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Bridging Traditional Project Management and AI: The roles of traditional competencies, Strategic Alignment, and AI literacy in an Exploratory Q-Sort Analysis

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Abstract in Italiano

I rapidi progressi nell'Intelligenza Artificiale (AI) stanno trasformando la gestione dei progetti, introducendo nuove opportunità per l'efficienza, il processo decisionale e l'esecuzione strategica. Questa tesi esplora il ruolo dell'alfabetizzazione all'AI nella gestione dei progetti, valutandone l'impatto sulle competenze chiave richieste sia negli ambienti di project management tradizionali che moderni. In particolare, si indaga su come gli strumenti e le metodologie basati sull'AI influenzino aspetti fondamentali dell'esecuzione del progetto, tra cui la competenza tecnica, la pianificazione strategica e le dinamiche di leadership. Utilizzando la metodologia Q-sort, questa ricerca identifica quattro prospettive di competenza tra i project manager: Esecuzione Tecnica, Visione Strategica, Competenze Soft e Alfabetizzazione all'AI. Lo studio applica l'Analisi Fattoriale Esplorativa (EFA) per classificare i project manager in base al loro allineamento con queste prospettive e analizza in che modo l'adozione dell'AI varia attraverso queste dimensioni di competenza. I risultati rivelano che l'esecuzione tecnica e la visione strategica rimangono dominanti nelle pratiche di gestione dei progetti, mentre le competenze trasversali (soft skills) sono sempre più riconosciute come fondamentali per la leadership e il coinvolgimento degli stakeholder. Tuttavia, l'alfabetizzazione all'AI è ancora un fattore emergente, con un'adozione limitata tra i project manager, suggerendo una transizione graduale ma inevitabile verso un approccio di gestione dei progetti migliorato dall'AI. Questa ricerca contribuisce alla letteratura esistente evidenziando l'interazione tra alfabetizzazione all'AI, competenze tradizionali di project management e standard di settore in evoluzione. Sottolinea la necessità di programmi di formazione mirati sull'AI per colmare il divario tra il potenziale dell'AI e la sua applicazione pratica nella gestione dei progetti. Per i professionisti del settore, lo studio fornisce spunti su come l'AI possa essere integrata nei framework esistenti per ottimizzare l'efficienza, senza compromettere le competenze essenziali legate alla leadership umana e al processo decisionale.

Key-words: Project Management, AI Literacy, Traditional Competencies, Strategic Alignment, Q-Sort Methodology, Soft skills.

Abstract

The rapid advancements in Artificial Intelligence (AI) are reshaping project management, introducing new opportunities for efficiency, decision-making, and strategic execution. This thesis explores the role of AI literacy in project management by assessing its impact on the core competencies required in both traditional and modern project environments. Specifically, it investigates how AI-driven tools and methodologies influence key aspects of project execution, including technical proficiency, strategic planning, and leadership dynamics. Using the Q-sort methodology, this research identifies four distinct competency perspectives among project managers: Technical Execution, Strategic Vision, Soft Skills, and AI Literacy. The study applies Exploratory Factor Analysis (EFA) to classify project managers based on their alignment with these perspectives and examines how AI adoption varies across these competency dimensions. Findings reveal that technical execution and strategic vision remain dominant in project management practices, while soft skills are increasingly recognized as critical for leadership and stakeholder engagement. However, AI literacy remains an emerging factor, with limited adoption among project managers, suggesting a gradual but inevitable shift towards AI-enhanced project management approaches. This research contributes to the existing body of knowledge by highlighting the interplay between AI literacy, traditional PM competencies, and evolving industry standards. It underscores the need for targeted AI training programs to bridge the gap between AI potential and its practical application in project management. For practitioners, the study provides insights into how AI can be integrated into existing PM frameworks to optimize efficiency without undermining essential human-centric leadership and decision-making skills.

Key-Words: Gestione dei Progetti, Alfabetizzazione all'Intelligenza Artificiale, Competenze Tradizionali, Allineamento Strategico, Metodologia Q-Sort, Soft skills.

Contents

Chapter 1: Introduction

1.1 Rationale behind the research

The contemporary industrial landscape is marked by rapidly evolving scenarios**,** where the ability to adapt to new technologies and methodologies is increasingly crucial. This dynamic environment necessitates that organizations not only embrace change but also proactively innovate to maintain competitive advantage.

One of the most effective ways for organizations to keep pace with the fast-moving industry is through the dissemination of competencies across all levels of the company**.** This requires not only equipping employees with the technical skills necessary to adapt to new technologies but also fostering a culture that supports continuous learning and development. As noted by Senge, (1994), creating a 'learning organization' is crucial for sustaining innovation and adaptability in dynamic environments. As a result, companies become more flexible and resilient, better positioned to navigate market changes and maintain a competitive edge (Schein, 1992; Nonaka and Takeuchi, 1995)

Since leading companies often have the resources to invest in innovation and continuously develop their workforce, it becomes crucial for aspiring companies to adopt similar strategies to remain competitive. This means constantly refining strategies to enhance technological and organizational competencies (Drejer, 2001). As Christensen, (1997) discusses in The Innovator's Dilemma, companies that ignore disruptive technologies can quickly be outpaced by more agile competitors.

Similarly, just as data and new technologies have become pervasive over the past few years, we can reasonably expect a comparable trajectory for artificial intelligence. As AI evolves, its diffusion across industries will likely follow the same path of increasing integration (Hansen, 2023), much like data-driven technologies. Recent research by the OECD (2021) highlights the widespread adoption of AI and its parallels with earlier digital technologies, pointing to similar challenges and opportunities (Suikki, Tromstedt and Haapasalo, 2006).

1.2 Structure of the work

This thesis is structured to provide a comprehensive analysis of AI literacy in project management, exploring its influence on traditional and modern project management competencies and its implications for both practitioners and academics. The research is designed to address key questions regarding the integration of AI into project management skills and its broader impact on the profession.

Chapter 1 presents the rationale behind the research, outlining the growing importance of AI adoption in project management and how it is reshaping competency frameworks. This section establishes the research questions and objectives, focusing on the relationship between traditional competencies, soft skills, and AI-driven capabilities in project environments.

Chapter 2 provides a comprehensive literature review on project management competencies, encompassing perspectives from both practitioners and academics. This chapter explores key competency models such as ICB.4, PMCD, APM BoK, Praxis, PMI Talent Triangle, and PRINCE2, analysing their role in shaping project management standards. It also contrasts traditional and modern project management approaches, discussing the transition from conventional methods to Agile and AI-driven practices. Additionally, the chapter examines project management competencies in academia, highlighting how researchers conceptualize and assess the skills required for project managers in an AI-driven landscape.

Chapter 3 introduces the concept of AI literacy within the field of project management, defining its core dimensions and discussing its current and potential applications. This section explores how AI is used for decision-making, strategic planning, and automation in project management, while also addressing the barriers to AI adoption in professional settings.

Chapter 4 details the methodology, focusing on the Q-sort methodology as a means to capture subjective perspectives on project management competencies. This chapter outlines the development of the Q-sample, participant selection (P-set), and the Q-sorting procedure, followed by Exploratory Factor Analysis (EFA) to identify dominant

competency perspectives among project managers. The methodology is designed to provide a systematic and structured approach to analysing how project managers perceive AI literacy alongside traditional competencies.

Chapter 5 presents the results of the factor analysis, identifying four key competency perspectives: technical execution, strategic vision, soft skills, and AI literacy. The findings reveal patterns of competency adoption, showing that while technical and strategic competencies remain dominant, soft skills are gaining importance, and AI literacy is still emerging as a critical but underdeveloped area in project management.

Chapter 6 discusses the implications of the findings, analysing how AI literacy interacts with existing project management competencies. This section critically evaluates the barriers and facilitators of AI adoption, comparing the study's results with existing literature. It also addresses the limitations of the research, including sample size and potential industry-specific biases, and proposes directions for future research to further explore AI's role in project management education and professional development.

By structuring the study in this way, the research offers a well-rounded exploration of how AI literacy is shaping project management competencies, providing valuable insights for both academic discourse and professional practice.

Chapter 2: Competencies in Project Management

2.1 Introduction to PM competencies

Before delving into the specific competences outlined by prominent standards, it is important to distinguish between "standards of practice" and academic research within project management. Standards of practice, such as the International Competence Baseline (ICB), the Association for Project Management Body of Knowledge (APM BoK), the Project Management Body of Knowledge (PMBOK), and the Project Manager Competency Development Framework (PMCD), are formalized guidelines developed by professional bodies.

Conversely, scholarly research in project management often examines these competencies from theoretical and empirical perspectives, seeking to understand their impact on project success, their interrelationships, and their evolution over time. Research studies may critique, expand, or offer new insights into the competencies established by professional standards, thus contributing to the dynamic field of project management.

The International Competence Baseline (ICB), APM Body of Knowledge (APM BoK), PMBOK, and Project Manager Competency Development Framework (PMCD) are the most important established standards of practice focusing on the competencies required by project managers. These frameworks detail and categorize necessary skills, facilitating structured professional development. Each presents unique perspectives on essential managerial competencies, from technical expertise to interpersonal abilities, ensuring project managers can navigate complex project environments successfully. Together, these standards provide comprehensive guidance for the training, assessment, and continuous development of project managers, adapting to evolving project demands and business environments.

2.2 PM competencies: standard of practice

This section delves into the major project management standards established by leading institutions, such as the Project Management Institute (PMI), the International Organization for Standardization (ISO), the Association for Project Management (APM),

and PRINCE2 (Projects IN Controlled Environments). Each of these institutions has contributed to the formalization of PM best practices, offering structured methodologies, certification programs, and frameworks that help organizations navigate the complexities of modern projects.

2.2.1 ICB.4

The first framework we'll examine is ICB.4 from IPMA (International Project Management Association). This framework is built upon three main pillars that categorize the types of competencies required for effective project management. These pillars serve as the foundational elements that guide the development and assessment of project managers' skills. Each pillar focuses on a distinct aspect of project management competency, ensuring a comprehensive approach.

The framework is structured around three main pillars:

- People competence area;
- Practice competence area;
- Perspective competence area.

2.2.1.1 People in ICB.4

The 'People' pillar focuses on personal and interpersonal skills that are essential for the success of projects, programmes and portfolios. This includes a number of soft skills that are included as equal to technical and long-term strategy skills. Some of these are self-management and self-discipline, integrity, communication, relationship building, leadership and negotiation, but also improvisation, conflict and crisis management and results orientation.

Self-discipline is the first component of the "people" pillar and is a unique aspect, as it is Chapter 2: Competencies in Project Managementnot included in any other institutional framework. The objective of this section is to enable individuals to manage and control their behaviour, recognizing the influence of emotions, preferences, and personal values. This competency facilitates the efficient utilization of human resources, fostering an open

and positive work environment that generates positive energy and promotes both internal and external balance.

In particular, self-discipline involves the application of specific techniques and methods, such as reflection and self-analysis techniques, stress management for oneself and others, relaxation techniques and methods, work rhythm management, feedback techniques and rules, prioritization techniques, time management, progress tracking, goal setting (e.g., using the SMART approach), and theories focused on achieving effectiveness. These elements together create a foundation for building strong interpersonal skills and achieving professional excellence.

2.2.1.2 Practice in ICB.4

The Practice section emphasizes the technical facets of managing projects, programs, and portfolios. This section of ICB 4.0 introduces various techniques employed by skilled project managers. For project design, the framework incorporates network planning methods such as the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT), alongside foundational tools like the Work Breakdown Structure (WBS), Organizational Breakdown Structure (OBS), Responsibility Assignment Matrix (RAM), and Logical Framework Approach (LFA). Additionally, it provides guidance on defining requirements and objectives, including techniques for requirements analysis and stakeholder prioritization. It also covers goal-setting strategies, such as SMART Goals, and the use of traceability matrices to ensure alignment and accountability throughout project execution.

For managing risk and opportunities, the framework suggests methods for identifying, analysing, and mitigating risks, alongside techniques for capitalizing on opportunities. Quality management is addressed with tools for ensuring that project deliverables meet the set standards, including continuous improvement processes and quality control mechanisms. Project organization is defined through structuring teams and defining roles and responsibilities clearly, utilizing tools such as organizational charts and delegation matrices. Finally, effective teamwork is fostered through the development and use of collaboration tools and conflict management frameworks.

The part on problem resolution includes techniques like root cause analysis and decision-making models to address and prevent issues proactively. Project control is reinforced through tools such as Earned Value Management (EVM), Gantt charts, and milestone trend analysis, ensuring projects remain on track and within scope. Project finance management is detailed with various budgeting, costing, and financial forecasting techniques, emphasizing the importance of financial control throughout the project lifecycle. Procurement and partnership management are covered with strategies for vendor evaluation, contract management, and maintaining effective external relationships.

This part of the framework also addresses change and transformation within projects, offering strategies for change impact analysis, stakeholder engagement, and transition planning. This ensures that projects are not only managed effectively but are also adaptable to changes in scope or objectives.

2.2.1.3 Perspective in ICB.4

The Perspective section of the ICB 4.0 addresses the broader context in which project, program, and portfolio management occurs, focusing on the strategic alignment and environmental awareness that project managers must possess. This part of the framework underscores the importance of understanding how projects contribute to the wider objectives of the organization and how they fit within the global market and societal context. Crucially, this part includes a strong emphasis on sustainability, urging project managers to identify and comply with relevant sustainability principles and objectives. This encompasses assessing the impact of projects on the environment and society, researching, recommending, and applying measures to limit or compensate negative consequences, thereby acknowledging and solidifying the relationship between project management and sustainable development.

Nevertheless, IPMA addresses the issue of sustainability through another reference document. The document in question is called the Sustainable Project Management ICB4 Reference Guide. The document again deals with the topics of people, practice and perspective, and guides them towards the perspective of sustainability. In fact, the document is no longer a project management guide, like ICB4, but it takes up the skills

and activities of the original document and teaches the reader the skills, knowledge and abilities needed to manage projects with sustainability in mind.

It also helps to identify and assess ESG risks and opportunities, and how to include this topic in the planning, organization, execution and closure phases, as well as governance and overall organization. In addition to this, it helps to communicate on the topic of sustainability with your project sponsor, team and other stakeholders. Finally, the main objective of this paper is to convey IPMA's belief that the reader and his or her family consider ESG principles and sustainability as key priorities. As a project manager, the reader is identified as the main actor in the global transformation. For this reason, the paper emphasizes the importance of paying special attention to these issues. Furthermore, it highlights the connections between the personal values of those who pay attention to ESGs and the Professional Competence Baseline delineation present in ICB4

2.2.2 PMCD

The *Project Manager Competency Development Framework* (PMCD) by the Project Management Institute (PMI) has evolved through three key editions, reflecting the changing demands of project management competencies. The first edition (2002) established a structured approach for defining, assessing, and developing project management competencies, providing an initial framework for professional growth. The second edition (2007) expanded upon this foundation by aligning with the *PMBOK® Guide – Third Edition* and the *PMP® Examination Specification*, offering a more detailed competency assessment model. The third edition (2017) further extended the framework to include competencies for program and portfolio managers, aligning with the *PMBOK® Guide – Sixth Edition* and broader PMI standards. This edition introduced structured guidelines for competency evidence and emphasized the importance of continuous professional development. The PMCD framework has thus progressively adapted to the evolving complexity of project management, reinforcing the role of competency-based assessment in ensuring project success.

