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Artificial Intelligence on Project Management Performance Domains

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Abstract

This study ambitions to investigate the influence of artificial intelligence tools on project management performance domains, aiming to investigate if it is possible to make any association between a specific set of artificial intelligence tools and certain project management performance domains, as well as verifying what are the benefits and challenges of said associations.
This study contributes to the Artificial Intelligence area, along with the Project Management area by providing purposeful insights on their alliance, and additionally, addresses a critical gap in the literature and provides valuable insights into the Project Management Performance Domains, contributing to advancements in the field.

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Keywords: Artificial Intelligence; AI; AI Tools; AI Solutions; AI Strategies; AI Techniques; Project Management

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1. Introduction

In recent years technological advancements have surged at an unprecedented pace, transforming the world and how we perceive it. The field of Artificial Intelligence (AI) is one of the main reasons for this extraordinary growth and evolution, due to its' disruptive changes across various domains. These innovations have not only redefined industries but also reshaped how we interact, learn, work, and communicate [1].

A particular field where AI is clearly having a significant impact is Project Management (PM), which has enormous potential for transformation through AI integration [2]. Even though it is possible to identify the prominence that the application of AI has gained in PM, the integration of AI tools into PM practices is relatively recent [1], consequently, the use of AI in PM and its' impacts are only now starting to be put into practice.

As we search and read about the application of AI in PM it is possible to identify some research gaps. A prime example of this has already been identified by Taboada, Daneshpajouh, Toledo, and Vass in [3] when coming to the conclusion that no studies have been conducted in the existing literature that address this subject and analyse the influence that AI tools have in the various project management performance domains (PMPD), presented in the 7th edition of PMBOK [4]. This paper is a valuable contribution as it aims to bring forth insights from the research conducted by these authors and presents more information about the identified research gaps. Therefore, the question that will be pursued in this paper is:

Research Question - What AI techniques are available to support PM considering the structuring by performance domains?

2. Theoretical Background

PM is one of the fundamental areas that assist organizations in ensuring that the projects they execute are managed properly [5]. As a leading academic discipline in the subject of management science PM harbours numerous definitions, for instance the Association for Project Management [6] describes PM as the application of processes, methods, knowledge, skills, and experience to accomplish project objectives. Projects are the vehicles for change in an organization. They are not routine business activities.

There are numerous PM approaches, manuals, and standards available today. The PMI methodology was considered to be the best fit for this study. The PMI, [7] which was founded in 1969, has developed into the top professional association for project managers. The PMI launched its PM certification program in 1984, and the developed most prestigious and well-known qualification in the project management field worldwide, the Project Management Professional (PMP). Additionally, the PMI was the first company in history to have its certification program achieve ISO 9001 certification from the International Organization for Standardization [8]. Furthermore, the authors were able to identify, throughout their study that "One of the things that PMI offers is a common dictionary and definitions to a lot of those things you don't find anywhere else".

The 7th PMBOK edition describes a project performance domain as a group of connected activities that are essential to the efficient delivery of a project outcome. These are characterized as dynamic, interconnected, and interdependent areas of concentration that function in harmony to accomplish the intended project outcomes [9].

There are eight project management performance domains according to [9]: (i) The Stakeholder Performance Domain; (ii) The Team Performance Domain; (iii) The Development Approach & Life Cycle Performance Domain; (iv) The Planning Performance Domain; (v) The Project Work Performance Domain; (vi) The Delivery Performance Domain; (vii) The Measurement Performance Domain; (viii) The Uncertainty Performance Domain.

PM is a field where AI is clearly having a significant impact, and it has enormous potential for transformation through AI integration.

It was John McCarthy [10] who first used the term "**Artificial Intelligence**" in 1956 and described it as "the science and engineering of making intelligent machines, especially intelligent computer programs", and further stated that it was equivalent to the analogous purpose of utilizing computers to study human intellect, although AI does not have to limit itself to physiologically observable ways.

