

The Mediating Role of Project Manager's Competencies in the Relationship Between Using Artificial Intelligence and Project Constraints

A study on the Contracting Companies in the Eastern Province of Saudi Arabia

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DEDICATION



ACKNOWLEDGMENT



ABSTRACT



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LIST OF DIAGRAMS

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1	Variables and Relationships Diagram



LIST OF ABBREVIATIONS

Abbreviation	Definition
AI	Artificial Intelligence
PMO	Project Management Office
BIM	Building Information Modeling
DT	Digital Twins
ML	Machine Learning
DL	Deep Learning
NLP	Natural Language Processing
RPA	Robotic Process Automation
PMI	Project Management Institute
IPMA	International Project Management Association
APM	Association for Project Management
AIPM	Australian Institute of Project Management
AACE	Association for the Advancement of Cost Engineering
GDPR	General Data Protection Regulation



CHAPTER 1

Introduction

Rapid technological advancements, particularly in Artificial Intelligence (AI), are significantly impacting various industries. AI has become a crucial tool in project management, introducing new trends like smart monitoring systems and offering the potential for improved project outcomes (Alshaikhi & Khayyat, 2021).

AI's capabilities in data collection and processing, especially for repetitive tasks, enhance project managers' decision-making skills, positively influencing planning strategies, risk management, communication, and resource allocation. By automating routine tasks and providing data-driven insights, AI simplifies complex decision-making processes, allowing project managers to focus on more strategic aspects of their work (Khatib & Falasi, 2021; Phaladi et al., 2022).

The predictive analytics offered by AI-enabled project management systems help mitigate project constraints, leading to more efficient execution and improved outcomes. AI also enables better time and resource management, making project managers more effective compared to traditional methods. Key areas where AI assists include planning, resource allocation, decision-making, and risk management (Prifti, 2022; Dam et al., 2019; Nagireddy, 2023).

This study examines the relationship between AI usage and project constraints within Saudi Arabia's contracting sector, a critical industry with an annual market size of approximately 255 billion Saudi Riyals. Understanding AI's role in this sector is essential to leveraging its potential for enhanced efficiency and better project outcomes, as noted by the Saudi Contractors Authority.

Keywords

Saudi Arabia, Artificial Intelligence, Project Manager Competencies, Project Constraints, AI-Driven Construction Projects.

Problem Statement

Project Management is an important part of any development, whether for Organizations or even Countries. Without properly managing the processes during the whole life cycle with the correct tools, the chances of not achieving the desired outcomes will be high. Therefore, as part of Saudi Vision 2030, a Project Management Office (PMO) was established by the Saudi Government to manage government projects. (Vision 2030)

Although AI is being widely used nowadays globally in several fields, it is not yet utilized in a wide range in the Project Management field. The Contracting sector in Saudi Arabia is no different for not yet utilizing the capabilities of AI technologies properly. Therefore, there is a need to understand the impact of AI on Project Management, specifically on the competencies of the Project Managers and the Project Constraints.

Like any other field, new technologies have impacts on Project Management in general, especially AI. Some major Multinational companies have already started to use AI to get their work done better and faster. However, it is unknown how AI is helping project managers do their jobs or how it makes it easier to finish projects on time and within budget.

Project managers need to keep up with technology, so they need new skills to work well with AI. Also, there is a need to look closely at whether AI is having an impact on the project constraints where it makes it easier in terms of dealing with them or it makes it more complicated.

It is worth noting that there is a scarcity of studies addressing the relationship between project managers' competencies and artificial intelligence, and linking it to project constraints in Arab countries in general, and in the Kingdom of Saudi Arabia in particular.

This research aims to look closely at how AI is affecting project managers' skills and the usual challenges in projects which is important for the Contracting sector in the Eastern Province of Saudi Arabia, where there are many ongoing construction and

services projects. This research will help companies and project managers understand the pros and cons of using AI, so they can make better plans for the future and be ready for more technologies in their work.

The study will answer the following main question and sub-questions related to using AI in Project Management in general, particularly on Project Managers Competencies and Project Constraints:

Q1- What is the impact of using AI on project managers' competencies in contracting companies in the Eastern Province of Saudi Arabia?

Q1.a- What are the new competencies required for project managers in the context of AI utilization in project management?

Q2- What is the impact of using AI on Project Constraints in contracting companies in the Eastern Province of Saudi Arabia?

Q3- What are the challenges faced by contracting companies in the Eastern Province when implementing AI in project management?

Importance of the Study

Theoretically, the study will help the companies and individuals within the study population to understand the difference between traditional project management and AI-enhanced project management.

Practically, it will make them aware of what is going on within the field of Project Management and what should be done by them to be in line with the technological trend that will change the contracting industry and will also provide an overview of the new technologies within the Project Management field that embedded AI and the recommended practices based on these new technologies.

Research Objectives

- 1- Examine the Relationship between AI usage and Project Managers' Competencies.
- 2- Examine the Relationship between AI usage and Project Constraints.
- 3- Examine the Relationship between Project Managers' Competencies and Project Constraints.

Research Hypotheses

The Hypotheses of these questions are:

- H.1-** There is a significant relationship between the use of AI, Project Constraints, and Project Managers' Competencies.
- H.2-** There is a positive impact of using AI on Project Managers' Competencies.
- H.3-** There is a positive impact of using AI on Project Constraints
- H.4-** There is a positive impact of Project Managers' Competencies on Project Constraints.
- H.5-** The significant impact of using artificial intelligence on project constraints increases when mediated by project managers' competencies.