The PMCD, is designed to guide the development and assessment of a project manager's competencies across various dimensions. Also this framework is structured around two main pillars:

- Performance competence;
- Personal competence;

Within this institutional work, another ‘pillar’ is also mentioned, namely that of “knowledge”, which emphasizes the theoretical understanding required for project management, including key methodologies, tools and techniques. It is important to note that although the PMCD mentions that knowledge competencies can be demonstrated through credentials such as the PMP examination, it does not define these competencies internally. Specific knowledge competencies are detailed in external documents such as the Project Management Professional (PMP) Examination Content Outline.

2.2.2.1 Performance pillar

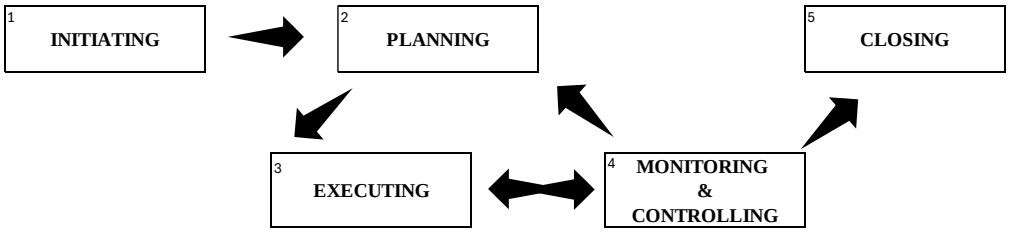
The Performance pillar of the Project Manager Competency Development Framework (PMCD) critically assesses the application of project management knowledge in real-world scenarios. This pillar gauges a project manager's ability to effectively lead and deliver projects, emphasizing the practical implementation of management principles. It includes evaluating how well project managers plan, execute, and close projects, ensuring they meet predefined objectives and constraints (such as time, budget and quality) and achieve desired outcomes. This assessment also covers a manager’s proficiency in adapting to changes, solving problems as they arise, and efficiently managing resources. Ultimately, this pillar measures a project manager’s capability to translate theoretical knowledge into actionable strategies that drive project success.

2.2.2.2 Performance pillar

The Personal pillar, on the other hand, focuses on the behavioural competencies and personal attributes essential for successful project management. This includes leadership skills, which enable a project manager to inspire and guide their team towards achieving project goals. Motivation is another critical aspect, as it relates to the manager's ability to maintain team spirit and drive, especially under challenging circumstances. Additionally, effective communication skills are paramount; they ensure that ideas, instructions, and feedback are clearly understood and appropriately acted upon by all team members. This pillar also examines a manager's ability to build and maintain professional relationships, manage stakeholder expectations, and navigate the complexities of team dynamics. These

personal competencies are vital as they directly influence a project's atmosphere, team collaboration, and overall success.

The PMCD is particularly useful in organizational settings that aim to standardize project management practices and develop a robust internal competency framework tailored to strategic goals, emphasizing practical application and behavioural aspects of project management competencies while directing those seeking detailed knowledge-based competencies to external assessments.



2.2.3 APM BoK

The Association for Project Management Body of Knowledge (APM BoK) incorporates both interpersonal skills and professionalism into its comprehensive framework for effective project management. Developed by the Association for Project Management, the APM BoK acknowledges the crucial role that interpersonal skills play in the successful management of projects, programs, and portfolios. Skills such as communication, conflict management, delegation, influencing, leadership, negotiation, and teamwork are vital for project managers to effectively lead teams, manage stakeholders, and ensure project success in collaborative and often challenging environments.

Additionally, the APM BoK emphasizes professionalism, which includes fostering communities of practice, maintaining competence, adhering to ethical frameworks, and facilitating leadership and development. These components highlight the importance of continuous professional development, ethical standards, and leadership growth expected of project managers. By advocating for a blend of technical management skills with strong interpersonal and professional practices, the APM BoK ensures that project managers are well-equipped to handle the complexities of modern project environments, leading to successful projects and contributing positively to the organization's goals.

This framework is divided into four chapters: *Setting up for success*, *Preparing for change*, *People and behaviours*, and *Planning and managing deployment.*

APM Bok, like other frameworks, has been released and published in several editions, reflecting the changing dynamics and advancements in Project Management. With each edition, the APM incorporates contemporary methodologies, case studies, and tools, ensuring that professionals remain equipped to navigate the ever-shifting landscape of Project Management practices. The seventh, which is also the latest, in 2019 has included interesting elements. In fact, it includes more modern project management methodologies such as agile, stakeholder engagement, and resilience are carefully explored. Not only that, but as part of the stakeholder engagement theme, the importance of sustainability is emphasised for the first time.

APM define Sustainability in the project profession as an approach to business that balances the environmental, social, and economic aspects of project-based working to meet the current needs of stakeholders without compromising or overburdening future generations. (APM Body of Knowledge, 7th edition)

2.2.4 Praxis

In 2019, the Praxis Framework was selected by the Australian Institute of Project Management as its body of knowledge. Being one of the largest project management organizations in the world, it is significant to incorporate this framework into "institutional" works.

The framework is divided into two main sections, management competencies and process competencies. Management competencies focus on behaviours and soft skills necessary for individuals to manage projects, programs, and portfolios. On the other hand, process competencies include the technical aspects of project management, such as scheduling, resource allocation, and risk and budget management.

Management competencies in the Praxis Framework are divided into delivery competencies and interpersonal competencies. Delivery competencies deal with quality compliance, stakeholder management, business case management, scope management, finance management, and resource management. Interpersonal competencies, on the other hand, relate to traditional soft skills such as communication, conflict management,

delegation, leadership, negotiation, and teamwork. These categories cover the essential aspects required for effective project, program, and portfolio management.

Process competencies in the Praxis Framework cover the structured steps necessary for managing projects and programs effectively. These competencies include identifying, defining, and delivering projects or programs, as well as sponsoring and closing them. Additionally, they encompass realizing benefits, and initiating, governing, managing, and coordinating portfolios. Each competency focuses on specific tasks that ensure projects are not only completed according to plan but also deliver value to the organization and its stakeholders.

2.2.5 PMI Talent triangle

The PMI Talent Triangle, developed by the Project Management Institute (PMI), emphasizes a comprehensive framework that project management professionals should master. This model comprises three core competency areas: technical project management skills, leadership, and strategic and business management skills. Technical project management skills include the foundational knowledge necessary to manage projects effectively, employing methodologies, tools, and techniques critical for successful project delivery. Leadership skills focus on the ability to motivate and guide teams, manage stakeholders, and navigate through complex project challenges, ensuring effective communication and collaboration. Strategic and business management skills equip project managers with the ability to align project objectives with the organization's strategic goals, understanding market conditions and business operations to make decisions that bolster both project and organizational success.

Table 1: recap table of institutional competence framework

Standard/Framework	Cluster/Group	Competency
ICB.4	People	Self-reflection and self-management; Personal integrity; Personal communication; Relationships and engagement; Leadership; Teamwork; Conflict and crisis; Resourcefulness; Negotiation; Result orientation
	Practice	Project design; Requirements and objectives; Scope; Time Organization and information; Quality; Finance; Resource Procurement; Plan and control; Risk and opportunity; Stakeholders; Change and transformation
	Perspective	Strategy; Governance, structure and processes; Compliance, standard and regulation; Power and interest; Culture and values
PMC.D.3	Performance	Project integration management; Project scope management; Project time management; Project cost management; Project quality management; Project human resource management; Project communication management; Project risk management; Project procurement management; Project stakeholder management
	Personal	Communicating; Leading; Managing; Cognitive ability; Effectiveness; Professionalism
APM	Interpersonal	Communication; Conflict management; Delegation; Influencing; Leadership; Negotiation; Teamwork
	Professionalism	Ethics framework, Leading and development
Praxis	Managment competences	Delivery competences such as manage stakeholders, resources, delivery and plan; Interpersonal competencies such as communication, delegation, conflict resolution, leadership
	Process competences	Process competences such as identify and define project programm and manage the delivery.
PMI Talent Triangle	Technical project management skills; Leadership; Strategic and business management skills	

We can see that all standard frameworks equate the classical technical skills of project management with soft skills, with a particular focus on leadership and communication. These works provide a useful institutional overview to lay the foundations of the competences that are perceived as most important by project management associations. In the next section we will analyse the academical literature on project management competences and how they deviate from the view of the institutions.

2.2.6 PRINCE2

Another important institutional framework that should be mentioned is PRINCE2, which was developed in Great Britain and provides a methodical way to manage projects within a clearly defined framework. This method is a process-based method so it builds on concepts such as time, budget constraints, quality and others, developing guidance from this foundation in the necessary activities. Since it is not a competence framework we are not going to delve further into this institutional project management methodology.

2.3 PM competencies: Traditional vs. Modern Project Management

As we have seen from the previous section, traditional project management assumes that all events are predictable, and all techniques and tools are well understood and perceived. Similarly, it is under the assumption that project specifications by the customer are also immediately understood and remain unchanged throughout the duration of the project. The strength of this approach is to have a well-structured, repeatable and easily understood system. However, this is very often not the case; it is often the case that a client has difficulty defining all requirements at the beginning of the project, and that specifications arrive in a random and unstructured order (Hass, K.B. 2007). The lack of flexibility is a disadvantage in today's fast-moving and complex project environment. To overcome this problem, modern project management approaches, such as Lean and Agile Project Management (APM), have emerged to help adapt to the new business environment and improve these projects. However, the literature provides only a few well-defined and effective approaches and effective or systematic evaluations of their results. (Conforto et al 2010). Most of the solutions are trying to establish a more flexible approach, adaptable to the contingencies of the project environment to improve project performance records (Conforto et al 2014).

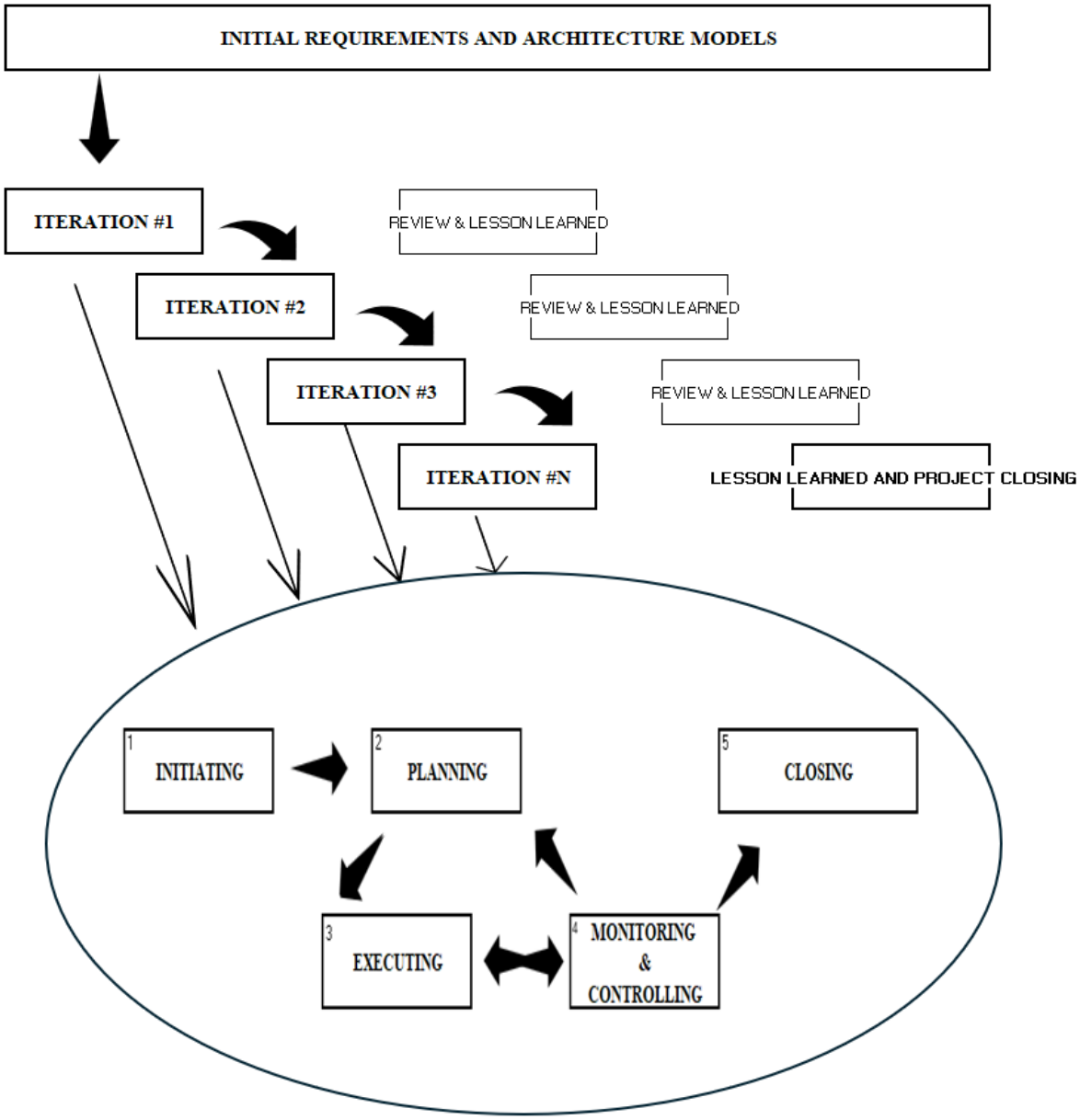
2.4 Agile Project Management

One such approach is Agile project management (APM), mainly used in IT projects. APM is a highly iterative and incremental process, in which stakeholders and developers work closely together to understand the domain, requirements and functionality desired by the customer, in a process that keeps repeating itself until the requirements are absolutely clear.(Hass, K.B. 2007)

The Agile approach is based on rapid and iterative cycles of planning and development, allowing continuous evaluation of intermediate results. This makes it possible to adapt the product according to the emerging needs of users and stakeholders, fostering constant improvement by the entire project team. It also makes it possible to make immediate changes in response to unforeseen requirements.

Here we can see a graphical representation of the Agile methodology in contrast to fig1:

Table 2: Graphical representation of Agile Methodology



Agility is now a core principle, crucial for organizations to adapt to fast-changing environments. Agile methodologies, as highlighted by Drejer and Riis (1999), underscore the need for flexibility and continuous learning within project teams. Companies that adopt these approaches can swiftly integrate new technologies and processes. Additionally, fostering agility requires a cultural shift, where learning behaviours, as noted by Fong and Chan (2004), enhance responsiveness and innovation.

2.5 Modern Project Management

Research into the competencies necessary for effective project management has evolved substantially, initially establishing project management as a specialized discipline. Research on project managers' competencies dates back to an early paper by Gaddis in 1959 and was further explored in a 1967 Harvard Business Review article by Lawrence and Lorsch titled "The Integrator." Since these foundational contributions, numerous studies have examined project management competencies.(Lawrence and Lorsch, 1967)(Gaddis, 1959)

Gaddis represents a particularly relevant forerunner in the study of project management skills, mainly for two reasons. Firstly, the scope of his research includes advanced technology industries such as electronics, nucleonics, astronautics and cytogenetics. These sectors, at the time of Gaddis' study, presented similar characteristics to those of the artificial intelligence industry today, making his insights extremely relevant. Secondly, Gaddis comprehensively and deeply explores a broad spectrum of managerial skills that have frequently been taken up in subsequent research, such as control, coordination, communication, and leadership, with an emphasis on the importance of setting high standards. He also emphasizes the need for project managers to possess a solid understanding of the industry in which they operate, enabling them to adapt to rapidly changing technological environments and to handle complex problems. (Gaddis, 1959)

Lawrence and Lorsch, similarly to Gaddis, emphasize in their article competencies such as communication skills, social skills, leadership, understanding of organizational dynamics, strategic thinking and flexibility. These skills are considered indispensable for the role of integrator, a role that is compared to that of project manager due to the importance of managing and coordinating diverse and heterogeneous teams. Indeed, the integrator assumes a key position within complex organizations, facilitating communication between different business functions, resolving potential conflicts and ensuring that common goals are pursued coherently. Thanks to his or her overview and flexibility in coping with rapid market and technology changes, the integrator is able to guarantee strategic alignment between the various business units, while ensuring a high level of collaboration and organizational agility. (Lawrence and Lorsch, 1967)

(Drossel, 1980) considers soft and hard skills as critical as technical skills in project management, emphasizing that project success hinges on good planning, effective teamwork, regular feedback in team meetings, and dedication to the project. Similarly, Zachary, (1984) emphasizes the importance of balancing technical and leadership skills in project management, aiming to boost team morale and enhance collaborative relationships to achieve project goals. Van Ingen, (2007) and Sampson, (2007) both assert that competencies required in project management are increasingly recognized as a balanced mix of traditional technical skills, such as risk management and scheduling, and soft skills that emphasize interpersonal communication. Corcoran, (1997) in contrast, believes that the best IT managers blend business acumen with technical expertise, highlighting the need for a technical background to navigate new technologies effectively.

