prediction considering human factors. *Industrial Engineering & Management Systems*, 21(1), 58–73. <https://doi.org/10.7232/iems.2022.21.1.058>
- Venkatachalam, A. V. D. A., Rajkumar, S., Selvanathan, N., & Karthick, K. (2017). *Agile SCRUM the revolution in IT industry*. Social Science Research Network. <https://doi.org/10.2139/ssrn.3122169>

- Vukadinović, D., & Fabac, R. (2022). Project Management in Digital Disruption: Emergence of Digital Project Management Office. Proceedings of the ENTRENOVA – Enterprise Research Innovation Conference, 8(1), 310–328. <https://doi.org/10.54820/entrenova-2022-0027>
- Wach, M., & Chomiak-Orsa, I. (2022). Determinants of the use of predictive models in the management of investment portfolios, on the example of KGHM Polska Miedź S.A. Procedia Computer Science, 207, 2374–2383. <https://doi.org/10.1016/j.procs.2022.09.296>
- Wachnik, B. (2022). Analysis of the use of artificial intelligence in the management of Industry 4.0 projects. The perspective of Polish industry. Production Engineering Archives, 28(1), 56–63. <https://doi.org/10.30657/pea.2022.28.07>
- Waymo. (2020). Waymo safety report. <https://waymo.com/safety/>
- Whitaker, S. (2019). Artificial Intelligence and Project Management. The Professional Project Manager Blog. <https://www.projectmanagement.com/blog-post/54072/artificial-intelligence-and-project-management>
- Wysocki, R. K. (2013). Effective project management: Traditional, Agile, Extreme. John Wiley & Sons.
- Yehorchenkova, N., & Yehorchenkov, O. (2021). Modeling of project portfolio management process by CART algorithm. In Advances in intelligent systems and computing (pp. 353–363). [https://doi.org/10.1007/978-3-030-58124-4\\_34](https://doi.org/10.1007/978-3-030-58124-4_34)
- Yehorchenkova, N., Yehorchenkov, O., & Sazonov, A. (2022). Modeling of project portfolio management process in Banking. In Lecture notes in networks and systems (pp. 479–492). [https://doi.org/10.1007/978-3-030-89902-8\\_35](https://doi.org/10.1007/978-3-030-89902-8_35)
- Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? International Journal of Educational Technology in Higher Education, 16(1). <https://doi.org/10.1186/s41239-019-0171-0>



**NOVA Information Management School**  
**Instituto Superior de Estatística e Gestão de Informação**

Universidade Nova de Lisboa