Literature Review

No	Title	Author	Year	Related Literature	Result	Recommendations
1	Investigating AI Applications in Construction Industry: A Systematic Review	Güray	2023	The paper examines how AI helps in handling the challenges in the Construction Industry.	There is a strong linkage between Building Information Modeling (BIM), Digital Twins (DT), Machine Learning (ML), and Deep Learning (DL).	Increasing the research in the construction field specifically the case studies about the AI Technologies being used in the Construction Industry.
2	Implementation of Artificial Intelligence in Project Management and effect in working personnel	Kelepouris	2023	This research studies the impact of AI in Project Management on the Working Personal.	Implementing AI in Project Management offers opportunities for boosting efficiency and achieving better results.	Considering a phased approach by Organizations in applying AI in Project Management.

3	Project Management in the Era of Artificial Intelligence	Sahadevan	2023	This research studies the pros of applying AI in Project Management on resource allocation, Risk Management, Decision Making, and Planning.	AI improves all the different sides of Project Management including decision making and resource allocation.	• Encouraging learning and innovation within the Organizational Culture will help to improve the technologies. • Project Managers, Data Scientists, IT Professionals, and Business Leaders should collaborate to integrate AI in Project Management. • Project Management Professionals should be up to date with all the innovations and utilize the
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						capabilities of the new Technologies.
4	A Qualitative Study on Artificial Intelligence and Its Impact on the Project Schedule, Cost and Risk Management Knowledge Areas as Presented in PMBOK®	Fridgeirsson, et al.	2023	The paper discusses the impact of AI on 3 out of 10 of the PMBOK 6th edition Knowledge Areas which are Cost Management, Schedule Management, and Risk Management.	AI will significantly impact Project Schedule, Cost, and Risk Management.	• Further research can give more specific results about the Impact of AI on Project Management. • Interviews with AI specialists could give exact answers on how AI can be used to help in the field of Project Management.
5	Artificial Intelligence and Its Impacts on Project Management	Nagireddy	2023	The study provides a literature review and case studies of adopting AI in Project Management and its impact.	AI has the capability of improving Project Planning, resource allocation, Risk	Further research investigating AI-based solutions is required for specific functions

					Management, and Decision-making.	from a scientific point of view.
6	The Role of Artificial Intelligence in Project Management	Odeh	2023	The paper discusses the importance of adopting AI in Project Management stating that stakeholders are expecting to see new tools and techniques for managing a successful project.	AI-supported applications can do better planning and other administrative tasks.	• Transforming from the Traditional project management approach to AI-supported applications is needed. • The Transformation process should be in phases involving people, processes, and technology.
7	Mapping Two Decades of AI in Construction Research: A Scientometric Analysis	Regona, et al.	2023	The study examined the effect of AI on enhancing productivity, sustainability, and efficiency in construction.	Utilizing Intelligent Systems shows an improvement in productivity,	Further research is required focusing on the identified challenges like the

	from the Sustainability and Construction Phases Lenses				efficiency, safety, and sustainability in the construction industry.	cost-effectiveness of implementing AI in the construction industry, ensuring fair access to AI-driven solutions, and resolving the data integration and interoperability issue.
8	The possibility of applying artificial intelligence techniques to stakeholder management in project management in the Kingdom of Saudi Arabia	Almohammad, et al.	2022	The paper focuses on utilizing AI to provide information to Stakeholders that support decision-making.	• There is an acceptance of applying AI Technology to Stakeholders Management/. • Applying AI in Project Management will help in Decision-making.	• It is important to get the assist and support from AI Specialists. • It is important to clarify the importance of AI in Project Management in Managing Stakeholders.

					• Using AI in Project Management can help specify the causes of delay. • Utilizing AI in Project Management can help in identifying future risks.	• Providing training to Stakeholders about AI. • Benefiting from other countries' experiences in utilizing AI in Project Management.
9	Knowledge management processes based on artificial intelligence in construction projects: an applied study in the Kingdom of Saudi Arabia	Alghamdi & Aldharman	2022	The paper discusses the impact of using AI on Knowledge Management processes in Construction Projects from the opinion of Contractors in Saudi Arabia.	• Applying Knowledge Management through AI Applications has an impact on the Construction Industry. • There is a relationship between	Enhancing the use of Knowledge Management Processes based on AI to resolve the problems that are related to progressing delay in the construction projects in Saudi Arabia and

					Knowledge Management Processes and AI Applications in Construction Projects.	taking care of the Financial side.
10	Adoption of Artificial Intelligence for Optimum Productivity in the Construction Industry	Victor	2022	The purpose of the study is to connect the benefits of AI with its practical applications in the construction industry by examining some case studies.	• Utilizing Touchplan application increases the predictability and profitability of project outcomes. • Utilizing Touchplan application saves time on projects by reducing rework in executing the projects.	• Increasing the allocated funds for scientific research in the construction sector. • Investigating AI systems for aspects other than planning like Engineering Design and Facility maintenance. • Invistegsting individual

						demographics like gender geography and culture to understand the challenges presented by these factors. • Investigating the Government Programs and Policies that affect on adaptation rate of an organization.
11	An investigation into the Impact of Artificial Intelligence on the Future of Project Management	Alshaikhi & Khayyat	2021	The paper investigates the importance of AI and its impacts on Project Management. It also emphasizes that AI, Machines, and Robots can automate tasks	Technologies and AI can run the machines and robots and perform some tasks but they can't replace humans.	• A skilled Project Manager is required to be able to utilize AI properly and achieve the desired outcomes of utilizing