Equally fundamental for all of these authors is the need to consider the audience or stakeholder being addressed. Consequently, having a strong interpersonal and multicultural understanding has been identified as an important and decisive factor in effectively managing diverse project environments. (Van Ingen, 2007,Sampson, 2007,Zachary and Krone, 1984)

Zielinski in 2005, while software were emerging, highlighted the importance of technical expertise in project management, noting that “there's no denying the importance of technical expertise to successfully orchestrating a project. Managing an initiative's scope, cost, risk, resources and schedule are all essential skills. Indeed, the quality of up-front planning (…) and a project leader's skill at replanning as project conditions change can determine a project's fate all on its own.” However, alongside these technical skills, also this research admit that there is an increasing appreciation for soft skills, such as communication and negotiation. (Zielinski, 2005)

These soft skills are now considered fundamental, as they enable project leaders to adapt plans in response to changing project conditions, a crucial ability in today’s dynamic environment. In conclusion, while technical knowledge remains the backbone of effective project management, the ability to integrate soft skills to navigate complexities and evolving challenges is seen as a decisive factor for success. (Zielinski, 2005) Almost 30 years before, in his 1987 work, Thomas Powers, also highlighted the importance of soft

skills in project success, as human resource management, leadership, and feedback management. (Powers, 1987)

2.6 Soft skills in Project management

Soft skills are increasingly recognized as critical determinants of success in project management, particularly in navigating the complex interpersonal and strategic challenges that projects typically present. This section of the literature review explores how competencies like leadership, emotional intelligence, and empowerment not only drive project outcomes but also foster sustainable practices and team cohesion across diverse industries.

2.6.1 Leadership

The first soft skill, and also the most common one we found when reviewing academic articles, is leadership. There have been as many attempts to define the concept of leadership, for example (Silva, 2016) citing (Stogdill, 1974) states that there are as many definitions of leadership as there are people who have tried to define it, underlining the vagueness and subjectivity of this term, (Bennis and Townsend, 1995) state that at the time of their research there were already 650 definitions of leadership, and the number has increased dramatically in fact, in an interview with Volkmann in 2012 he states that there are about 1400 different definitions. These numbers, whether exaggerated or real, suggest that the definition of leadership is not something on which we have reached a consensus.

Some definitions of leadership do not include personality traits bass (1990)(Bass B. M., 1990), although we have evidence that these traits have an impact on leadership ability (see, for example, (Mann R. D, 1959), conclusions as compared with the reanalysis of his data by (Lord R. G., 1986). Second, researchers have routinely defined leadership either as standing out in a crowd or as occupying a senior position in an organisation. Both definitions overlook the fundamental essence of leadership. (Hogan and Kaiser, 2005).

On these themes, Yang, Yen and Chiang, (2012) explore how leadership competencies directly influence team motivation and satisfaction. His research in Taiwanese police departments reveals that leadership is not just about guiding project success but also about enhancing job satisfaction, which itself acts as a motivational booster. Yang et al. show

that when project leaders exhibit strong leadership competencies, they not only achieve better project outcomes but also significantly increase job satisfaction among team members. This, in turn, creates a feedback loop where motivated and satisfied teams are more effective, engaged, and less prone to conflict.

Some studies shows that leadership between adaptability, coordination, decision-making, personal development and communication; is the only skill that does not change between a postgraduate student and a student at the first year of university, highlighting the fact that leadership is a personality trait, and it's difficult to train it and get better at. (De Prada, Mareque and Pino-Juste, 2022)

The definition of leadership conceptualised by Hogan, after a careful literature review, seems to solve both problems and provides a clear definition. In their view, leadership is the ability to build and maintain a group that performs well relative to its competition. It follows that leadership should be assessed in terms of group performance, and not in terms of which person emerges as 'leader' within a group.(Hogan and Kaiser, 2005)

2.6.2 Coordination

Effective team performance is built on several key characteristics, As highlighted by (Zaccaro and Klimoski, 2002) First, team members must successfully integrate their individual efforts, ensuring their actions contribute to shared objectives. Second, teams are increasingly required to operate in complex and dynamic environments, demanding adaptability and resilience. Third, team leadership plays a fundamental role, as certain individuals are responsible for setting clear goals, defining team structures, responsibility and composition, and guiding members to collaborate effectively.

(Zaccaro, Rittman and Marks, 2001) identified four essential processes for team effectiveness: cognitive, motivational, affective, and coordination. Among these, coordination is particularly vital, as it aligns individual contributions and ensures cohesive team functioning. Leadership is directly responsible for fostering this coordination, providing a foundation for effective teamwork.

For example, a study by (Wang, Chou and Jiang, 2005)explores how a charismatic leadership style, which is the most commonly used in Asia, strengthens team cohesion and coordination, thereby improving teamwork and achieving better results.

2.6.3 Problem-solving

The second skill we will look at is problem solving. The literature has dealt with this topic for example with the concept of Complex Problem-solving (CPS), the first to introduce the concept are (Sternberg and Frensch, 1991) and (Frensch and Funke J., 1995). The first book covers a wide range of concepts, including arithmetic, reading, writing, legal reasoning, but above all problem solving. The link between all these topics is that they share a factor that is not theoretical but methodological, namely the use of expert-novice comparisons. The implicit agreement of the authors is to call "complex problem solving" anything that is not "simple problem solving".(Sternberg and Frensch, 1991)

The second book focuses on totally different tasks from the first book and devotes an entire chapter to the definition of 'complex problem solving'; the definition given for CPS is the process required to overcome barriers between a current state and a desired goal state through behavioural and/or cognitive multi-step activities. (Frensch and Funke J., 1995).

CPS tasks are characterized by their dynamic nature, where initial actions shape the context for future decisions and task elements can change independently from the solver's actions. These tasks are also time-sensitive, requiring timely decisions in response to environmental conditions. Furthermore, they are complex, with variables that interrelate in multifaceted ways rather than in simple one-to-one correspondences. Success in these tasks demands a series of interconnected decisions, where each decision influences subsequent choices. (Frensch and Funke J., 1995).

Regarding the classical definition of problem solving, more than 20 years before, Newell and Simon, (1972) proposed that problem solving consists of searching within a 'problem space'. This imaginary space has an initial state, a 'goal' state and a set of operators that can move the problem from the initial state to the goal state. For the sake of simplicity, we will refer to problem solving as the definition given by (Newell and Simon, 1972). as the ability of an actor to solve a problem by changing the conditions at play.

2.6.4 Stakeholder Engagement

(Greenwood, 2007) definition of stakeholder engagement as 'the practices that the organisation undertakes to involve stakeholders in organisational activities in a positive way' has since become the most cited definition in the literature on business and society.

In a similar manner, (Manetti and Toccafondi, 2012) emphasise that stakeholder engagement constitutes 'a process that creates a dynamic context of interaction, mutual respect, dialogue and change, not unilateral stakeholder management'. These definitions highlight that the meaning of stakeholder engagement is everything that has to do with communication, understanding, flexibility in adapting to potential changes of scope, and transparency between the different stakeholders.

2.6.5 Adaptability

Another soft skill that has been found to be fundamental in the field of project management within the academic literature is adaptability. This characteristic was first conceptualised by (Pulakos *et al.,* 2000) They structured adaptability into 8 fundamental dimensions:

- managing the uncertain or unpredictable situations;
- managing crises or emergencies;
- solving problems with creativity;
- managing work stress;
- learning new tasks, technologies and procedures;
- demonstrate interpersonal adaptability;
- demonstrating intercultural adaptability;
- demonstrating physically oriented adaptability;

Further research on adaptability in the workplace shows that the dimensions of employee adaptability changes depending upon the type and nature of Job (Charbonnier-Voirin and Roussel, 2012). From now on, we'll refer to adaptability as the ability to adjust effectively to changing conditions, challenges, and demands in the workplace. It encompasses a proactive mindset and a versatile skill set that enable individuals to respond to unexpected situations, learn new skills, and collaborate effectively in diverse environments.

Finally, systems thinking and improvisational skills have gained prominence in the literature as critical competencies for handling project complexity. Elia, Margherita and Secundo, (2020) in the "Project Management Canvas: A Systems Thinking Framework

to Address Project Complexity", emphasizes the importance of holistic thinking, while Facing the Challenge of Improvisation in Project Management, Malucelli, Barbosa and Carvalho, (2021) highlights the value of flexibility and adaptive decision-making in responding to unforeseen challenges.

2.6.6 Teamwork

It is well known Teamwork is a fundamental concept in business work and in any project in general. However, it is not clear in the literature whether this concept is actually a soft skill or whether it is a consequence of people working well together with strong interpersonal skills. For example, (De Prada, Mareque and Pino-Juste, 2022), set the concept of successful teamwork as a result of the soft skills possessed by the members of a team, it is curious how these soft skills are very similar to those that were chosen from this paper prior to reading this paper. In particular, they are called teamwork skills and are: adaptability, coordination, decision-making, leadership and communication.

Others, however, (Freire *et al.,* 2011) confirm that the most important skills for the world of work are the ability to learn motivation, concern for quality and teamwork, thus classifying this concept as a skill.

The issue we are interested in, however, is to find a clear definition of teamwork, so as to define the concept simply. Particularly noteworthy in this perspective, is a work by (Xyrichis and Ream, 2008) who, after a careful review of the teamwork concept and a thorough literature review, concludes that the teamwork in workplace can be defined as a dynamic process involving two or more professionals with complementary skills and backgrounds, working collaboratively to achieve shared goals. It is characterized by open communication, interdependent collaboration, and shared decision-making, requiring concerted physical and mental effort. This definition seems the most suitable for the purpose of our research, as it encompasses and includes the majority of the explicit and implicit meanings provided by the literature.

2.6.7 Negotiation

Negotiation research spans multiple disciplines, leading to diverse criteria for assessing effectiveness. Two primary approaches dominate this field: expert-based indicators, which evaluate skill mastery, and outcome-based indicators, which assess tangible negotiation results. Skills training programs increasingly emphasize integrative

techniques, aiming to enhance collaborative capabilities and value creation (Cutcher-Gershenfeld, 1994; Lewicki and Stevenson, 1997). However, the ability to navigate distributive dynamics remains crucial, particularly in competitive scenarios.

Negotiation is broadly characterized as a complex process of interaction through which parties seek agreements to guide and regulate their future behaviour (Sawyer and H. Guetzkow, 1965). It is a communication-driven activity where individuals, groups, or entities exchange proposals, develop potential agreements, and define the nature of their interdependence. Interdependence, as a fundamental aspect of negotiation, underscores that while parties are reliant on one another to achieve their goals, they are simultaneously competing for resources and often pursuing conflicting objectives. This duality positions negotiation as a mixed-motive process, intertwining elements of cooperation and competition within social interactions. (Putnam and Roloff, 1992)

Negotiation distinguishes itself from related processes like persuasion, argumentation, compliance gaining, and conflict management. While persuasion and argumentation focus on influencing others or defending claims through evidence and reasoning (Putnam and Roloff, 1992) negotiation extends beyond these dynamics by integrating tactics such as concealing weaknesses, exploring creative options, and addressing incompatibilities. Similarly, negotiation contrasts with compliance gaining, which primarily uses influence strategies like threats and promises, by incorporating unique processes such as issue development and concession-making (Putnam and Roloff, 1992) Despite parallels to group decision-making and conflict management, negotiation's defining feature lies in its iterative exchange of proposals and counterproposals to balance self-interests with joint gains.

Negotiation traditionally centres on resource allocation, with its etymological root, *negotiari* (Latin for "to transact business"), emphasizing its transactional nature (Bell, 1988). Two dominant paradigms guide this process: distributive and integrative negotiation (McKersie and Perry, 1965).

Distributive negotiation focuses on self-interest and value claiming, characterized by setting resistance points, making extreme offers, and employing strategic concessions (Lax and Sebenius, 1986). This approach emphasizes competitive tactics aimed at maximizing individual outcomes. Integrative negotiation, in contrast, seeks to create

value by identifying shared interests, fostering collaboration, and developing creative solutions that benefit all parties. This paradigm hinges on open communication and cooperative problem-solving to achieve win-win outcomes.(McKersie and Perry, 1965)

While these models may seem dichotomous, negotiations often integrate elements of both approaches, employing them in sequences or adapting them to the context. Effective negotiation, therefore, requires flexibility and the ability to blend distributive and integrative strategies.

2.6.8 Decision-making

Another important skill is so-called decision-making. It is difficult to find a precise definition in the literature because it seems that this term is used by all with a consensus on its meaning as: the cognitive and rational process by which an individual or a group analyses information, evaluates options, and chooses a course of action among several available alternatives. (Tversky and Kahneman, 1974)

Most of the relevant literature focuses on the processes by which decisions are made. Of note, for example, are the studies on game theory, the latter of which was probably devised by Borel in the 1920's (Borel, 1921) and later the concept was taken up by von newman in 1928 (Von Neumann, 1928). Game theory, however, became relevant after the work of Von Neumann and Morgenstern, (1944) called 'Theory of games and economic behaviour.', in which the concept is expanded and becomes dogma.

2.6.9 Motivation

In the realm of post-disaster project management, the competence-based system development study by Von Meding et al., (2016) underscores the importance of strategic decision-making, negotiation, and motivation witch are perceived in our work as soft skills. This research emphasizes the need for effective direction of subordinates and skilled leadership in high-stakes, post-crisis reconstruction efforts. Similarly, Xue et al., (2020) investigate how soft competencies like communication, leadership, and conflict resolution impact project sustainability in the construction industry. Their findings highlight the crucial role of adept human resource management and leadership in driving project success, demonstrating how these competencies contribute to sustainable practices within dynamic project environments.

Motivational factors are critical in project management, particularly among younger professionals seeking engagement and long-term commitment to their projects. Lechler's research identifies autonomy, competence, and relatedness as key motivational drivers for young project managers, underscoring the importance of creating empowering environments. Similarly, the study by Amirghodsi et al., (2024) points to psychological empowerment as instrumental in enhancing knowledge dissemination and creation within teams—processes essential for maintaining a dynamic flow of information and fostering innovation in project settings.

Recent studies have highlighted competencies essential for managing complex and fast-evolving projects. For example,(Amirghodsi *et al.*, 2024). identify psychological empowerment as crucial for promoting knowledge dissemination and creation within project teams, both of which are vital for knowledge-driven projects. Absorptive capacity, or the ability to recognize and leverage new knowledge, has been shown to directly impact project success, particularly in digitalization initiatives, (Ngereja, Hussein and Wolff, 2024).