Sharma and Garg's insights [11] emphasize that the integration of AI doesn't seek to supplant human capabilities but rather to fortify them, thereby enhancing overall performance. Their research highlights numerous collaborative avenues between humans and AI. These encompass amplifying existing abilities, refining perception, and comprehension.

To obtain a thorough understanding of the landscape of AI technologies, it was necessary to conduct a detailed examination of their various applications. The author in [12] identified seven areas of AI application which help us gain a deeper understanding of the purpose of AI techniques. The aforementioned areas are Language Understanding, Learning and adaptive Systems, Problem Solving, Perception (visual), Modeling, Robots and Games. For this paper the Games area was not considered since its application is not foreseeable in PM. These areas are presented in Table 1 so that we can obtain a better understanding of each one and what their definition is.

Table 1 – Artificial Intelligence Application Areas

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

Several authors have identified various approaches of AI techniques; however, for the purpose of this paper we chose to focus specifically on a few of these. Following a summary of the main approaches is given:

Natural Language Processing (NLP) focuses on enabling computers to understand, interpret, and generate human language in order to gain practical understanding in order to address problems [11]. As observed by [3], NLP seeks to accomplish two objectives: (1) facilitate human communication; and (2) extract information from written language.

According to [11], **Machine Learning (ML)** concentrates on developing algorithms and models that enable computers to perform tasks without explicit programming instructions. ML algorithms are designed to learn from data patterns and make inferences, allowing them to adapt and improve their performance over time. This field encompasses various approaches, including supervised learning, unsupervised learning, and reinforcement learning. The aim of ML is to allow independent decision-making by machines.

The writer in [13] provided a detailed explanation on **Neural Networks (NNs)** and declared that these are computational models inspired by the structure and function of biological neural networks. They consist of interconnected nodes organized in layers. NNs process input data through layers of interconnected neurons, where each neuron performs a weighted sum of its inputs followed by an activation function.

Fuzzy logic (FL) is a mathematical approach that deals with reasoning that is approximate rather than precise, allowing for the representation of uncertainty and vagueness in decision-making. [3] argued that FL expands Boolean logic (1 or 0) by focusing thinking and decision-making on all potential answers between 0 and 1.

Expert Systems (ES) are AI systems that emulate the decision-making ability of a human expert in a particular domain [11]. These systems encode domain-specific knowledge in the form of rules or facts and use inference engines to make deductions and provide recommendations or solutions. Expert Systems capture and preserve expertise and knowledge in specific domains, providing consistent and reliable decision support.

As stated by Sravanthi et al. [16] **Chatbots**, are AI programs designed to simulate a conversation with a user in natural language. It can interact via messaging services, webpages, mobile apps, or even over the phone. Additionally, chatbots may be integrated with other applications, for instance, PM systems.

In table 2 summarizes of each one of these six AI techniques.

Table 2 – Artificial Intelligence Techniques

TECHNIQUE	APPLICATION AREA	OBJECTIVE	EXAMPLE
Machine Learning	Modelling, Learning and adaptive Systems, Problem Solving	Employed for data prediction and classification without being specifically built for it	Siri
Neural Networks	Modelling, Learning and adaptive Systems, Perception	Model complex connections in data and use learned patterns to support predictions.	Image Recognition on your Smartphone [11]
Natural Language Processing	Language Understanding	Enable computers to understand, interpret, and generate human language	Smartphone spell check and autocorrect [11]
Fuzzy Approaches	Modelling, Perception	Enable computers to simulate human thought processes	Traffic Light Control
Expert Systems	Learning and adaptive Systems, Problem Solving	Emulate the decision-making ability of human experts in specific domains	Flight-tracking systems [11]
Chatbots	Language Understanding, Learning and Adaptive Systems, Problem Solving, Robotics - Chatbots	Simulate human-like interactions to answer questions, provide information, assist with tasks, and improve user experiences	Eliza [11]

3. Related Work

While initially, there might be some uncertainty about merging PM and AI, many researchers have identified that PM is one area where AI is undoubtedly having a big influence and has a lot of room to grow through AI integration. Although the use of AI in PM has become more prominent, the incorporation of AI technologies into PM processes is still relatively new [1].