				and tools, but they need humans to manage.		AI in Project Management.
12	Impact of Artificial Intelligence in South African Construction Project Management Industry	Makaula, et al.	2021	The purpose of this paper is to explore the influence of AI technology across various project lifecycle stages, intending to develop an integrated framework for construction management.	AI is important in the Construction industry and it can be used in several stages within the Project Lifecycle.	Innovated Technologies should be utilized in the Construction Sector, especially in Africa.
13	Research on the Application of Intelligent Construction Site in Construction Site Management	Zhang	2020	The paper discusses the use of Information Technology making an intelligent worksite to manage the workers and the site and to have more efficient management than the traditional management style.	It is important to utilize information technology in solving the problems in the construction industry with quality management and the utilization of intelligent construction sites.	• Adopting Information Technology to manage Personal and Construction Sites and implementing intelligent worksite concepts. • Implementing Training, Teaching,

						and Technical methods addressing quality and safety issues in construction sites. • Implementing BIM Technology. • Applying real-time management and control to improve efficiency.
14	Artificial Intelligence Enabled Project Management: A Systematic Literature Review	Taboada, et al	2023	The paper discusses the possibilities of improving project performance by applying AI.	• An Increase in the publications related to AI-enabled Project Management. • There are various AI applications that can	• There is a need to do more research on AI applications. • A Developed Framework guiding the integration of AI. • Developing the skills of Project Managers

					improve Project Management. • More researches are required about the challenges of adopting AI in Project Management	to be able to utilize AI effectively.
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Although research about AI in different fields is the trend nowadays. However, there are still more topics that are not yet completely covered in research in the field of AI that is related to Project Management. Therefore, this research will be a reference for future research related to AI in Project Management and will help in covering some of the topics that are not yet covered.

Based on the literature review, no research in the scientific community studies the impact of AI on Project Manager's Competencies and Project Constraints specifically on the Contracting Sector in Saudi Arabia. Therefore, this study is expected to explain the importance of AI to Project Managers, company owners, and decision-makers.

The Role of Artificial Intelligence in Project Management

The term Artificial Intelligence was brought up by John McCarthy in the middle of the 1950s when he defined it as "The Science and Engineering of making intelligent machines" (Manning, 2020). It is simply a technical revolution that has invaded almost every field. From the righteous utilization like the medical field (Haleem et al., 2019) to the Banking sector (Balcioğlu et al., 2022) reaching to the Media sector (Díaz-Noci et al., 2024) and then to the evil side when humans started to utilize it in the Armies (Walker, 2023).

AI is transforming project management by integrating advanced algorithms and computational methods that enhance decision-making, automate routine tasks, and improve overall efficiency. With its ability to analyze large datasets, predict outcomes, and provide actionable insights, AI modernizes traditional project management practices. Key AI-powered tools for project management include Machine Learning, which refines predictions, optimizes resource allocation, and analyzes historical data for project forecasting and risk assessment. Another important tool is Natural Language Processing (NLP), which enables AI systems to understand and manage project communications and documentation (Krishnan & Krishnan, 2023; Felicetti et al., 2024).

AI-powered tools such as chatbots and Virtual Assistants help streamline project management by automating administrative tasks like communication, meeting

scheduling, and reminders. Predictive Analytics, fueled by historical data, allows for forecasting project timelines, costs, and potential risks, enabling project managers to make informed, data-driven decisions. Additionally, Robotic Process Automation (RPA) automates repetitive tasks like data entry and report generation, freeing project managers to focus on more strategic activities (Odeh, 2023; Savio & Ali, 2023; Krishnan & Krishnan, 2023).

Data Visualization Tools enable real-time monitoring of project performance, allowing managers to quickly identify and address potential issues. Additionally, Decision Support Systems, powered by AI, analyze data to provide recommendations for project planning, execution, and monitoring, thereby enhancing decision-making (Krishnan & Krishnan, 2023; Duică et al., 2022).

Benefits of AI for Project Constraints

AI plays a pivotal role in addressing project constraints by optimizing decision-making, streamlining resource allocation, and automating repetitive tasks. It enhances scheduling by analyzing constraints and dependencies to create optimized project timelines. AI-powered scheduling tools allow project managers to monitor factors influencing deadlines, enabling timely decisions to prevent delays and keep projects on track (Savio & Ali, 2023). This helps overcome common project challenges by ensuring efficient use of resources and adherence to project timelines.

AI enhances budget management by providing accurate forecasts through historical data and real-time analytics, helping project managers allocate resources effectively, track expenditures, and minimize the risk of budget overruns. Additionally, AI can evaluate team members' skills and workloads to assign tasks more efficiently, ensuring optimal resource utilization by matching the right resources to the appropriate tasks. This capability not only enhances human capital efficiency but also improves overall project performance (Krishnan & Krishnan, 2023; Belharet et al., 2020).

AI plays a crucial role in project management by offering early warnings and recommending mitigation strategies, allowing project managers to address potential risks before they escalate, and ensuring projects stay on track and within scope. It also enables real-time project monitoring, allowing managers to track progress and detect deviations instantly, providing enhanced visibility and timely insights for stakeholders,

which improves project control and responsiveness. Furthermore, AI automates routine administrative tasks, freeing project managers to focus on strategic decision-making and value-added activities, thereby enhancing efficiency and supporting smoother project execution. Additionally, AI analyzes large datasets to extract valuable insights that improve project planning and execution, enabling project managers to make well-informed decisions that align with project objectives and constraints (Savio & Ali, 2023; Odeh, 2023; Krishnan & Krishnan, 2023).

In summary, AI enhances project management by offering tools and insights that effectively address constraints related to time, cost, resources, risk, and decision-making, ultimately improving project efficiency and outcomes.