Similarly, Zachary and Krone, (1984) underscore the importance of fostering team morale and building strong working relationships, positioning leadership and motivation as integral to achieving project objectives and cultivating a shared commitment to completion.

In the realm of emotional intelligence, Khosravi, Rezvani and Ashkanasy, (2020) explore its pivotal role in managing conflicts and maintaining team harmony, especially in projects characterized by high stakes and complexity. Emotional intelligence, they argue, is crucial for navigating interpersonal challenges and ensuring project cohesion and to foster a positive environment of motivated people.

2.6.10 Summary of soft skills

The studies collectively highlight the significance of soft skills in project management, underscoring how competencies like leadership, emotional intelligence, adaptability, problem-solving, decision-making, stakeholder engagement, communication, and negotiation contribute to project success. Leadership, as consistently emphasized in the

literature (e.g., Hogan and Kaiser, 2005; Yang, Yen, and Chiang, 2012), is not merely about directing teams but about building cohesive groups that perform effectively. Emotional intelligence, as Khosravi, Rezvani, and Ashkanasy (2020) demonstrate, plays a crucial role in managing conflicts, maintaining team harmony, and fostering motivation, particularly in high-stakes, complex projects.

Adaptability, as conceptualized by Pulakos et al. (2000), enables project managers to adjust effectively to changing conditions, while problem-solving, framed by Newell and Simon (1972) and further explored by Frensch and Funke (1995), involves navigating dynamic and multifaceted challenges. Decision-making, influenced by foundational theories such as game theory (Von Neumann and Morgenstern, 1944), is a core competency for aligning project actions with strategic objectives.

Stakeholder engagement and communication, as defined by Greenwood (2007) and Manetti and Toccafondi (2012), ensure transparency and collaboration, while negotiation, characterized by Sawyer and Guetzkow (1965) and Putnam and Roloff (1992), balances cooperation and competition to achieve favourable agreements. These competencies, rooted in decades of academic research, collectively illuminate the indispensable role of interpersonal and cognitive skills in complementing technical expertise to ensure project success in diverse and evolving contexts.

2.7 Hard skills in Project management

Hard skills are essential foundations of effective project management, enabling precise control over technical aspects and project deliverables. This section examines critical technical competencies, such as risk management, budgeting, and scheduling, showcasing how they directly influence the efficiency and outcome of projects across different industries.

Hard competencies needed by PM’s were more systematically categorized and analysed. (Powers, 1987), conducted a cluster analysis that identified 18 competencies linked to superior project performance, which were then grouped into four main areas: goal and action management, directing subordinates, human resource management, and leadership.

This early classification provided a foundational framework that still inspires modern works in understandings project management competencies.

Adding to this foundation, White, Hodgson and Crainer, (1996) introduced a contemporary approach by highlighting strategies for managers to navigate today's increasingly volatile corporate environment. Their work emphasized the importance of adaptability and resilience, arguing that change and uncertainty are core indicators of leadership excellence in modern conditions.

Building upon this framework, the study by Zhu and Kindarto, (2016) delves into the intricacies of government IT project failures in developing countries, illuminating how leadership styles, specifically transactional, empowering, and laissez-faire, along with robust team dynamics and competent decision-making, directly correlate with project outcomes. Added to this is another very interesting study conducted by Wang in 2005, analysing the impact of a charismatic leadership style on 500 IT projects, with a particular focus on ERP system implementation projects. The results confirm that leaders should adopt more charismatic behaviour to foster ERP project team cohesion and, consequently, improve team performance. Furthermore, the positive relationship between team cohesion and overall team performance was statistically confirmed.

Further, the leadership importance was remarked by the work by (Oh and Choi, 2020) on the competencies of project team members within open innovation frameworks enriches our understanding by incorporating emotional, managerial, and intellectual competencies (EQ, MQ, IQ). The impact of these competencies on project success across various industries, they conclude, accentuates the role of human resource management and leadership in fostering environments conducive to innovation and collaborative success.

Other specific industry applications of project management competencies further refined the understanding of required skills. Studies by (Edum-Fotwe and McCaffer, 2000) and (Crawford, 2000) examined competencies in construction management, linking project success with managerial skills tailored to complex, resource-intensive environments. Their findings emphasized the importance of aligning project manager competencies with industry-specific demands, marking a shift towards field-specific frameworks. To support this, the concept of contingent competencies, as proposed by (Shenhar, 2001),was

introduced, an holistic approach by suggesting that project manager skills should be adapted based on project type. Shenhar's research advanced the idea that adaptability and strategic alignment are critical in tailoring competencies to fit specific project environments, thereby enhancing effectiveness and responsiveness across various types of projects.

Further supporting contingent competency approaches, (Müller and Turner, 2007, 2010) confirmed the importance of aligning project managers' skills with project type, showing a positive correlation between specific competencies and project success across sectors like IT, engineering, and business management.

In the Chinese construction sector, (Zheng, Wen and Qiang, 2020) collected all job advertisements tagged as CPM (construction project manager) from the top five Chinese job search websites, which reportedly cover more than 60% of the whole job market, these efforts resulted in a data set of 293,558 job advertisements in total. The job requirements section was composed of a job introduction, qualifications, and skill sets. STM was used to uncover the key competences demanded by the industry by extracting topics from the text of job descriptions.

The STM revealed eight major competence areas for CPMs, such as technical expertise, coordination, stakeholder management, and organizational management. By including firm-level attributes as covariates, the study also highlighted differences in competence priorities between large and small firms and between public and private companies. For example, larger firms prioritized construction site management and organizational capabilities, while private firms emphasized communication and stakeholder management. The results of the Structural Topic Model (STM) analysis are summarized in Table 2. Each topic is identified with a unique ID, and the table outlines the associated themes, their respective percentages (indicating their prevalence in the dataset), and additional details that further describe the content of each topic.

Table 3: Recap of competencies and frequencies.

ID Tema	Tema	Percentuale (%)	Dettagli
1	Experience and Certification	4.8	- Experience in engineering projects - Possession of certifications (e.g., CPM)
2	Professional and Technical Skills	46.8	- Professional knowledge of engineering - Expertise in designing and building mega-projects - Site monitoring
3	Construction Site Management	16.1	- Supervision of work execution - Coordination and problem-solving on-site
4	Project Objective Monitoring	1.6	- Monitoring of project schedules and expected outcomes
5	Project Team Management	6.5	- Ability to inspire team spirit - Handling team pressure and processes
6	Coordination and Communicatio	12.9	- Coordination among teams and stakeholders - Communication with clients and other parties
7	External Stakeholder Manageme	1.6	- Managing relationships with external stakeholders
8	Organizational Management Capability	9.7	- Management of the overall project organization - Control and approval of processes

They found that motivational, organizational, and technical skills are particularly valued, underscoring the importance of aligning competencies with sector-specific demands. This research highlights the need for project managers to possess robust organizational capabilities and technical expertise to navigate resource-intensive environments effectively.

Collectively, these studies illustrate the evolution of project management competencies from technical and managerial basics to more advanced abilities, including adaptability, emotional intelligence, and systems thinking. This shift reflects the growing need for project managers to navigate diverse, dynamic environments, reinforcing flexibility and responsiveness as essential qualities in contemporary project management.

2.7.1 Project planning

Research results show that effective project planning on industrial and building projects leads to improved performance in terms of cost, schedule, and operational characteristics (Gibson et al., (1995); R Hamilton and Gibson Jr, (1996)).

Although each of these research studies has focused on different owner organizations and/or project types, the pre-project planning process shares significant similarities. There are 3 studies worth of notices conducted by the Construction Industry Institute and the University of Texas, that highlight the significance of early project planning in achieving project success, focusing on tools like the PDRI-Industrial and examining the impact of scope definition and participant alignment on cost, schedule, and contract modifications.

The first of them comes from the Construction Industry Institute (CII), in 1991, they formed a team of 16 practitioners and two academic researchers. They reviewed 62 capital projects that were randomly selected from a nominated pool of industrial projects offered by 24 owner organizations. The definition of project planning used by this study was *"the process of developing sufficient strategic information with which owners can address risk and decide to commit resources to maximize the chance for a successful project"*. (Gibson *et al.,* 1995)

The second research, also from the CII, in 1994, was conducted in a similar way, they formed a team composed of 15 practitioners and 3 academic researchers, this time the goal of the research was to develop effective and easy-to-use project planning management tools. To do this they identified two goals, (i) quantify project planning effort; (ii) analyze the impact of the alignment of the project participant.

The Project Definition Rating Index for Industrial Projects (PDRI-Industrial) was developed as a scope definition tool. It is a weighted matrix comprising 70 scope definition elements—key issues to address during project planning—organized into 15 categories and summarized into three main sections. (Dumont and Gibson G, 1996)

The PDRI enables project teams to quantify the completeness of a project's scope definition, with a maximum score of 1,000 points. A lower score indicates a more complete scope definition. (Dumont and Gibson G, 1996)

The third The University of Texas (UT) System OFPC conducted this study to enhance early project planning for its capital projects. The goals were: (1) to evaluate the performance of OFPC capital projects completed between 1990 and 1995 as a baseline for improvement, (2) to assess the level of project planning conducted for these projects, and (3) to propose recommendations for improving early planning processes for UT System capital projects. (Gibson *et al.*, 1995)

Data was collected from 37 building projects, totaling approximately $402 million in construction costs. The sample included new construction, renovation, and engineering/specialty projects, and was analyzed for project planning practices and project performance in terms of cost, schedule, and contract modifications. Factors influencing schedule and cost changes were identified and examined.

This study specifically explored the correlation between project planning efforts and project performance metrics. Analytical methods such as descriptive statistics, analysis of variance, *t*-tests, and qualitative approaches were applied. A facility programming guide process was developed to improve future planning efforts, and the OFPC capital budgeting process was adjusted to emphasize scope definition. Key findings revealed that cost estimates and schedules submitted for approval were frequently unrealistic and poorly defined. Furthermore, insufficient early determination of requirements and scope definition between planners and project sponsors resulted in numerous design and construction changes initiated by end users during the execution phase. (R Hamilton and Gibson Jr, 1996)

2.7.2 Monitoring

Monitoring involves systematically tracking and collecting information about something. It entails close and continuous observation or evaluation. In project management, monitoring serves three primary purposes: (i) ensuring the project progresses within acceptable parameters for budget, schedule, and quality; (ii)

supporting decision-making for advancing the project through its stages; and (iii) validating subjective judgments that expected benefits will be achieved (Oliver and Walker, 2006) Data on progress relative to budget, schedule, and quality offers feedback on team performance, enhancing accountability and potentially motivating more diligent or effective behavior in alignment with management objectives (Bergen, Dutta and Walker, 1992). (Crawford and Bryce, 2003). Additionally, this information supports the implementation of corrective actions when necessary (Al-Jibouri, 2003). Crawford and Bryce, in particular, emphasize the importance of aligning project objectives with broader organizational goals. This alignment not only enhances team motivation but also provides employees, including those in less important roles, with a clear understanding of the purpose and significance of their contributions. (Crawford and Bryce, 2003)

Numerous studies have empirically examined the effects of monitoring. In a laboratory experiment involving 102 students, increased monitoring was found to decrease project failure by mitigating over-commitment (Kirby and Davis, 1998). Another experiment with 228 students demonstrated that monitoring encouraged subordinates to align their actions with their managers' interests (Tosi, Katz and Gomez-Mejia, 1997). Additionally, a study of 110 board members revealed that monitoring prompted actions, meaning preemptive monitoring actions executed on time, resulted in time and cost savings for the organization. (Kosnik, 1987)

2.4 Research-based project managers' competencies

As we have seen the competencies required of project managers have undergone significant transformations over time, shaped by rapid advancements in technology, evolving economic conditions, and organizational shifts. While the competencies identified in earlier sections provide a robust theoretical foundation, it is crucial to ascertain whether these competencies remain relevant and are reflected in more recent academic studies.

For this reason, we conducted an analysis of the research published from 2005 onwards, a period selected to capture contemporary developments in the field of project management. The purpose of this analysis was to determine whether the competencies

identified in classical literature are also present in generic project management papers published after 2005. This ensures that the theoretical framework aligns with contemporary developments and practical applications in the field. To achieve this, a review of 32 selected research articles was conducted. The first table summarizes the articles by providing the index, authors, title, and publication year, offering a broad overview of the sources analyzed.

Table 4: Recap of literature review

Index	Author	Title	Year
1	Zhu, Yu-Qian; Kindarto, Asdani	A garbage can model of government IT project failures in developing countries	2016
2	Oh, Minjeong; Choi, Sungyong	The competence of project team members and success factors with open innovation	2020
3	Furniss, Dominic; Curzon, Paul; Blandford, Ann	Exploring organisational competences in Human Factors and UX project work	2017
4	Krpálek, Pavel; Berková, Kateřina; Kubišová, Andrea et al.	Formation of professional competences and soft skills of public administration employees	2021
5	Lutsenko, Galyna	Case study of a problem-based learning course of project management	2018
6	Ron Schipper, R.P.J.; Gilbert Silvius, A.J.	Characteristics of smart sustainable city development	2018
7	Blaskovics, Bálint; Maró, Zalán Márk; Klimkó, Gábor et al.	Differences between Public-Sector and Private-Sector Project Management Practices	2023
8	Nchez, Luis Ballesteros-Sá; Ortiz-Marcos, Isabel	Investigating the gap between engineering graduates and practicing project managers	2021
9	Varajão, João; Silva, Hélio; Pejic-Bach, Mirjana	Key competences of information systems project managers	2019
10	Borg, Elisabeth; Soderlund, Jonas	The nature and development of liminality competence	2015
11	Makatsoris, Charalampos	An information and communication technologies-based framework for enhancing project management	2009
12	Loufrani-Fedida, Sabrina; Saglietto, Laurence	Mechanisms for Managing Competencies in Project-Based Organizations: An Integrative Multilevel Analysis	2014
13	Bourne, Lynda; Walker, Derek H.T.	Advancing project management in learning organizations	2004
14	von Meding, Jason; Wong, Joel; Kanjanabootra, Sittimont et al.	Competence-based system development for post-disaster project management	2016
15	Salminen-Tuomaala, Mari; Koskela, Tiina	How can simulation help with learning project work skills?	2020
16	Karlsen, Jan Terje; Farid, Parinaz; Torvatn, Tim	Project manager roles in a public change project: the case of a municipal merger	2020
17	Larsson, Johan; Larsson, Lisa	Integration, application and importance of collaboration in sustainable project management	2020
18	Xue, Jian; Rasool, Zeeshan; Gillani, Aqsa et al.	The impact of project manager soft competences on project sustainability	2020
19	Yang, Li-Ren; Yen, Hsiu-Feng; Chiang, Yu-Fu	A framework for assessing impacts of leadership competency on police project performance	2012
20	Llamas, Bernardo; Storch de Gracia, M. Dolores et al.	Assessing transversal competences as decisive for project management	2019
21	Magano, Jose; Silva, Claudia Sousa; Figueiredo, Claudia et al.	Project Management in Engineering Education: Providing Generation Z with Transferable Skills	2021
22	de la Cruz López, María Pilar; Cartelle Barros, Juan José et al.	New approach for managing sustainability in projects	2021
23	Ruuska, Inkeri; Vartiainen, Imatti	Critical project competences – a case study	2003
24	Blixt, Carley; Kirytopoulos, Konstantinos	Challenges and competencies for project management in the Australian public service	2017
25	Säisä, Marika Eve Katariina; Tiura, Katariina; Matikainen, Rita	Agile project management in university-industry collaboration projects	2019
26	De Los Ríos-Carmenado, Ignacio; López, Fernando Rodriguez et al.	Promoting professional project management skills in engineering higher education	2015
27	Estévez, J.; García-Marín, A.P.; Ayuso-Muñoz, J.L.	Self-perceived benefits of cooperative and project-based learning strategies	2020
28	Li, Long; Li, Zhongfu; Wu, Guangdong et al.	Critical success factors for project planning and control in prefabrication housing production	2018
29	Sołtysik, Mariusz; Zakrzewska, Małgorzata et al.	Assessment of project manager's competence in the context of individual competence baseline	2020
30	Poveda-Bautista, Rocio; Diego-Mas, Jose-Antonio et al.	Analysis of the visual perception of the competences of project managers	2021
31	Bartoška, Jan; Svobodová, Radka et al.	IPMA standard elements and feedback in project management teaching	2011
32	Souza, Mariane; Margalho, Élida; Lima, Rui M. et al.	Rubric's Development Process for Assessment of Project Management Competences	2022

The second table categorizes project management competencies by sector, allowing for a comparative analysis across different industries such as Government IT, Cross-industry, Public Administration, Education, IT, and the Private Sector. The classification highlights how specific competencies—such as leadership, problem-solving, stakeholder engagement, and project methodologies—are prioritized in various contexts. For example, leadership is frequently referenced across all sectors, with notable emphasis in education ([5, 8, 15, 21]) and the private sector ([14, 28]). Similarly, problem-solving appears predominantly in education ([5, 26, 29]) and the private sector ([28]), while adaptability is emphasized in Government IT ([6]) and IT ([9]).