Authors, such as [14] and [15] mentioned that project managers dedicate a big amount of their time to administrative duties, such as handling check-ins and overseeing updates. These authors suggest that AI can support project managers in reducing their workload through various means, such as prompting them to maintain records, updating statuses, and notifying stakeholders. This would allow project managers to devote more attention to the intricate processes behind their management. With time spared using AI-enabled project management systems, they would be able to dedicate extra time to supporting their employees, potentially empowering them, and uncovering further proficiencies.

Simultaneously, [16] identified that the adoption of Artificial Intelligence (AI) in project management also represents some disadvantages and barriers, that impede its widespread integration. One significant obstacle is the necessity for human assistance to refine Machine Learning (ML) capabilities, highlighting the need for skilled professionals to enhance AI systems effectively. Another challenge arises from the expense associated with labeling data, which can be prohibitively costly, thus hindering AI implementation efforts. Moreover, the establishment of a robust support infrastructure is essential for facilitating wide-scale AI implementation within project management frameworks. Furthermore, the scarcity of training data may lead to performance degradation, compromising the effectiveness of AI applications in project management contexts.

According to Alshaikhi and Khayyat [1], project management has embraced Artificial Intelligence, promising positive outcomes for future project activities, even thought, despite its potential, Project Management is still in early stages within the realm of AI and requires further development to achieve its primary objectives. Moreover, the authors in stated that several issues and challenges in project management have been identified, those which could be addressed by artificial intelligence systems. Thus, there is a significant opportunity for various AI systems to be employed in improving the efficiency of project managers' daily tasks.

Utilizing available resources, prioritizing emerging tools and techniques beneficial for project management, and establishing realistic project schedules constitute pivotal areas where the AI-powered system can significantly enhance project management conditions for organizations. Developing a streamlined system for project management utilizing machine learning models could yield a more sustainable solution [5].

It is also important to note that the PMBOK 6th edition [17], predecessor to the most recent version, offers a framework divided into knowledge areas, which many authors, such as [18], [19] and [20], used to base their research and tried to create a framework applying AI in these areas. Meanwhile, on the 7th edition some updates were made, and these knowledge areas are not integrated in this edition, and the Performance Domains were incorporated. This

study aims to provide valuable insights into the use of AI in Project Management on a Performance Domain perspective.

4. Methodology

This study applies both a Systematic Literature Review and a Multivocal Literature Analysis (MLR,) and its aim is to have a general understanding of the influence of artificial intelligence on PM performance domains, considering the theme under investigation and all of its issues.

The research questions aim to explore the tools available within Artificial Intelligence and what would be the impacts of their integration in PMPD, as well as to understand the benefits and difficulties associated with this incorporation.

For both reviews the search string used was composed by the combination of three keywords (“Artificial Intelligence” OR "ai") AND (“Project Management”) AND (“Tools” OR "Solutions" OR "Techniques" OR "Strategies"). As it is possible to observe some abbreviations and synonyms were employed to ensure that no study would be unconsidered for having a very restrictive string.

In the pursuit of synthesizing the outcomes of the body of literature several selection criteria were used, which differ from the SLR to the MLR.

For the Systematic Literature Review the database selection consists of the following: Scopus, IEEE Xplore Digital Library, EBSCO, Web of Science and ACM Digital Library.

The first stage of this process was to apply the search string on the selected databases which resulted on a total of 205318 articles, which dropped significantly to 1224 studies after applying the first criteria, selecting only papers that present the keywords on their abstract, and removing the ones that failed to do so. Afterwards only the papers which were published on a date interval from 2018 to 2023 and of scientific nature, such as conferences papers, journals, or articles and that had been publish in English were selected. The last step of the process helped ensure that the paper was insightful and relevant to the literature review, and it had not presented itself on a different database search, which meant that papers which their contents were not significant for the literature review and or duplicates were excluded. Table 3 demonstrates the data bases used and the criteria applied, presenting a certain number of papers after each step. Ultimately the search unravelled a total of 25 papers.