Challenges of AI Implementation

Adopting AI in project management brings several challenges that organizations need to address for successful implementation, including:

1. The quality of data and its availability: AI systems depend on high-quality, relevant data for accurate analysis and decision-making. Incomplete, outdated, or inconsistent data can result in unreliable conclusions and negatively impact project outcomes (Sahadevan, 2023; Duică et al., 2022).
2. Insufficient Experience: A significant shortage of skilled professionals capable of designing, developing, and implementing AI systems effectively poses a major challenge. This skills gap can hinder the successful integration of AI into project management workflows (Sahadevan, 2023; Alshaikhi & Khayyat, 2021).
3. Seamless integration with current platforms: Incorporating AI technologies into existing project management systems can be complex and time-consuming, especially in large organizations. Successful integration is crucial to fully realizing the benefits of AI (Sahadevan, 2023; Duică et al., 2022).
4. Change Resistance: Employees may resist adopting AI due to fears of job displacement or challenges in adapting to new technologies. Implementing

effective change management strategies is essential to alleviate these concerns and foster acceptance (Vegar & Mijač, 2024; Oyekunle et al., 2024).

5. **Ethical Controversies:** The adoption of AI introduces ethical challenges, including algorithmic bias and data privacy issues. Organizations must ensure compliance with legal regulations and ethical standards to build trust and maintain stakeholder confidence (Oyekunle et al., 2024; Duică et al., 2022).
6. **Implementation Expenses:** The significant initial investment needed for AI tools, infrastructure, and training can be a challenge, particularly for smaller organizations or those operating with limited budgets (Sahadevan, 2023)
7. **Independence and Authority:** As AI systems gain greater autonomy, project managers may face challenges in maintaining oversight and control over AI-driven processes. This can raise concerns about accountability and the transparency of decision-making (Belharet et al., 2020).
8. **Creativity and Human Intuition:** AI cannot replicate human creativity and intuition, which are often essential in project management. This limitation may reduce AI's effectiveness in scenarios requiring innovative solutions or nuanced decision-making (Belharet et al., 2020).

Addressing these challenges requires thoughtful planning, a well-defined AI strategy, and a commitment to continuous learning and adaptation within organizations. By fostering a culture of innovation and collaboration, organizations can successfully navigate the complexities of AI integration and maximize its potential benefits.

Project Constraints and Their Impact on Project Success

Overview of Project Constraints

The traditional project constraints, commonly known as the "triple constraints" or the "iron triangle," comprise scope, time, and cost. These constraints are essential elements of project management and have a profound impact on project outcomes. However, there are several Project Management Organizations that are making the standards and certifications in the project management field. The most famous organizations among them are:

- Project Management Institute (PMI).
- International Project Management Association (IPMA).
- Association for Project Management (APM).
- AXELOS (PRINCE2®).
- Australian Institute of Project Management (AIPM).

Each of these organizations has identified project constraints from their point of view. PMI identified the constraints as Scope, Time, Cost, Quality, Resources, and Risk and this is what IPMA identified as constraints (PMI, 2021; IPMA, 2015;). APM, AXELOS, and AIPM have identified constraints exactly similar to PMI & IPMA but they have also added other things. APM has identified Stakeholder Engagement and Governance as a Constraint to be added to the previous list (APM, 2019). AXELOS added to the list of PMI and IPMA Benefits as a constraint (AXELOS, 2017). AIPM added Strategic Alignment and Governance as a constraint (AIPM, 2014). These constraints have a significant influence on the project outcomes.

The scope of a project outlines its boundaries, detailing the specific deliverables and the work necessary to complete the project. A clearly defined scope ensures that all stakeholders share a common understanding of the project's objectives. Poor scope management can result in scope creep, where additional features or requirements are introduced without corresponding adjustments to the timeline and budget, potentially compromising the project's success (Nagireddy, 2023).

The Time pertains to the project's timeline, outlining the schedule for completing deliverables. Adhering to timelines is crucial to ensure that tasks are finished as planned. Delays can increase costs and negatively impact stakeholder satisfaction. Effective time management requires developing a realistic schedule and maintaining adherence to it, which is vital for sustaining project momentum and meeting deadlines (Davahli, 2020).

The Cost involves the budget allocated for the project, covering all resources needed to complete it. Effective cost management is essential, as exceeding the budget can jeopardize the project's success. Accurate cost estimation and continuous budget monitoring are critical to ensuring the project remains financially sustainable (Rahman et al., 2020).

Quality relates to the standards and requirements a project must meet to satisfy stakeholders. Inadequate quality management can result in rework, increased costs, and diminished stakeholder satisfaction (PMI, 2021). Deliverables that fail to meet quality expectations can harm the organization's reputation and long-term success. Achieving consistent quality demands clear specifications, ongoing monitoring, and strict adherence to established standards.

Resources include the personnel, materials, equipment, and tools needed to complete a project. Inefficient allocation of resources can lead to delays, cost overruns, and reduced productivity (IPMA, 2015). For instance, a lack of skilled labor can compromise project performance, while over-allocation of resources may result in burnout and decreased team efficiency.

Risk refers to the uncertainties and potential adverse events that may affect project success. Inadequate risk management can cause unexpected disruptions, cost overruns, and missed deadlines (AACE International, 2016). Proactively identifying, assessing, and mitigating risks is crucial to minimizing their impact and keeping the project on track.

Stakeholder Engagement involves identifying, analyzing, and addressing the interests and expectations of individuals or groups affected by or capable of influencing the project. Inadequate engagement can result in misaligned objectives, unmet expectations, and resistance to project outcomes, threatening the project's success (APM, 2019). Conversely, effective engagement promotes collaboration, builds trust, and ensures stakeholder needs are considered throughout project planning and execution.

Governance ensures that projects are carried out within the organizational framework, following established processes, standards, and policies. Poor governance can result in scope creep, resource mismanagement, and a lack of accountability, all of which can undermine project success (APM, 2019). Conversely, robust governance structures clarify roles and responsibilities, ensure adherence to legal and ethical standards, and support informed decision-making, contributing to better project outcomes.