This division by sector enables a more nuanced understanding of how competencies are valued in different environments, offering insights into sector-specific requirements and trends. It also sheds light on areas where competencies overlap or diverge, highlighting opportunities for targeted skill development. The findings from this analysis will serve as a foundation for validating the relevance of classical competencies and identifying emerging trends in project management.

Table 5: Recap of soft skills

Skill/Category	Government IT	Cross-industry	P.A.	Education	IT	Private Sector
Leadership	[1]	[2, 3, 7, 10]	[4, 16, 17]	[5, 8, 15, 21]	[9, 18]	[14, 28]
Problem Solving	[1]	[3, 10]	[16]	[5, 26, 29]		[28]
Stakeholder Engagement		[7, 10]	[17]	[8, 26]		
Adaptability	[6]			[8]	[9]	
Teamwork				[5, 26, 15]		
Negotiation		[7, 10]	[4, 16]	[21]		
PM Methodologies	[1]	[2, 3, 7]	[4, 16, 17]	[5, 15, 26]	[9, 18]	[14, 28]
PM Techniques	[1]	[2, 3]	[4, 16, 17]	[5, 15, 26, 29]	[9, 18]	[14, 28]
Project Design and Planning	[1, 6]	[2, 3, 7, 10, 12, 22]	[4, 16, 17, 19]	[5, 8, 13, 15, 26, 31]	[9, 18]	[14, 28]
Monitor Project Schedules and Budget	[1, 6]	[2, 10, 12]	[4, 16, 19]	[5, 13, 15, 20, 26, 29]	[9, 18]	[14, 28]

Chapter 3: Introduction to Artificial Intelligence literacy

3.1. Introduction to the concept of AI Literacy

The concept of AI literacy is an expansion of traditional literacy, tailored to meet the specific demands of engaging with artificial intelligence technologies effectively. AI literacy encompasses not only a basic understanding of AI principles but also the capability to apply these principles critically. This includes evaluating AI technologies and leveraging them to solve real-world problems.

In machine learning, AI literacy involves familiarity with how algorithms learn from data and the ability to interpret their outputs, which is fundamental for applying AI in practical scenarios (Touretzky *et al.*, 2019). Statistical inference is another critical component, enabling individuals to use statistical methods to make predictions or to infer properties of a population based on a sample. This skill is vital for analysing data and drawing meaningful conclusions (OECD, 2018b). Additionally, understanding data patterns involves recognizing and extracting useful insights from large datasets, which includes skills in data visualization and preprocessing to discern trends, anomalies, and correlations. It is equally important to clean the data thoroughly before using it with any algorithm or for any application. Organizing the data in a structured, retrievable, and reverse-engineerable manner is also crucial to ensure transparency and replicability.(Estevez *et al.*, 2022).

Initial AI education efforts primarily targeted university students and the general public, focusing heavily on technical skills like programming and algorithms. This approach often overlooks essential foundational AI concepts, which are critical for individuals from non-technical backgrounds who are increasingly encountering AI in various sectors. Such educational strategies can exclude those outside computer science or engineering disciplines, limiting their understanding and potential to effectively utilize AI technologies (Mishra and Siy, 2020; Lee et al., 2021).

Moreover, existing educational frameworks typically concentrate on K-12 and higher education settings, prioritizing the development of future technologists and educators

(Touretzky *et al.*, 2019). This leaves a significant gap in training for professionals already in the workforce or those in non-academic careers, who may require AI literacy to adapt to new technologies integrated into their industries. Most programs do not address the distinct needs of these professionals, who need to understand not only how to use AI tools but also to assess their impact and integrate AI into their decision-making processes (Vazhayil *et al.*, 2019).

The integration of AI into educational curricula is explored through various studies, each underscoring the importance of AI literacy across different educational stagesVazhayil et al., (2019) explore the implementation challenges and successes in Indian educational systems, emphasizing the necessity of teacher training programs to enhance AI integration. (Zhao, Wu and Luo, 2022) further this discussion by linking teachers' AI literacy directly with their ability to effectively incorporate AI tools and libraries, into classroom teaching, suggesting a significant impact on educational outcomes.

AI literacy is increasingly recognized as a crucial skill set essential for navigating the pervasive impact of AI technologies in various sectors, including education. The foundational understanding of AI involves recognizing **its capabilities, limitations, and** the ethical **implications of its use** INSERT CITATION. Chen, Zaharia and Zou, (2023) highlight how GenAI tools like ChatGPT are used to facilitate knowledge building in educational settings, showing the practical application of AI in enhancing learning experiences. This introduction to AI, particularly through interactive and application-based learning, is pivotal in developing a comprehensive AI literacy that empowers students to use this technology mindfully and effectively.

Druga, Otero and Ko, (2022) and Kong, Man-Yin Cheung and Zhang, (2021) both demonstrate that project-based learning approaches can significantly enhance understanding of AI technologies among students. These studies advocate for an educational framework that not only equips students with technical skills but also fosters critical thinking and ethical reasoning, essential for responsible use of AI. The literature collectively calls for a structured approach to AI education that balances technical skills with critical and ethical considerations INSERT CITATION2019);, preparing students

for a future where AI is seamlessly integrated into daily life and professional environments.

AI literacy often intersects with data literacy, sharing key competencies such as the creation and evaluation of labeled datasets and the identification of data biases. However, many AI literacy frameworks do not fully integrate the comprehensive stages of the data lifecycle, underscoring the need for programs that enhance data competencies alongside AI skills (Long and Magerko, 2020; Prado and Marzal, 2013; Ridsdale et al., 2015).

According to Long and Magerko, (2020); Prado and Marzal, (2013); Ridsdale et al., 2015 there is a significant gap in current AI literacy programs, which often overlook the depth of data competencies required. These studies advocate for educational programs that not only address AI skills but also enhance data literacy to ensure that learners can fully engage with all aspects of AI work. Including but not limitating to: understanding how data underpins AI technologies, recognizing the implications of data quality and structure on AI outputs, and applying these insights to develop more accurate and equitable AI systems.

AI education should empower individuals to effectively navigate and utilize AI technologies, fostering skills beyond technical knowledge to include critical evaluation and ethical considerations. AI literacy programs must prioritize inclusivity and address inequalities to ensure diverse groups can benefit from and contribute to the AI-driven future ((Kong, Man-Yin Cheung and Zhang, 2018); Brennan and Resnick, 2015)

To better summarize the core aspects of AI literacy and their connections to relevant research, the following table organizes the key components of AI literacy alongside the sources that address them. This structured approach highlights the critical contributions from the literature and emphasizes the main skills, concepts, and educational strategies necessary to develop comprehensive AI literacy.

Table 6: AI literacy recap

Aspect of AI literacy	Relevant Sources	Key Contributions
Understanding Fundamental AI Principles	- Touretzky et al. (2019) - OECD (2018b)	Explains foundational AI concepts and emphasizes understanding AI capabilities for decision-making.
Machine Learning	- Touretzky et al. (2019)	Highlights how algorithms learn from data and the importance of interpreting outputs.
Statistical Inference	- OECD (2018b)	Focuses on statistical methods for predictions and inferring properties from populations.
Data Analysis and Interpretation	- Estevez et al. (2022)	Emphasizes skills in recognizing patterns, trends, and anomalies using data visualization and preprocessing.
Education on AI Fundamentals	- Mishra and Siy (2020) - Lee et al. (2021)	Highlights foundational concepts for non-technical individuals and advocates for inclusivity in AI education.
Training for Working Professionals	- Vazhayil et al. (2019)	Discusses the need for AI training to help professionals integrate AI into workflows and decision-making.
AI in Teacher Training	- Zhao, Wu, and Luo (2022)	Links teachers' AI literacy to their ability to effectively incorporate AI tools in classrooms.
AI-Based Educational Projects	- Druga, Otero, and Ko (2022) - Kong, Man-Yin Cheung, and Zhang (2021)	Explains how project-based learning enhances critical thinking, practical AI skills, and hands-on experience.
Interactive and Application-Based Approaches	- Chen, Zaharia, and Zou (2023)	Shows how tools like ChatGPT can enhance learning experiences and practical AI competency development.
Intersection of AI Literacy and Data Literacy	- Long and Magerko (2020) - Prado and Marzal (2013) - Ridsdale et al. (2015)	Stresses the integration of AI and data literacy, data lifecycle skills, and identifying biases in datasets.
Ethical Considerations in AI	- Brennan and Resnick (2015) - Kong et al. (2018)	Encourages critical thinking about AI's ethical and societal impacts and advocates for ethical reasoning.
Inclusivity in AI Programs	- Kong et al. (2018) - Brennan and Resnick (2015)	Stresses inclusive AI literacy programs that reduce inequalities and ensure accessibility for all.

The table below consolidates the findings of the literature review, serving as the foundation for the development of the statements for the quantitative analysis we'll see in the next chapter. These statements were not created arbitrarily but emerged through a rigorous and systematic process of synthesizing theoretical frameworks, empirical evidence, and practitioner insights from diverse disciplines. The selection of competencies and their corresponding statements reflects a deliberate effort to address the multifaceted nature of project management, bridging the gap between theoretical constructs and practical applications.

Each statement was designed to capture the critical skills and knowledge areas identified in the literature, emphasizing their relevance to real-world challenges and opportunities in project management. By integrating perspectives from established institutions, such as ICB.4, PRINCE2, and PMCD.3, and combining these with practitioner contributions, the resulting framework ensures a balanced and comprehensive approach. This methodological rigor guarantees that the statements are grounded in academic theory while being applicable to dynamic and complex project environments.

Ultimately, the table provides a structured organization into distinct **classes**, identified during the literature review, to reflect the diverse skill sets necessary for project management success. The classes include: Specific Project Management Competencies, Interpersonal Soft Skills, Personal Soft Skills, Technological and AI-Related Skills, and Business Acumen Skills.

Table 7: Referenced statements

	Specific Project managment competencies			
#	**Institutions**	**Reference**	**Competence**	**Statement**
1	ICB.4, PRAXIS	Van Ingen (2007), Sampson (2007), Gibson et al. (1995), Oliver GR & Walker RG (2006)	Effective risk and quality management competencies	Effective risk and quality management competencies are crucial for anticipating and mitigating potential failures and drawbacks in projects.
2	ICB.4, PRAXIS	Powers (1987), Bell (1988), Xue et al. (2020), Oh & Choi (2020)	Efficient procurement and resource allocation	It is important to procure and allocate resources efficiently, considering the cost and infrastructure requirements of technologies and of competences.
3	-	Van Ingen (2007), Sampson (2007), Zielinski (2005, p. 22), Oliver GR & Walker RG (2006), Bergen M, Dutta S & Walker Jr. (1992), Crawford P & Bryce P (2003)	Estimating financial revenues and project outcomes	The ability of estimating financial revenues and project outcomes is essential for delivering successful projects.
4	ICB.4	White, Hodgson & Crainer (1996), Zielinski (2005, p. 22), Oliver GR & Walker RG (2006)	Change management and scope control	Change management and scope control are vital in project management to prevent scope creep and manage requirement changes, ensuring project goals are met on time and within budget.
5	PMCD.3, PRINCE2	Frensch & Funke J. (1995), Oliver GR & Walker RG (2006)	Time and cost management skills	Time and cost management skills are fundamental for meeting project deadlines and managing multiple tasks efficiently.
6	ICB.4	Powers (1987), Bell (1988), Xue et al. (2020), Oh & Choi (2020), Oliver GR & Walker RG (2006)	Team selection and composition	The team selection and composition is crucial for the success of the project.

	Interpersonal soft skills			
#	**Institutions**	**Practitioners**	**Competence**	**Statement**

7	ICB.4, PMCD.3, APM, PMI,	Gaddis (1959), Lawrence & Lorsch (1967), Van Ingen (2007), Sampson (2007), Greenwood (2007, pp. 317-318)	Interpersonal communication skills	Interpersonal communication skills are key to resolving conflicts and facilitating teamwork.
8	PMCD.3	Bergen M, Dutta S & Walker Jr. (1992), Crawford P & Bryce P (2003), Zaccaro et al. (2001), Von Meding et al. (2016), Yang, Yen & Chiang (2012), Amirghodsi et al. (2024), Zachary & Krone (1984)	Fostering motivation in the team	One of PM key competence is foster motivation in the team.
9	-	Van Ingen (2007), Sampson (2007)	Interpersonal and multicultural understanding	Interpersonal and multicultural understanding is crucial for every PM in order to understand the needs of each team member.
10	ICB.4, APM, PRAXIS	Putnam (1990), Zielinski (2005, p. 22), Putnam & Roloff (1992), Bell (1988), Walton & McKersie (1965)	Negotiation skills	Negotiation skills are essential for project managers to secure favorable terms in agreements and foster beneficial partnerships.