Table 3 – SLR Results

		Search String	Keywords present on abstract	Published between 2018-2023	Scientific Paper	Written in English	Relevant Contents	No duplicates
Data Bases	Scopus	26788	185	115	71	67	23	16
	EBSCO	173 086	955	638	243	225	24	6
	IEEE	3729	26	17	16	16	7	2
	ACM	1365	4	1	0	0	0	0
	Web Of Science	350	54	32	26	26	13	1
	Total	**205318**	**1224**	**803**	**356**	**334**	**66**	**25**

As for the Multivocal Literature Review fewer criteria were employed, as it is possible to observe in Table 4. For this review the database used was Google Schoolar.

Table 4 – MLR Criteria

	Criteria
C1	Keywords are present on the studies’ abstract
C2	The language used for writing was English
C3	The study contents are relevant to the literature review
C4	Study is not duplicated

5. Findings

After conducting both literature reviews and analyzing what had been already identified by the existing literature it was possible to gather an overview of the possible associations between different AI techniques and different Project Management Performance domains.

Regarding the **Stakeholder PD**, Taboada [3], concluded that certain AI techniques, such as ML, NLP and NN would be used for Stakeholder Management. Moreover, this author identified that Pérez Vera and Bermudez Pena [21] had already contributed with a fuzzy inference system that classifies stakeholders by utilizing two ML clustering algorithms. Additionally, the author in [22] forecasted that PM could be assisted by AI when the project manager must identify the stakeholders involved in the project and learn about them and their preferences, as well as, when creating a plan to communicate with these interested parties and carrying it out.

Concerning the **Team PD** many aspects were identified for having potential to be impacted by AI. AI uses data visualization to give instant updates on project progress. This helps the team and the leader make informed decisions about the project's important aspects, facilitating discussions with the team about the project's status [23]. Another important aspect. Furthermore [3] noted how AI-assisted communication can improve team performance.

Even though there was no literature concerning the **Development Approach and Life Cycle PD** [3] it is possible to project how AI could affect this domain. We can expect AI techniques to impact the projects methodology, life cycle and its deliverables since these aspects are the base of this domain. The impact on these aspects would contribute to a continuous evaluation of the project and an improved management of the project's deliverables.

In reference to the **Planning PD** many authors reported how important and impactful AI is when planning a project. Sravanthi et al. [23] affirmed that AI can help project managers plan projects more accurately and track progress more efficiently. Moreover, AI-powered project management solutions could aid in making better resource allocation decisions by using machine learning algorithms, as well as provide updates regarding project data, which would allow an informed decision-making process concerning many aspects such as project duration and cost. Likewise, [14] noted that using AI techniques for PM would be beneficial regarding Resource Allocation, Budgeting and Forecasting.

Regarding the **Project Work PD** authors in [3] identified an already existing cost-efficient AI-powered chatbot framework tailored for project management. This innovative solution holds promise in saving time for project managers and mitigating project failures.

Writers in [3], come to the conclusion, about the **Delivery PD**, that automation of project quality management using AI-powered techniques offer the prospect of efficient project delivery.

In regard of the **Measurement PD** the authors in [3] identified that AI techniques can be employed to evaluate project performance metrics, identifying delays, implementing suitable responses, and monitoring activities leads to accurate project assessment. Furthermore, the authors identified numerous existing works forecasting Earned Value Management and comparing them to AI techniques, where it was considered that AI techniques are better at predicting when the training and test sets are similar.