Benefits are a key constraint in project management, focusing on ensuring that projects deliver tangible value to stakeholders, inform decision-making, and align with

organizational goals. Effective management of this constraint is essential for achieving long-term success and sustainable outcomes (AXELOS, 2017).

Strategic Alignment ensures projects contribute to the broader organizational objectives. Managing this constraint effectively is essential for achieving long-term value and stakeholder satisfaction (AIPM, 2014).

The interaction among these constraints implies that a change in one can significantly impact the others. For instance, expanding the project scope may demand additional time and resources, resulting in higher costs. Conversely, shortening the project timeline might require reducing features or increasing expenditures to meet the adjusted deadline. To make it short, project constraints are interconnected and play a vital role in influencing the overall success of a project (Mohammad & Chirchir, 2024).

Impact of AI on Constraints

AI enhances scope management by offering tools that automate the identification and management of project requirements and changes. For example, machine learning algorithms can analyze historical project data to uncover patterns and trends, enabling project managers to define and adjust the project scope more accurately and efficiently (Krishnan & Krishnan, 2023) and can also aid in tracking project deliverables to ensure they remain aligned with the defined scope, thereby minimizing the risk of scope creep (Odeh, 2023).

AI significantly improves time and cost management by leveraging automation and predictive analytics. It can automate scheduling tasks, such as setting deadlines and managing resource calendars, allowing project managers to focus on higher-level strategic activities. AI-driven tools also provide real-time updates and alerts on project timelines, helping managers identify potential delays early and take corrective actions, which enhances the accuracy of time estimates and ensures projects stay on schedule. In terms of cost management, AI delivers more accurate budget forecasts and detects potential cost overruns in advance by analyzing historical data and current project metrics, enabling project managers to predict future expenses and recommend cost-saving strategies. Additionally, AI optimizes resource allocation, ensuring financial

resources are used efficiently across project tasks, leading to significant cost savings (Belharet et al., 2020; Odeh, 2023; Wardi, 2024; Krishnan & Krishnan, 2023).

In summary, AI enhances project management by optimizing the management of project constraints through automation, predictive analytics, and data-driven insights, ultimately driving more successful project outcomes.

Limitations of AI in Addressing Constraints

Although AI provides significant advantages in project management, there are certain situations where it falls short in addressing specific constraints, making human judgment essential.

1. **Complex Decision-Making:** While AI excels at data analysis and pattern recognition, it may falter in handling complex decisions that demand nuanced understanding and contextual awareness. For example, project managers often encounter situations involving conflicting stakeholder interests, ethical dilemmas, or unexpected events that require human intuition, judgment, and experience to manage effectively (Bushuyev et al., 2024).
2. **Emotional Intelligence:** AI is unable to perceive or respond to human emotions, a critical aspect of managing team dynamics and stakeholder relationships. Human project managers can empathize with team members, provide motivation, and resolve conflicts with sensitivity and understanding—capabilities that AI cannot replicate (Bushuyev et al., 2024; Kelepouris, 2023).
3. **Creative Problem-Solving:** While AI can analyze data and propose solutions based on historical patterns, it cannot often develop innovative ideas or tackle unique challenges creatively. Human creativity is indispensable for brainstorming, strategic planning, and adapting to new situations that demand out-of-the-box thinking (Bushuyev et al., 2024).
4. **Ethical and Moral Judgements:** AI systems often struggle to address ethical dilemmas or moral questions that arise during project execution. Decisions involving fairness, equity, and ethical considerations require human judgment

to ensure alignment with organizational values and societal norms (Kelepouris, 2023).

5. **Data Quality and Availability:** AI depends on high-quality, structured data for optimal performance. When data is incomplete, inconsistent, or biased, AI may deliver unreliable results. Human oversight is crucial to assess data quality, address gaps, and make informed decisions based on available information (Belharet et al., 2020; Alshaikhi & Khayyat, 2021).
6. **Change Management:** The implementation of AI systems can sometimes cause resistance among team members who may feel threatened by automation. Human project managers are essential in managing this change by effectively communicating the benefits of AI, addressing concerns, and fostering a collaborative culture that integrates both human and AI contributions (Kelepouris, 2023).
7. **Interpersonal Relationships:** Establishing trust and rapport among team members and stakeholders is critical for project success. Human project managers rely on their interpersonal skills to build strong relationships and promote collaboration—capabilities that AI cannot replicate (Bushuyev et al., 2024).

In summary, while AI enhances efficiency and provides valuable insights into project management, human judgment remains indispensable in areas requiring emotional intelligence, creativity, ethical reasoning, and complex decision-making. Striking a balance between AI capabilities and human expertise is vital for achieving successful project outcomes (Kelepouris, 2023; Bushuyev et al., 2024).

Key Competencies of Project Managers in AI-Driven Projects

Technical Competencies

Project managers require a diverse range of technical skills to effectively integrate AI into project management. These skills empower them to utilize AI tools and technologies to improve project outcomes.