	Personal soft skills			
#	**Institutions**	**Practitioners**	**Competence**	**Statement**

11	ICB.4, PMCD, APM, PMI	-	Effective leadership	Effective leadership is crucial in guiding teams through complex projects and achieving organizational goals.
12	-	Pulakos et al. (2000), Putnam & Roloff (1992), Friedman (1993), Lewicki (1997)	Creativity and innovation	Creativity fuels innovation, allowing teams to find novel solutions to unexpected challenges during projects.
13	-	Friedman (1993), Lewicki (1997), recap table 5, 26, 29	Strong problem-solving skills	Strong problem-solving skills are essential for overcoming obstacles and keeping projects on track.
14	ICB.4	Prada M Merenque, Pino-Juste (2022), Tversky & Kahneman (1974), Vazhayil et al. (2019), Borel (1927), Gaddis (1959), Lawrence & Lorsch (1967), Manetti & Toccafondi (2012, p. 365), Putnam (1990), Malucelli, Barbosa & Carvalho (2021), Drejer & Riis (1999)	Quick and effective decision-making	Quick and effective decision making is vital to maintaining project momentum and meeting deadlines.
15	-	Gaddis 1959), Lawrence and Lorsch (1967), Manetti and Toccafondi (2012, p. 365), Putnam, 1990), Malucelli, Barbosa and Carvalho, (2021),Drejer and Riis (1999)	Flexibility and adaptability	Being flexible allows project managers to adapt strategies and actions when project dynamics change.
	Technological and AI related skills			
#	**Institutions**	**Practitioners**	**Competence**	**Statement**
16	-	Zielinski (2005, p. 22)	Technical expertise in project-related software tools	Technical expertise in project-related software tools enhances efficiency and accuracy.
17	-	-	Understanding AI strengths and limitations	Understanding where AI excels and where it falls short is key to maximizing its potential and could be very impactful in a project.
18	-	Zhao, Wu & Luo (2022)	Leveraging AI and libraries effectively	It is important to have someone on the team who can leverage AI and libraries effectively, as they streamline development, simplify complex tasks, and boost overall productivity.
19	-	Estevez et al. (2022)	Data cleaning and preparation skills	Knowing how to clean data is crucial before using it with AI. Clean data ensures accuracy, reduces errors, and improves the quality of AI outputs, leading to more reliable insights and better decision-making.
20	-	Long & Magerko (2020), Prado & Marzal (2013), Ridsdale et al. (2015)	Interpreting AI outputs for informed decision-making	Understanding AI and its outputs is essential for informed decision-making. Clear interpretation helps leaders use insights effectively, reduce risks, and make decisions aligned with business objectives.
21	-	Long & Magerko (2020), Prado & Marzal (2013), Ridsdale et al. (2015)	Awareness of AI data sources and potential biases	It is crucial to understand where AI data comes from and recognize potential biases. Awareness of data sources and bias helps ensure fair, accurate AI outputs and supports ethical decision-making.

	Business acumen skills			
#	**Institutions**	**Practitioners**	**Competence**	**Statement**
22	OECD	Suikki, Tromstedt & Haapasalo (2006)	Understanding customer needs and market trends	Understanding customer needs and market trends is crucial for project strategy, vision and for its success.
23	OECD	Suikki, Tromstedt & Haapasalo (2006)	Understanding global market dynamics	Building a comprehensive understanding of global market dynamics allows project managers to anticipate changes and adapt their strategic direction proactively.
24	ICB.4, PMCD, PMI	-	Continuous improvement and efficiency	It is crucial to practice continuous improvement and seek efficiency in order to fine-tune the rusty processes.
25	-	Crawford P & Bryce P (2003)	Aligning immediate actions with broader organizational objectives	For maintaining a long-term perspective, each project team member has to ensure that immediate actions are in sync with broader organizational objectives.

Chapter 4: Methodology

4.1. Valuation of possible methodologies

In the design phase of this study, several methodological approaches were evaluated to investigate the emerging and underexplored domain of AI competencies in project management. Given the novelty and complexity of the topic, the primary objective was to identify a method capable of capturing the subjective perceptions of experts while systematically analyzing patterns across diverse perspectives.

4.1.1 AHP

We considered adopting the AHP (Analytic Hierarchy Process) method in our research because our aim was to understand how project managers prioritise different competences, with a focus on comparing AI competences with traditional project management competences.

AHP is a particularly useful method in contexts where a hierarchical ranking based on comparative judgements is desired, allowing quantitative weights to be assigned to the different alternatives analysis. In our case, project managers would rate the competencies through pairwise comparisons, allowing us to determine the extent to which AI-related competencies are perceived as more or less important than traditional ones.(Darko *et al.*, 2019)

A critical aspect of AHP is that the number of comparisons required grows rapidly as the number of items to be analyzed increases. In an ideal scenario, we could have structured the comparison in such a way as to evaluate all competencies against each other, resulting in a complete and well-defined hierarchy. However, a problem with this approach is that the least prioritized competencies, discarded in the first iterative steps, would not be compared directly with the most relevant ones, reducing the quality of the overall classification.

In order to achieve a more robust and representative hierarchy, it would be necessary to also compare the least relevant competences with the most important ones, further

increasing the number of comparisons required. The total number of pairwise comparisons in the AHP method is determined by the formula:

$$\frac{n(n-1)}{2}$$

where n represents the total number of competences to be compared. In our case, having identified 25 competences (represented by relative statements), the number of comparisons required would be:

$$\frac{25(25-1)}{2}$$

This means that each participant would have to make 300 separate comparisons, which is excessive both in terms of the time required and the cognitive load on respondents. Such a large number of comparisons would not only risk fatiguing the participants, but could also compromise the quality of the collected data by increasing the likelihood of inconsistent responses.

4.1.2 Delphi method

Another alternative we considered was the Delphi method. The Delphi method is based on an iterative consultation process with experts through a series of question-and-feedback cycles, aiming to achieve consensus on a given topic. In our case, the study focuses on experts' perceptions of project management competencies.

The process begins with defining the research topic, objectives, and key questions. A panel of qualified experts is then selected to ensure the validity of the analysis. The first operational step involves designing an open-ended questionnaire (Round 1), which serves as the foundation for the study's initial phase. Experts respond by providing their opinions and evaluations.

Based on the responses collected in the first round, a second questionnaire (Round 2), typically with closed-ended questions, is developed to structure and quantify the previously expressed opinions. After completing the second round, experts receive feedback with a summary analysis of the aggregated responses. At this stage, they have

the opportunity to revise and, if necessary, modify their responses in light of others' perspectives.

The process may include further iterative cycles until an acceptable level of consensus is reached. The number of iterations is not fixed, but the method concludes when responses converge and variations between rounds become negligible.

We decided not to adopt the Delphi method for three main reasons.

1) This methodology is time-intensive and complex, making it impractical and difficult to implement in practice. Additionally, the limited availability of experts further complicates to secure participation for the whole process.
2) Traditional project management competencies are already well-defined in both academic literature and key institutional frameworks (e.g., PMI, IPMA, PRINCE2). As a result, the first round of Delphi, which is designed to collect open-ended insights for structuring concepts, would be unnecessary for this set of competencies.
3) Delphi's iterative nature seeks to harmonize expert opinions, which could lead to a stronger emphasis on defining emerging competencies rather than systematically comparing traditional and AI-related competencies. This could dilute the primary focus of our research.

For these reasons, we conclude that the Delphi method is not the most suitable tool for our study, and other methodologies are better suited to achieving our research objectives.

4.1.3 Conjoint Analysis

The Conjoint Analysis is a well-established quantitative method used primarily in marketing and decision science to determine how individuals value different attributes of a product or service. The core principle of this methodology is to decompose a decision-making process into a set of attributes and levels, allowing for the estimation of the relative importance of each factor. Participants are presented with different combinations of attributes and asked to choose between them, simulating real-world decision-making

trade-offs. The analysis of these choices then provides insights into the weight each attribute holds in influencing the final decision.

Applying Conjoint Analysis to the study of project management competencies would require structuring competencies into measurable attributes. For instance, competencies could be categorized into traditional project management skills and emerging AI-related skills, with additional attributes such as perceived importance and difficulty of acquisition. Through this approach, participants would evaluate different competency profiles, where each profile represents a combination of these attributes. By analyzing their choices, the study could identify which competencies are valued most and under what conditions they are prioritized over others.

Despite its structured approach, Conjoint Analysis is not well suited for this research for two reasons:

1) First, defining meaningful attribute levels for competencies is inherently complex. Unlike product features, which can be easily modified and measured (e.g., price, size, color), competencies are more abstract and context-dependent, making their decomposition into quantifiable attributes somewhat artificial.
2) Second, the method requires participants to make trade-offs between different competency profiles, which may not reflect how competencies are evaluated in practice. In real-world professional settings, competencies are not necessarily chosen in exclusion of one another, but rather assessed holistically. Finally, the primary objective of this study is to compare and rank competencies rather than to identify preference trade-offs between different configurations of skills.

4.2. Q-sort Methodology

Given these limitations, the Q-methodology was selected as the most appropriate framework for this study. This hybrid approach integrates qualitative and quantitative techniques, enabling a structured yet flexible exploration of subjectivity. By requiring participants to rank a predefined set of statements along a continuum from "strongly agree" to "strongly disagree," the Q-sort procedure systematically captures individual perspectives while facilitating the identification of shared patterns. This method is

particularly well-suited for research in underexplored domains, where the goal is to uncover and analyze divergent viewpoints within a specific population.

Moreover, the Q-methodology aligns closely with the objectives of this study, as it allows for the systematic exploration of emerging themes without imposing a priori assumptions. By focusing on the subjective perceptions of experts, this approach provides a robust foundation for understanding the complex and evolving landscape of AI competencies in project management.

The Q-methodology is a robust qualitative-quantitative technique designed to systematically study subjectivity, that is, the personal viewpoints, attitudes, and perceptions of individuals (Brown, 1980). Unlike traditional surveys or interviews, which often impose external frameworks on participants, the Q-sort allows individuals to express their perspectives in a structured yet flexible manner. Below, we outline the key components and procedures of the Q-sort methodology as applied in this study.

Typically, in a Q-methodological study, individuals are presented with a sample of statements about a given topic, referred to as the Q-set. These respondents, known as the P-set, are asked to rank-order the statements from their individual point of view, according to some preference, judgment, or feeling about them, mostly using a quasi-normal distribution (Smith, 2001). By ‘Q-sorting’ the statements, respondents assign subjective meaning to them, revealing their personal perspective (Brouwer, 1999). Unlike conventional survey data, where rows represent respondents and columns correspond to statements, Q-sort analysis organizes data differently: rows denote opinions, attitudes, or behaviors, while columns represent respondents. Participants are typically presented with a set of items—often 20 to 50 (Excel and Graaf, 2005), but sometimes 60 (Donner, 2001) or even up to 100 statements (Cross, 2004)—and are required to rank them along a specified scale, such as from "disagree" to "agree," depending on the nature of the assessment. By positioning items at the extreme ends of the scale, respondents indicate the strength of their opinions, effectively clarifying which values they associate with particular concepts.

The individual rankings (or viewpoints) are then subjected to factor analysis. Stephenson (1935) introduced Q-methodology as an inversion of conventional factor analysis, in the

sense that it correlates persons instead of tests: “whereas previously a large number of people were given a small number of tests, now a small number of people a large number of test items are given” (Stephenson, 1935). Correlation between personal perspectives then indicates similar viewpoints or segments of subjectivity that exist (Brown, 1980). If each individual had a unique set of preferences, their perspectives would not correlate; however, when significant clusters of correlations exist, they can be factorized and described as common viewpoints, typologies, or dominant perspectives (Stephenson, 1935).

Q-methodology allows for an in-depth examination of the perspectives held by different stakeholders or actors by analyzing both differences and similarities in viewpoints (McKeown and Thomas, 1988). Unlike R-methodology (e.g., surveys and questionnaires), which asks respondents to express views on isolated statements, Q-methodology captures respondents’ views on statements within the context of the valuation of all presented statements (Dryzek and Berejikian, 1993). Additionally, whereas R-methodology often aims to measure the level of support for different perspectives among a population, Q-methodology instead seeks to identify and describe the variety of perspectives that exist within a population. Consequently, Q-methodology relies on purposive sampling and smaller sample sizes rather than random sampling and large samples. The inclusion criterion is simply the assumption that a person may hold a different perspective, making their participation valuable to the study (McKeown and Thomas, 1988).

The Q-sort methodology has several strengths for studying complex and underexplored topics. It is systematic yet flexible: the structured sorting process ensures consistency while still allowing for nuanced interpretation through qualitative comments. Furthermore, the approach is participant-centered, directly engaging individuals by having them rank statements based on their own perspectives rather than responding to predefined survey questions. It is particularly well-suited for small sample sizes, prioritizing depth over breadth, making it ideal for studies with limited participant pools. Additionally, the methodology reveals both shared and divergent perspectives by identifying factors that uncover commonalities and differences in how participants view the topic. If, for instance, there are eight categories within a concourse, a researcher might

select four to five of the most representative statements from each category, yielding a Q-set of 32–40 statements (Webler et al., 2009).

Owing to the fact that in our research we were interested in the value of the singular competences in the field of project management, in understanding the effective practicality of these competences and how they are perceived by experienced project managers

4.2.1 Development of Q-sample

The first step in the Q-sort process is the creation of the Q-sample, a set of statements that represent the concourse of opinions, ideas, or attitudes related to the research topic, in this case a set of statement that represent PM's competences. In this study, the Q-sample was developed and produced after a thorough literature review and after an initial consultation with experts project management. The first phase in constructing the statements was writing the literature review. After a thorough analysis, the literature review identified a list of 25 competencies. This list was merely an output of the literary analysis and, therefore, had no form of back testing. The raw competencies were as follows, as shown in Table 8:

Table 8: Raw competencies drafted

N	**Competence**
Techical skills	
1	Risk and quality management
2	Procurement and resource allocation
3	Revenue estimation and project outcomes
4	Change management and scope control
5	Time and cost management
6	Team selection and composition
Soft skills	
7	Interpersonal communication
8	Team motivation
9	Cultural and interpersonal understanding
10	Negotiation
11	Leadership
12	Creativity and innovation
13	Problem-solving
14	Quick and effective decision-making
Technological skills	
15	Flexibility and adaptability
16	Use of project-related software
17	Understanding AI strengths and limitations
18	Using AI and libraries
19	Data cleaning and preparation
20	Interpreting AI outputs for decisions
21	Awareness of AI data sources and biases
Vision	
22	Understanding customer needs and market trends
23	Understanding global market dynamics
24	Continuous improvement and efficiency
25	Aligning actions with business objectives

The second phase of constructing the statements was back-testing. To achieve this, we assembled a group of seven individuals, consisting of five academics and two project managers. These participants were consulted via a video call. Initially, we considered it useful to test the overarching categories we intended to use for classifying the competencies. The initial categorization was as follows:

Techical skills
Soft skills
Technological skills
Vision

We gathered feedback on this categorization. First, it became evident that the categories needed more formal and evocative names. More importantly, the discussion made us realize that the scope of soft skills was quite broad—perhaps too broad to be grouped under a single classification. As a result, we decided to divide them into two distinct categories:

- Interpersonal skills: referring to abilities related to interactions between different individuals, such as communication and motivation.
- Personal skills: referring to soft skills tied to the individual and their behavior, such as problem-solving and creativity.

The final result brought us to this set of categories:

Specific Project managment competencies
Interpersonal soft skills
Personal soft skills
Technological and AI related skills
Business acumen skills

Next, we proceeded to review the competencies. The group unanimously accepted all of them, with no redundancies or missing competencies. Therefore, the only remaining tasks were to allocate the soft skills into the two newly defined categories and to formally refine each competency. The final result is as follows:

Table 9: Final competencies drafted

N	**Competence**
Specific Project managment competencies	
1	Effective risk and quality management competencies
2	Efficient procurement and resource allocation
3	Estimating financial revenues and project outcomes
4	Change management and scope control
5	Time and cost management skills
6	Team selection and composition
Interpersonal soft skills	
7	Interpersonal communication skills
8	Fostering motivation in the team
9	Interpersonal and multicultural understanding
10	Negotiation skills
Personal soft skills	
11	Effective leadership
12	Creativity and innovation
13	Strong problem-solving skills
14	Quick and effective decision-making
Technological and AI related skills	
15	Flexibility and adaptability
16	Technical expertise in project-related software tools
17	Understanding AI strengths and limitations
18	Leveraging AI and libraries effectively
19	Data cleaning and preparation skills
20	Interpreting AI outputs for informed decision-making
21	Awareness of AI data sources and potential biases
Business acumen skills	
22	Understanding customer needs and market trends
23	Understanding global market dynamics
24	Continuous improvement and efficiency
25	Aligning immediate actions with broader organizational objectives

A total of 25 items were selected to cover the breadth of competencies in project management, including ensuring a balanced representation of technical and managerial dimensions.