Concerning the **Uncertainty PD** authors [14] [15] and [22] expressed how the utilization of various AI technologies and algorithms can aid when dealing with risk management. More specifically [22] suggests that maintaining a list of potential adverse effects, utilizing advanced checklists, conducting variance analysis, and implementing intelligent sorting and grouping can help organizations anticipate and mitigate the costs associated with risk events more effectively. Furthermore, [19] stated that effective project management involves thoroughly planning responses to project risks, and furthermore identified that ML has been successfully applied to to assess the degree of risk and measure its anticipated impact, as well as, NLP application in risk identification. Additionally the author stated that there is a distinct emphasis on ML techniques for risk assessment, alongside a clear dedication to risk identification, analysis and response planning, however other AI domains hold potential for application in these aspects.

A summary of the identified connections between Project Management Performance Domains and AI Techniques is presented in table 5.

Table 5 – Utilization of AI Techniques in Project Management Performance Domains

Performance Domains	AI Techniques	Impacted Aspects of PM	Contributions	Examples
Stakeholder	ML, Natural Language Process Neural Networks, Fuzzy Approaches	Stakeholder Management [3] [20] Stakeholder Identification [22]	Improved Communication Risk Identification Opportunity Identification Expectation Alignment Improved Collaboration	Fuzzy Inference Systems [21]
Team	Chatbots, ML	Team Performance [3] Task Management [15] [22] [23] Leadership Development [23] Team Management [3] [20] [22]	Improved Communication Knowledge Management Optimised Team Work Improved Motivation and Team Spirit Abilities Development Improved Work Culture	Rescoper [1] Clickup [1] Clarizen [1]
Development Approach & Life Cycle	Chatbots, ML, Neural Networks	Project Methodology Project Life Cycle Project Deliverables	Deliverables Management Continuous Evaluation	
Planning	Fuzzy Approaches, Neural Networks, Expert Systems, AI Chatbots, ML	Budgeting [14] [20] [23] Decision Making [23] Resource Allocation [14] [23] Project Schedulling [23] Forecasting [23]	Flexibity to Change Improved Risk Managament Maximising Resources Efficiency	Primavera P6 [23] Zivebox [23] Celoxis [23] Project Wise [23] Deltek Acumen [23] Polydone [23] Tara [18]
Project Work	Expert Systems, Fuzzy Approaches, Neural Networks, ML, Natural Language Process, Chatbots	Project Processes Stakeholder Communication [3] [20]	Knowledge Management Optimised Team Work Improved Communication Continuous Learning	Clickup [1]
Delivery	Neural Networks, Fuzzy Expert Systems, AI Chatbots, ML, Natural Language Process	Scope Definition and Delivery Deliverables Management Project Quality [3] Schedule Compliance	Improved Deliverables Quality Optimised Produt	Model to consolidate Critical Sucess Factors [3]
Measurement	ML, Fuzzy Approaches, Neural Networks, Expert Systems, AI Chatbots	Earned Value Methods [3] [19] KPIs [20] Stakeholder Satisfaction Risk Monitoring [19]	Refined Metrics Pattern Identification Risk Identification	Comparison between ML Algorithms and Earned Value Managament (EVM) methods [3]
Uncertainty	Fuzzy Approaches, ML, Neural Networks, NLP, Expert Systems	Change Management Risk Management [15] [19] [20] Response Planification [19] Risk Identification & Analysis [19] Monitoring [19] Stakeholder Satisfaction	Improved Flexibity and Adaptability Improved Communication Improved Planning Continuos Learning	ML-based prediction system to forecast the risk [3]

6. Conclusion

This study explored how AI Techniques could be integrated in Project Management, specifically through the Performance Domains. It incorporates an innovative approach since most of the existing literature is based on PMBOK 6th edition knowledge areas, as where in this study the framework is built around the performance domains. With that being, this study contributes significantly to fill the research gaps identified and offer knowledge to the subject. Through table 5 we can have a better understanding of the topic and we are able to answer the research question as we can see what associations are possible to form between AI and PMPD as well as what contributions they provide. We can understand that the domain with less research is the Development Approach and Life Cycle and the one where most research was done was the Planning domain.

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