1. **Data Analysis and Interpretation:** Project managers need proficiency in analyzing data produced by AI systems. This involves understanding how to interpret AI-generated insights, forecasts, and recommendations to make well-informed decisions (Bushuyev et al., 2024; Tubman, 2022).
2. **Familiarity with AI Tools and Technology:** Project managers should know various AI tools and platforms that support project management. This includes understanding how to operate software with AI capabilities, such as task automation, predictive analytics, and resource allocation features (Wardi, 2024; Lokhande, 2022).
3. **Machine Learning Basics:** A foundational understanding of machine learning concepts enables project managers to grasp how AI systems learn from data and make predictions. This knowledge is essential for effectively integrating AI into project workflows and making informed decisions about its use (Taboada et al., 2023).
4. **Technical Project Management Skills:** Proficiency in traditional project management methodologies, such as Agile and Waterfall, is essential. Project managers should be capable of incorporating AI capabilities into these frameworks to enhance efficiency, adaptability, and overall project effectiveness (Kelepouris, 2023; Dam et al., 2019).
5. **Risk Management:** Understanding how AI can assist in identifying and mitigating risks is crucial. Project managers should leverage AI tools to analyze potential risks, predict their impact, and develop proactive strategies to address them effectively (Krishnan & Krishnan, 2023; Tubman, 2022).
6. **Knowledge of Automation Processes:** Familiarity with automation techniques and their application in project management is essential. This includes understanding how to automate repetitive tasks, such as scheduling and reporting, to save time and enable project managers to focus on more strategic responsibilities (Wardi, 2024; Belharet et al., 2020).

7. **Collaboration and Communication Tools:** Proficiency in utilizing collaboration tools with integrated AI functionalities is vital for enhancing team communication, streamlining project tracking, and ensuring seamless coordination among stakeholders (Kelepouris, 2023; Belharet et al., 2020).
8. **Understanding of Ethical Considerations:** Awareness of the ethical implications of using AI in project management is crucial. This includes understanding issues related to data privacy and algorithmic bias, and ensuring transparency in AI-driven decision-making processes (Belharet et al., 2020).

By cultivating these technical skills, project managers can effectively leverage the capabilities of AI to enhance project management processes, drive efficiency, and achieve better outcomes.

Leadership and Behavioral Competencies

In AI-driven projects, project managers must develop a distinct set of leadership and behavioral competencies to effectively address the complexities introduced by artificial intelligence technologies. These competencies can be grouped into the following key areas:

1. **Adaptability:** Project managers must remain flexible and open to change, as AI technologies evolve rapidly. The ability to adjust strategies and approaches in response to new information or shifting project dynamics is essential for maintaining project alignment and success (Oyekunle et al., 2024).
2. **Data-Driven Decision-Making:** Project managers must be adept at interpreting AI-generated insights and utilizing data analytics to make informed decisions. Comfort and proficiency in using data to guide strategies and actions are critical for navigating AI-driven projects effectively (Oyekunle et al., 2024; Müller et al., 2024).
3. **Collaboration and Teamwork:** AI-driven projects often require interdisciplinary collaboration, making it essential for project managers to cultivate a culture of teamwork. This involves encouraging cross-functional collaboration among

team members with diverse expertise to ensure cohesive project execution (Oyekunle et al., 2024; Kelepouris, 2023).

4. **Communication Skills:** Effective communication is crucial for explaining the benefits and implications of AI technologies to stakeholders. Project managers must be able to simplify complex AI concepts, present them in a clear and accessible manner, and foster meaningful discussions among team members (Oyekunle et al., 2024; Kelepouris, 2023).
5. **Change Management:** Managing change effectively is vital, as integrating AI often necessitates adjustments to existing processes and workflows. Project managers must develop change management strategies that address team concerns, mitigate resistance, and foster acceptance of new technologies within the organization (Kelepouris, 2023).
6. **Ethical Awareness:** Project managers must understand the ethical implications of using AI, such as concerns related to data privacy, bias, and accountability. They should ensure that AI applications adhere to ethical standards and align with the organization's values and societal expectations (Kelepouris, 2023; Bushuyev et al., 2024).
7. **Critical Thinking and Problem-Solving:** In an AI-driven environment, the ability to analyze situations critically and devise innovative solutions is crucial. Project managers must evaluate AI-generated recommendations thoughtfully and make informed decisions grounded in their expertise and experience (Bushuyev et al., 2024).
8. **Leadership and Motivation:** Inspiring and motivating team members is essential, particularly in a landscape where AI may alter traditional roles. Project managers should foster a supportive environment that values creativity, encourages innovation, and helps team members adapt to evolving responsibilities (Oyekunle et al., 2024; Kelepouris, 2023).

By cultivating these competencies, project managers can successfully lead AI-driven projects, leveraging the full potential of artificial intelligence while upholding high standards of project management practices.

Strategic and Business Competencies

Project managers play a vital role in AI initiatives with organizational objectives and making strategic decisions. To navigate this complex landscape effectively, they must possess a range of competencies, including:

1. **Technical Knowledge of AI:** Project managers need a solid understanding of AI technologies, including machine learning, data analytics, and automation tools. This expertise allows them to evaluate the feasibility of AI initiatives and determine how these technologies can be effectively integrated into existing processes and workflows (Kelepouris, 2023; Wardi, 2024).
2. **Strategic Thinking:** The ability to think strategically is crucial for aligning AI initiatives with organizational objectives. Project managers must comprehend the broader business context and identify how AI can create value, improve efficiency, and support the organization's long-term goals (Kelepouris, 2023; Müller et al., 2024).
3. **Leadership and Change Management:** Strong leadership skills are essential for guiding teams through the transformations brought about by AI implementation. Project managers must excel in managing change, addressing resistance, and cultivating a culture that embraces innovation and continuous improvement (Kelepouris, 2023; Bushuyev et al., 2024).
4. **Data-Driven Decision-Making:** Project managers must be proficient in analyzing and interpreting data, enabling them to make informed decisions using AI-generated insights. This includes leveraging data analytics to forecast trends, assess risks, and evaluate project performance effectively (El Khatib & Al Falasi, 2021; Tubman, 2022).
5. **Communication Skills:** Strong communication skills are essential for explaining the benefits and implications of AI initiatives to stakeholders. Project managers

must articulate complex AI concepts in a clear and accessible way for non-technical stakeholders, ensuring alignment, understanding, and support for AI projects (Kelepouris, 2023; Odeh, 2023).