Then each statement was carefully crafted to be clear, concise, and relevant to the research objectives but at the same, together with the expert. Moreover, the statements, unlike those used in other Q-sort studies, are intentionally ambiguous and broadly agreeable. In other words, these statements are designed to appear valid and relevant to all respondents, ensuring that no particular perspective is favored or disadvantaged. The Q-sample was then pilot-tested with a small group of experts to ensure clarity and relevance.

Table 10: Final statements

Group	Index #	#	Statements
PM Tecnique	1.1	1	Effective risk and quality management competencies are crucial for anticipating and mitigating potential failures and drawbacks in projects.
	1.2	2	It is important to procure and allocate resources efficiently, considering the cost and infrastructure requirements of technologies and of competences.
	1.3	3	The ability of estimating financial revenues and project outcomes is essential for delivering successful projects.
	1.4	4	Change management and scope control are vital in project management to prevent scope creep and manage requirement changes, ensuring project goals are met on time and within budget.
	1.5	5	Time and cost management skills are fundamental for meeting project deadlines and managing multiple tasks efficiently.
	1.6	6	The team selection and composition is crucial for the success of the project
Interpersonal	2.1	7	Interpersonal communication skills are key to resolving conflicts and facilitating teamwork.
	2.2	8	One of pm key competence is foster motivation in the team
	2.3	9	Interpersonal and multicultural understanding is crucial for every Pm in order to understand the needs of each team member
	2.4	10	Negotiation skills are essential for project managers to secure favorable terms in agreements and foster beneficial partnerships.
Personal	3.1	11	Effective leadership is crucial in guiding teams through complex projects and achieving organizational goals
	3.2	12	Creativity fuels innovation, allowing teams to find novel solutions to unexpected challenges during projects.
	3.3	13	Strong problem-solving skills are essential for overcoming obstacles and keeping projects on track.
	3.4	14	Quick and effective decision making is vital to maintaining project momentum and meeting deadlines.
	3.5	15	Being flexible allows project managers to adapt strategies and actions when project dynamics change.
Technological	4.1	16	Technical expertise in project-related software tools enhances efficiency and accuracy.
	4.2	17	Understanding where AI excels and where it falls short is key to maximizing its potential could be very impactful in a project.
	4.3	18	It's important to have someone on the team who can leverage AI and libraries effectively, as they streamline development, simplify complex tasks, and boost overall productivity.
	4.4	19	Knowing how to clean data is crucial before using it with AI. Clean data ensures accuracy, reduces errors, and improves the quality of AI outputs, leading to more reliable insights and better decision-making.
	4.5	20	Understanding AI and its outputs is essential for informed decision-making. Clear interpretation helps leaders use insights effectively, reduce risks, and make decisions aligned with business objectives.
	4.5	21	It is crucial to understand where AI data comes from and recognize potential biases. Awareness of data sources and bias helps ensure fair, accurate AI outputs and supports ethical decision-making.
Vision	5.1	22	Understanding customer needs and market trends is crucial for project strategy, vision and for its success.
	5.2	23	Building a comprehensive understanding of global market dynamics allows project managers to anticipate changes and adapt their strategic direction proactively.
	5.3	24	it is crucial to practice continuous improvement and seek efficiency in order to fine-tune the rusty processes
	5.4	25	For maintaining a longterm perspective each project team member has to ensure that immediate actions are in sync with broader organizational objectives.

Table 11: Statement's References

Group	Index #	#	Reference
PM Tecnique	1.1	1	ICB.4, PRAXIS – Van Ingen (2007), Sampson (2007), Gibson et al. (1995), Oliver GR & Walker RG (2006), Powers (1987), Bell (1988), Xue et al. (2020), Oh & Choi (2020)
	1.2	2	ICB.4, PRAXIS – Powers (1987), Bell (1988), Xue et al. (2020), Oh & Choi (2020)
	1.3	3	Van Ingen (2007), Sampson (2007), Zielinski (2005, p. 22), Oliver GR & Walker RG (2006), Bergen M, Dutta S & Walker Jr. (1992), Crawford P & Bryce P (2003)
	1.4	4	ICB.4 - White, Hodgson & Crainer (1996), Zielinski (2005, p. 22), Oliver GR & Walker RG (2006)
	1.5	5	PMCD.3, PRINCE2 – Frensch & Funke J. (1995), Oliver GR & Walker RG (2006)
	1.6	6	ICB.4 – Powers (1987), Bell (1988), Xue et al. (2020), Oh & Choi (2020), Oliver GR & Walker RG (2006)
Interpersonal	2.1	7	ICB.4, PMCD.3, APM, PMI – Gaddis (1959), Lawrence & Lorsch (1967), Van Ingen (2007), Sampson (2007), Greenwood (2007, pp. 317-318)
	2.2	8	PMCD.3 – Bergen M, Dutta S & Walker Jr. (1992), Crawford P & Bryce P (2003), Zaccaro et al. (2001), Von Meding et al. (2016), Yang, Yen & Chiang (2012), Amirghodsi et al. (2024), Zachary & Krone (1984)
	2.3	9	Van Ingen (2007), Sampson (2007)
	2.4	10	ICB.4, APM, PRAXIS – Putnam (1990), Zielinski (2005, p. 22), Putnam & Roloff (1992), Bell (1988), Walton & McKersie (1965)
Personal	3.1	11	ICB.4, PMCD, APM, PMI – *(No specific references provided in the original text)*
	3.2	12	Pulakos et al. (2000), Putnam & Roloff (1992), Friedman (1993), Lewicki (1997)
	3.3	13	Friedman (1993), Lewicki (1997), *recap table 5, 26, 29*
	3.4	14	ICB.4 – Prada M. Merenque, Pino-Juste (2022), Tversky & Kahneman (1974), Vazhayil et al. (2019), Borel (1927), Gaddis (1959), Lawrence & Lorsch (1967), Manetti & Toccafondi (2012, p. 365), Putnam (1990), Malucelli, Barbosa & Carvalho (2021)
	3.5	15	Gaddis 1959), Lawrence and Lorsch (1967), Manetti and Toccafondi (2012, p. 365), Putnam, 1990), Malucelli, Barbosa and Carvalho, (2021),Drejer and Riis (1999)
Technological	4.1	16	Zielinski (2005, p. 22)
	4.2	17	
	4.3	18	Zhao, Wu & Luo (2022)
	4.4	19	Estevez et al. (2022)
	4.5	20	Long & Magerko (2020), Prado & Marzal (2013), Ridsdale et al. (2015)
	4.5	21	Long & Magerko (2020), Prado & Marzal (2013), Ridsdale et al. (2015)
Vision	5.1	22	OECD - Suikki, Tromstedt & Haapasalo (2006)
	5.2	23	OECD - Suikki, Tromstedt & Haapasalo (2006)
	5.3	24	ICB.4, PMCD, PMI
	5.4	25	Crawford P & Bryce P (2003)

4.2.2 Participant Selection (P-set)

The second step involves selecting the P-set, or the group of participants who will complete the Q-sort. Unlike traditional surveys, which aim for large, representative samples, Q-methodology prioritizes having a smaller pool of respondents, in fact typically, the P-set consists of 20–40 participants who represent the diversity of perspectives relevant to the research topic.

In this study, participants were selected based on their expertise in AI and project management, including academics and industry professionals. This diverse P-set ensured that the Q-sort captured a wide range of viewpoints, from technical specialists to strategic decision-makers.

The following table Wrap up the main information gathered for the 25 partecipants for the selection:

Table 12: Demographic recap of respondants (1)

Years of experience	Number of occurencies
2-10	3
10-15	10
15+	12

Table 13: Demographic recap of respondants (2)

Industry	Number of occurencies
Construction	7
Consulting	6
Energy	7
Finance	5

4.2.3 The Q-sorting Procedure

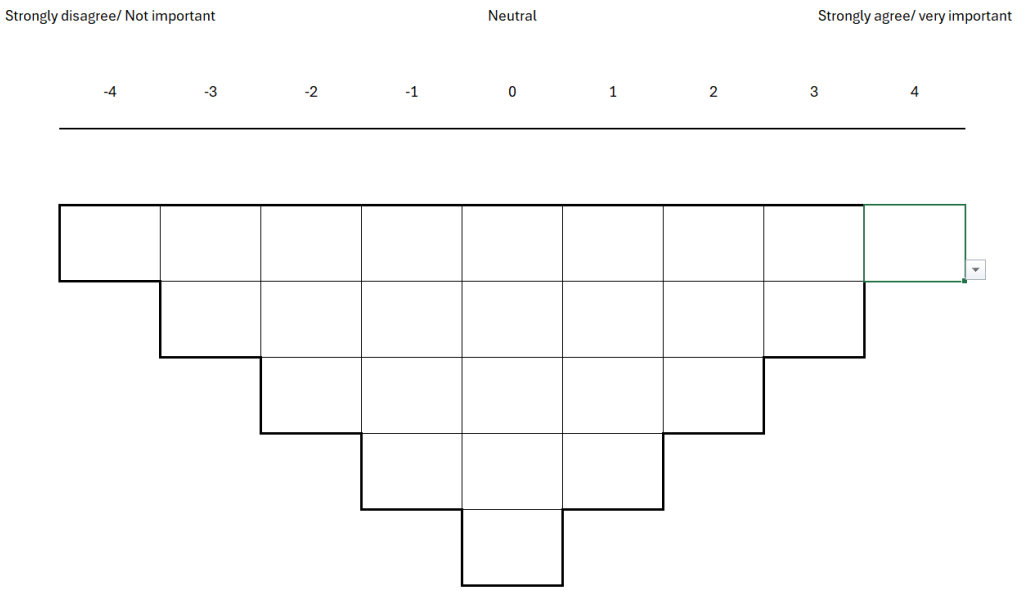
The core of the Q-methodology is the Q-sorting procedure, during which participants rank the statements in the Q-sample along a predefined distribution. Participants are asked to sort the statements into a quasi-normal distribution grid, ranging from "strongly agree" (+4) to "strongly disagree" (–4). The grid typically forces participants to place fewer

statements at the extremes and more in the middle, reflecting the natural distribution of opinions.

Thanks to the deliberate ambiguity in the construction of the statements, as explored in Chapter (INSERT Creation of Statements), it becomes challenging for respondents to place items in the lowest-ranking cells (e.g., -4, -3, etc.). As a result, when participants of the P-set rank the statements, they are effectively "forced" to take a stance. The objective of this approach is to identify which competencies are truly prioritized by modern project managers and to determine the relative positioning of AI-related technical competencies compared to traditional project management skills.

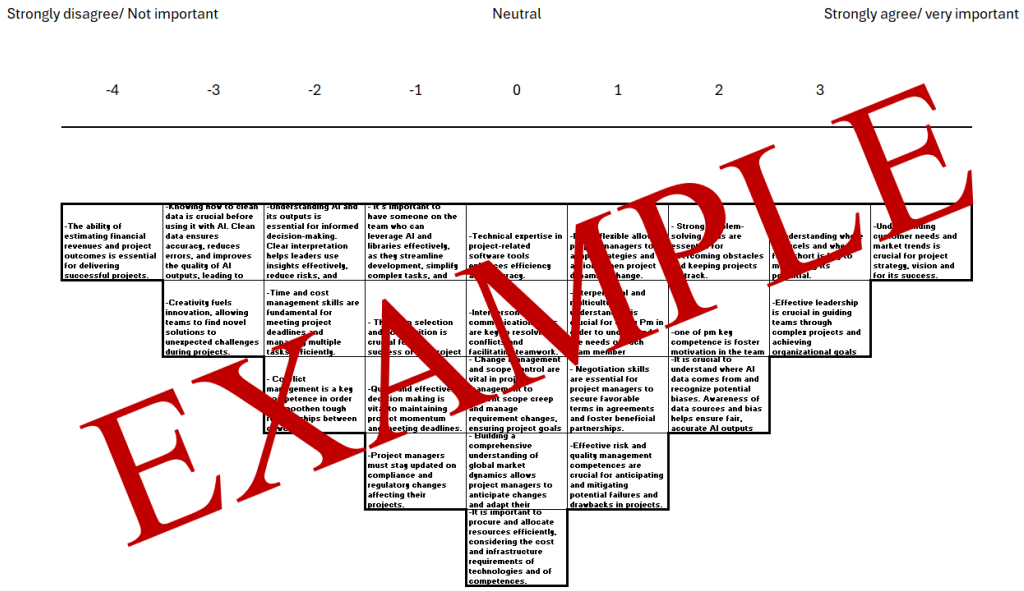
Participants were provided with the following grid (Table 13) that allowed them to place the statements:

Table 14: Q-sort grid



Conversely, this is how the grid looks when completed (Table 14):

Table 15: Example of compiled Q-sort grid



The data were then collected in another tab following using the formula:

=SUMPRODUCT(('Q-sort'!$E$5:$M$5)*('Q-sort'!$E$7:$M$11=data_gathering!C5))

The formula uses the SUMPRODUCT function to calculate a weighted sum based on specific conditions in the Q-sort grid. It works by multiplying two arrays: one representing the weights or scores assigned to the Q-sort columns and another representing whether the items in the grid meet a certain condition (e.g., matching a particular value). The second array is a logical test that evaluates whether each item satisfies the condition, returning TRUE or FALSE values, which are treated as 1 and 0, respectively. By multiplying these two arrays, the formula ensures that only the weights corresponding to items that meet the condition contribute to the final sum. This approach provides a structured way to see data as follows in (Table 15)

Table 16: Example of data gathering

#	Statement	Points taken
-1)	Effective risk and quality management competencies are crucial for anticipating and mitigating potent	4
-2)	It is important to procure and allocate resources efficiently, considering the cost and infrastructure re	-2
-3)	The ability of estimating financial revenues and project outcomes is essential for delivering successful	0
-4)	Change management and scope control are vital in project management to prevent scope creep and n	0
-5)	Time and cost management skills are fundamental for meeting project deadlines and managing multip	0
-6)	The team selection and composition is crucial for the success of the project	0
-7)	Interpersonal communication skills are key to resolving conflicts and facilitating teamwork.	-1
-8)	One of pm key competence is foster motivation in the team	2
-9)	Interpersonal and multicultural understanding is crucial for every Pm in order to understand the need	1
-10)	Negotiation skills are essential for project managers to secure favorable terms in agreements and fost	3
-11)	Effective leadership is crucial in guiding teams through complex projects and achieving organizational	2
-12)	Creativity fuels innovation, allowing teams to find novel solutions to unexpected challenges during prc	2
-13)	Strong problem-solving skills are essential for overcoming obstacles and keeping projects on track.	1
-14)	Quick and effective decision making is vital to maintaining project momentum and meeting deadlines.	-1
-15)	Being flexible allows project managers to adapt strategies and actions when project dynamics change.	1
-16)	Technical expertise in project-related software tools enhances efficiency and accuracy.	3
-17)	Understanding where AI excels and where it falls short is key to maximizing its potential could be very	-3
-18)	It's important to have someone on the team who can leverage AI and libraries effectively, as they strea	1
-19)	Knowing how to clean data is crucial before using it with AI. Clean data ensures accuracy, reduces errc	-1
-20)	Understanding AI and its outputs is essential for informed decision-making. Clear interpretation helps	0
-21)	It is crucial to understand where AI data comes from and recognize potential biases. Awareness of dat	-2
-22)	Understanding customer needs and market trends is crucial for project strategy, vision and for its succ	-4
-23)	Building a comprehensive understanding of global market dynamics allows project managers to anticip	0
-24)	it is crucial to practice continuous improvement and seek efficiency in order to fine-tune the rusty pro	-2
-25)	For maintaining a long-term perspective each project team member has to ensure that immediate act	-3

The participant were also provided, in a different tab with four open questions, as follows:

Table 17: Qualitative questions

Question	Answers
Quanti anni di esperienza possiedi nel campo del Project managment?	
Da quale settore (industry) provieni?	
Tu o i tuoi colleghi utilizzate AI nel lavoro di tutti i giorni?	
Tu o i tuoi colleghi utilizzate AI generativa o altre forme di AI? Se si quali?	