6. **Collaboration and Interpersonal Skills:** Project managers must foster collaboration among cross-functional teams, including data scientists, IT professionals, and business stakeholders. Building strong relationships and encouraging teamwork is vital for successfully integrating AI into project management practices (Kelepouris, 2023; Duică et al., 2022).
7. **Ethical Awareness:** Understanding the ethical implications of AI, such as data privacy, bias, and accountability, is essential. Project managers must ensure that AI initiatives adhere to ethical standards and align with the organization's values and societal expectations (Bushuyev et al., 2024; Kelepouris, 2023).
8. **Adaptation and Continuous Learning:** In the face of rapidly evolving AI technologies, project managers must be adaptable and dedicated to continuous learning. Staying informed about the latest advancements in AI and project management methodologies is crucial for maintaining a competitive edge and ensuring project success (Kelepouris, 2023; Wardi, 2024).

By honing these competencies, project managers can successfully align AI initiatives with organizational objectives, enhance their strategic decision-making abilities, and drive successful project outcomes.

Competencies are essential for bridging the gap between the effective use of AI and achieving successful project outcomes. Project managers need the competency to understand both the capabilities and limitations of AI technologies. This knowledge allows them to seamlessly integrate AI tools into project workflows, maximizing the technology's potential. For example, recognizing how AI can automate routine tasks enables project managers to concentrate on strategic activities, ultimately improving project outcomes (Belharet et al., 2020; Bushuyev et al., 2024).

Competencies in data analysis and interpretation are crucial for project managers to make informed decisions using AI-generated insights. While AI can process large

datasets and offer recommendations, project managers must have the skills to interpret these insights and apply them effectively to project planning and execution. This ability enhances risk management, optimizes resource allocation, and improves overall project performance (Fridgeirsson et al., 2021; Bushuyev et al., 2024).

Implementing AI often necessitates changes to existing processes and workflows. Project managers with strong change management skills can effectively lead their teams through these transitions by addressing concerns, mitigating resistance, and fostering a culture that embraces innovation. These competencies are critical for ensuring the successful adoption of AI tools and maximizing their benefits (Kelepouris, 2023; Bushuyev et al., 2024).

Strong collaboration and communication skills are essential for project managers to effectively work with both AI systems and their teams. As AI tools become integral to project management, the ability to bridge communication between human team members and AI systems is increasingly important. This ensures stakeholder alignment and maximizes the effective utilization of AI's contributions to the project (Tubman, 2022; Bushuyev et al., 2024).

Competencies in ethics and compliance are vital when implementing AI systems in project management. Project managers must understand the ethical implications of AI, including concerns about data privacy and algorithmic bias. By addressing these issues, they can ensure the responsible use of AI, which is essential for maintaining stakeholder trust and upholding the integrity of the project (Kelepouris, 2023; Bushuyev et al., 2024).

The fast-paced evolution of AI technologies requires project managers to embrace continuous learning. Building competencies in emerging technologies and methodologies enables them to stay updated and adjust their strategies as needed. This adaptability is critical for effectively leveraging AI and ensuring project success in a constantly changing environment (Fridgeirsson et al., 2021; Bushuyev et al., 2024).

In summary, competencies act as a vital link between AI utilization and project success, equipping project managers with the skills needed to understand, implement, and manage AI technologies effectively. By cultivating these competencies, organizations can elevate their project management practices and achieve improved outcomes.

Competencies are crucial in determining the effectiveness of Artificial Intelligence (AI) in managing project constraints, either enhancing its potential or limiting its impact. Project managers with a solid understanding of AI technologies can effectively utilize AI tools to manage constraints like time, cost, and scope. Competencies in data analytics and machine learning empower them to interpret AI-generated insights, resulting in more accurate forecasting and informed decision-making (Kelepouris, 2023; Müller et al., 2024).

Effective management of project constraints heavily depends on data quality and availability. Project managers with strong competencies in data management can ensure that the data used by AI systems is accurate, relevant, and reliable. This is critical, as AI systems require high-quality historical datasets to deliver optimal results (Fridgeirsson et al., 2021; Savio & Ali, 2023).

Integrating AI into project management often requires adjustments to existing processes and workflows. Project managers with strong change management skills can facilitate smooth transitions, guiding teams to adapt to new AI tools and methodologies. This adaptability is crucial for fully leveraging AI's potential in managing project constraints (Kelepouris, 2023; Bushuyev et al., 2024).

Strong communication skills are essential to ensure all stakeholders understand the role of AI in project management. Project managers who can effectively articulate the benefits and limitations of AI tools foster collaboration among team members, enhancing the overall effectiveness of AI in managing project constraints (Kelepouris, 2023; Müller et al., 2024).

Competencies in ethical AI usage are becoming increasingly critical. Project managers must recognize potential biases in AI algorithms and ensure that AI applications are used transparently and fairly. This ethical awareness helps prevent challenges arising from mismanaged AI systems, safeguarding project outcomes and stakeholder trust (Bushuyev et al., 2024; Savio & Ali, 2023).

Despite AI's ability to automate tasks, the human element remains indispensable in project management. Project managers with strong leadership and emotional intelligence skills can guide their teams effectively, fostering resilience to challenges associated with AI integration. This human oversight is vital for maintaining team

morale and ensuring the effective utilization of AI tools (Fridgeirsson et al., 2021; Kelepouris, 2023).

In summary, project managers' competencies play a crucial role in determining the effectiveness of AI in managing project constraints. By cultivating the required skills and knowledge, they can maximize the potential of AI tools, resulting in improved project outcomes. Conversely, the absence of these competencies can impede the successful implementation and utilization of AI in project management.

Integrative Analysis and Synthesis

Project manager competencies play a crucial role in enhancing AI's ability to address project constraints. These skills enable project managers to effectively utilize AI technologies, ensuring improved project performance while managing key constraints.

Project managers with a solid understanding of AI technologies can seamlessly integrate AI tools into project workflows. This expertise enables them to select the most suitable AI applications to automate tasks, optimize resource allocation, and enhance decision-making, effectively addressing project constraints (Kelepouris, 2023; Müller et al., 2024).

Proficiency in data analysis allows project managers to accurately interpret AI-generated insights. By utilizing AI for data collection and reporting, they can make informed decisions to mitigate risks, manage project timelines, and effectively address constraints related to project delivery (Müller et al., 2024; Fridgeirsson et al., 2021).

In an AI-driven environment, adaptability is essential. Project managers who can embrace new technologies and methodologies are better equipped to adjust their strategies based on AI insights, enabling them to respond effectively to changing project conditions and constraints (Oyekunle et al., 2024; Kelepouris, 2023).

Project managers proficient in change management can effectively guide their teams in adopting AI tools. By addressing resistance to change and fostering a culture of innovation, they ensure that AI systems are fully utilized to manage project constraints successfully (Kelepouris, 2023; Bushuyev et al., 2024).

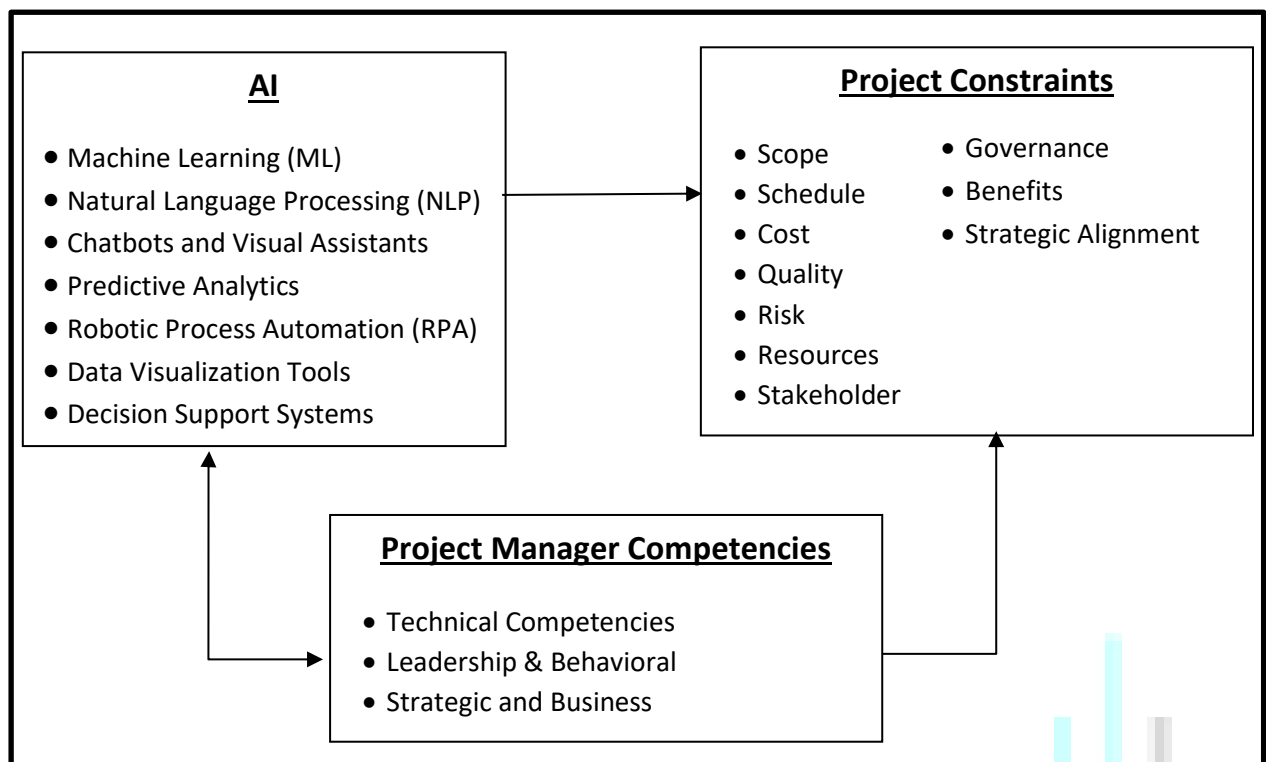
Effective communication skills allow project managers to convey the benefits and functionalities of AI tools to teams and stakeholders. This alignment fosters collaboration and helps address constraints stemming from miscommunication or lack of coordination, ensuring smoother project execution (Kelepouris, 2023; Müller et al., 2024).

Recognizing the ethical implications of AI usage is crucial for project managers. By ensuring that AI applications are implemented responsibly, they can address risks related to data privacy and bias, preventing potential project delays and mitigating constraints (Bushuyev et al., 2024; Kelepouris, 2023).

Project managers with strong leadership skills and emotional intelligence can inspire and motivate their teams to adopt AI technologies. This support fosters enhanced team performance and resilience, enabling more effective management of project constraints (Kelepouris, 2023; Müller et al., 2024).

In summary, project manager competencies are vital in maximizing AI's effectiveness in addressing project constraints. By leveraging their expertise and skills, project managers can seamlessly integrate AI technologies into project management practices, resulting in enhanced efficiency, improved decision-making, and successful project outcomes.

Conceptual Model



1 - Diagram representing the Variables and their Relationships

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