The questions were deliberately written in Italian to make it easier for participants to respond. Allowing them to answer these open-ended questions in their native language increased the likelihood of obtaining more detailed and comprehensive responses. The questions were as follows:

- How many years of experience do you have in the field of project management?

- Which sector (industry) do you come from?
- Do you or your colleagues use AI in your daily work?
- Do you or your colleagues use generative AI or other forms of AI? If yes, which ones?

We will later see, after the factor analysis, how these answers will be cross-analysed with the results of the statements.

The Q-sort analysis is designed to identify groups of shared opinions among participants and to understand how they perceive and prioritize competencies in project management, with particular attention to AI-related competencies within the "GROUP NAME." The primary aim is to identify factors that represent recurring patterns of thought.

After collecting all the data in separate sheets, using the formula previously mentioned, the goal was to create a matrix that combines the statements with the scores assigned by each interviewer for each respondent. The resulting table provides a structure where the rows represent the statements, and the columns display the scores assigned by each respondent. This allows for a comprehensive view of how each statement was evaluated across all participants (Table 17).

Table 18: Example of data for analysis

	Statement 1	Statement 2	Statement 3	Statement 4	Statement 5	Statement 7	(...)
P1	0	0	1	2	1	1	...
P2	0	1	-1	-2	2	2	...
P3	3	2	1	3	4	0	...
P4	3	2	2	3	1	1	...
P5	0	1	1	3	0	1	...
P6	2	1	1	4	3	1	...
P7	1	3	0	4	1	-2	...
P8	3	2	3	4	2	-1	...
P9	4	2	1	0	3	2	...
P10	2	2	1	-4	-3	-3	...
P11	4	-2	0	-1	0	1	...
P12	1	0	1	-2	0	-1	...
P13	1	2	1	1	0	-3	...
P14	0	-4	-2	2	1	0	...
P15	-3	2	-1	1	0	1	...
P16	0	-1	1	2	2	0	...
P17	1	2	2	0	2	3	...
(...)	...	...	...	...	...	...	...

This matrix alone provides a basis for an interesting analysis. By summing the "scores" of each individual statement (i.e., the values in each columns), a single total score can be calculated for each statement. With 25 respondents, this score has a maximum possible value of 100 points (if all 25 respondents assign a value of 4 to the statement) and a minimum possible value of -100 points (if all 25 respondents assign a value of -4 to the statement). A similar way of reasoning can be applied to the average values per statement, with a maximum (and minimum) value of 4 (and -4), the following table provide an overview of this preliminary analysis showing which statement are the most popular.

Table 19: Preliminary results

Statement	Total	Mean
-11) Effective leadership is crucial in guiding teams through complex projects and achieving organizational goals	31	1.24
-2) It is important to procure and allocate resources efficiently, considering the cost and infrastructure requirements of technologies and of competences.	30	1.2
-1) Effective risk and quality management competencies are crucial for anticipating and mitigating potential failures and drawbacks in projects.	29	1.16
-6) The team selection and composition is crucial for the success of the project	28	1.12
-3) The ability of estimating financial revenues and project outcomes is essential for delivering successful projects.	17	0.68
- 4) Change management and scope control are vital in project management to prevent scope creep and manage requirement changes, ensuring project goals are met on time and within budget.	17	0.68
-13) Strong problem-solving skills are essential for overcoming obstacles and keeping projects on track.	17	0.68
-5) Time and cost management skills are fundamental for meeting project deadlines and managing multiple tasks efficiently.	16	0.64
-14) Quick and effective decision making is vital to maintaining project momentum and meeting deadlines.	14	0.56
-22) Understanding customer needs and market trends is crucial for project strategy, vision and for its success.	12	0.48
-24) it is crucial to practice continuous improvement and seek efficiency in order to fine-tune the rusty processes	10	0.4
-7) Interpersonal communication skills are key to resolving conflicts and facilitating teamwork.	6	0.24
-10) Negotiation skills are essential for project managers to secure favorable terms in agreements and foster beneficial partnerships.	-4	-0.16
-15) Being flexible allows project managers to adapt strategies and actions when project dynamics change.	-5	-0.2
-12) Creativity fuels innovation, allowing teams to find novel solutions to unexpected challenges during projects.	-9	-0.36
-20) Understanding AI and its outputs is essential for informed decision-making. Clear interpretation helps leaders use insights effectively, reduce risks, and make decisions aligned with business objectives.	-10	-0.4
-16) Technical expertise in project-related software tools enhances efficiency and accuracy.	-13	-0.52
-23) Building a comprehensive understanding of global market dynamics allows project managers to anticipate changes and adapt their strategic direction proactively.	-18	-0.72
-25) For maintaining a long-term perspective each project team member has to ensure that immediate actions are in sync with broader organizational objectives.	-18	-0.72
-8) One of pm key competence is foster motivation in the team	-21	-0.84
-18) It's important to have someone on the team who can leverage AI and libraries effectively, as they streamline development, simplify complex tasks, and boost overall productivity.	-22	-0.88
-19) Knowing how to clean data is crucial before using it with AI. Clean data ensures accuracy, reduces errors, and improves the quality of AI outputs, leading to more reliable insights and better decision-making.	-24	-0.96
-21) It is crucial to understand where AI data comes from and recognize potential biases. Awareness of data sources and bias helps ensure fair, accurate AI outputs and supports ethical decision-making.	-25	-1
-17) Understanding where AI excels and where it falls short is key to maximizing its potential could be very impactful in a project.	-27	-1.08
-9) Interpersonal and multicultural understanding is crucial for every Pm in order to understand the needs of each team member	-31	-1.24

This total score can be interpreted as follows:

- Statements with higher scores: These statements are more frequently placed on the right side of the Q-sort grid. They represent the most popular statements among respondents and are perceived as having higher importance.
- Statements with lower scores: These statements are more frequently placed on the left side of the Q-sort grid. They represent the least popular statements among respondents and are perceived as having lower importance.

The initial rankings suggest a general preference for traditional management skills, including leadership, resource allocation, and risk management, while competencies related to AI and data-driven decision-making appear to elicit more varied responses. However, as Q-methodology is inherently comparative and does not rely on absolute ratings, the next stage of analysis will focus on factor extraction and pattern identification to determine clusters of shared perspectives among participants.

These preliminary findings will be further analysed using factor analysis to identify dominant viewpoints and categorize different participant profiles. The interpretation of these patterns will help clarify how competencies are prioritized in different project management contexts and whether emerging technologies, such as AI, are perceived as integral or peripheral to project success.

4.2.3 Preliminary analysis

Factor analysis is a fundamental statistical method for dimensionality reduction and identifying latent structures in a dataset. This study applies an exploratory factor analysis (EFA) to data collected through the Q-sort methodology, aiming to identify latent factors that describe the main response patterns among participants. The process involves a preliminary phase to assess the dataset's adequacy, followed by the application of principal component analysis (PCA) techniques and the extraction of the most relevant factors.

Factor analysis require certain analysis to be met for valid results, among these assumptions, the suitability of the correlation matrix for factor extraction is critical. The Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity are fundamental

diagnostic tests that assess whether factor analysis is appropriate for a given dataset. The KMO measure evaluates sampling adequacy, while Bartlett's Test determines if correlations among variables are sufficient for structure detection (Tabachnick & Fidell, 2018). This paper examines these two tests in detail, highlighting their significance in ensuring reliable factor analysis.

4.2.3.2 Bartlett's Test of Sphericity

Bartlett's Test of Sphericity checks whether the correlation matrix of the dataset is an identity matrix. An identity matrix is a special type of matrix where all diagonal elements are equal to 1, and all off-diagonal elements (representing correlations between different variables) are equal to 0. This means that none of the variables in the dataset are related to each other.

If Bartlett's test confirms that the correlation matrix is an identity matrix, it suggests that the variables are completely uncorrelated. In this case, factor analysis would not be useful because the goal of factor analysis is to identify underlying patterns or relationships between variables. Without meaningful correlations, there is no shared variance among the variables to group them into meaningful factors.

The test statistic follows a chi-square ($\chi 2$) distribution:

$$\chi 2 = -(N - 1 - \frac{2p + 5}{6}) ln \mid R \mid$$

Where:

- N is the sample size,
- P is the number of variables,
- R si the correlation matrix determinant.

A significant Bartlett's test (p-value < 0.05) indicates that the correlation matrix significantly differs from an identity matrix, meaning that factor analysis is appropriate. If the test is not significant (p-value > 0.05), factor analysis should not be applied, as variables do not share enough common variance.

In our case, the p-value for Bartlett's test was 1.3418E-119, which is extremely small ($p < 0.001$). This result indicates that the correlation matrix significantly differs from an identity matrix, confirming that there are meaningful relationships among participants and that factor analysis is an appropriate method for this dataset.

Since Bartlett's test yielded a strongly significant result, we can conclude that the dataset contains a sufficient level of intercorrelation to justify factor extraction. This positive outcome allows us to move forward with evaluating sampling adequacy through the Kaiser-Meyer-Olkin (KMO) test.

4.2.3.2 Kaiser-Meyer-Olkin

The KMO measure assesses the adequacy of the sample size by comparing the magnitude of observed correlation coefficients to the magnitude of partial correlations. In particular, it compares the sum of correlations between variables with the sum of partial correlations. If the partial correlations are low, it means that the variables are strongly correlated, and factor analysis is appropriate. If the partial correlations are high, then the variables do not share a common structure, and factor analysis may not be useful. It is defined mathematically as:

$$KMO = \frac{\sum\sum rij2 + \sum\sum pij2}{\sum\sum rij2}$$

Where:

- Rij rapresents the correlation coefficients between variables,
- Pij represents the partial correlation coefficients.

The KMO value ranges between 0 and 1, with higher values indicating that factor analysis is more suitable. The interpretation of KMO values (Kaiser, 1974) is as follows:

Table 20: KMO overview

KMO Value	Suitability for Factor Analysis
Above 0.90	Excellent
0.80 - 0.89	Good
0.70 - 0.79	Adequate
0.60 - 0.69	Mediocre
0.50 - 0.59	Poor
Below 0.50	Unacceptable (Factor analysis not recommended)

A high KMO value suggests that correlations between pairs of variables are explained by other variables, making the dataset suitable for factor analysis. A low KMO value indicates weak correlations, meaning that factor analysis may not be appropriate.

In our case, the value of KMO was *0.592267995,* although the KMO value (0.592) is below the ideal threshold of 0.70, we chose to proceed with factor analysis due to the following considerations:

- Bartlett's Test of Sphericity was significant, confirming that correlations among participants exist and that factor analysis is justifiable.
- The Scree Plot and Eigenvalues supported the four-factor solution, suggesting that meaningful latent structures could still be extracted.
- Exploratory Nature of the Study: Given that this is an exploratory analysis, the insights gained from factor loadings and participant grouping still provide valuable information, even with a suboptimal KMO value.

4.2.4 Number of factor

Principal Component Analysis (PCA) is a statistical method used to reduce the dimensionality of a dataset while retaining as much variance (information) as possible. It transforms a set of correlated variables into a new set of uncorrelated variables called principal components (PCs). These new components are linear combinations of the original variables, arranged in order of their ability to explain the variance in the dataset.

PCA is particularly useful in exploratory data analysis and in determining the number of meaningful factors to retain in a factor analysis, which is crucial in fields such as psychology, finance, and machine learning.

PCA follows these key steps:

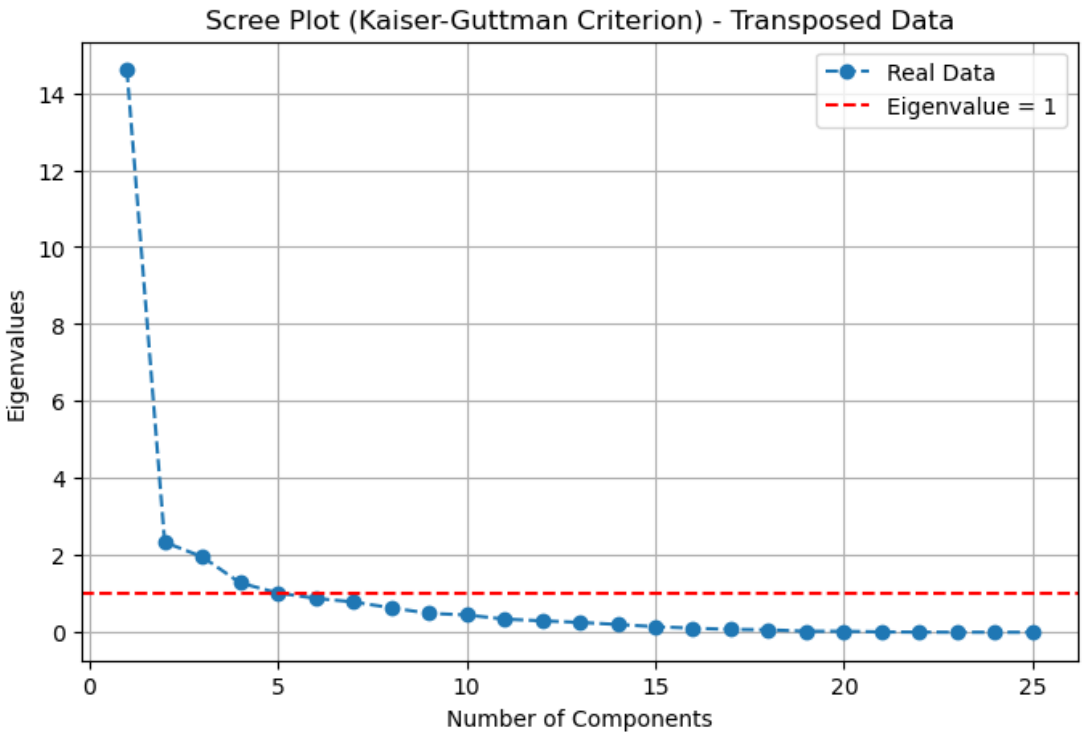
The process began with standardization, a crucial step to ensure that all variables contributed equally. Although standardization is generally required when variables are on different scales, in this case, it was not strictly necessary, as all data values were already within the range of -4 to 4. However, for methodological consistency and to ensure comparability with other studies, we opted to standardize the data by transforming each variable to have a mean of 0 and a standard deviation of 1.

Following standardization, we computed the covariance matrix to examine the relationships between variables and to identify patterns of correlation. From this matrix, we extracted eigenvalues and eigenvectors, which form the foundation of PCA. Eigenvalues indicate the proportion of variance explained by each principal component, with higher values corresponding to components that capture more information. Eigenvectors define the directions of these components in the feature space, shaping how the data is projected onto the new coordinate system.

To determine the optimal number of components to retain, we analysed the eigenvalues using multiple selection criteria. The Scree Plot provides a graphical representation of the eigenvalues in descending order, allowing us to identify the "elbow" point where the variance explained by additional components diminishes. Typically, in a well-defined elbow scenario, we would observe a sharp drop followed by a noticeable flattening, where additional components contribute significantly less variance. In this case, as we can see in TABLE ** the steep drop occurs at Component 1, followed by a more gradual decline. Given this, the elbow method alone may not be reliable in determining the number of factors. The Kaiser-Guttman criterion suggests retaining only components with eigenvalues greater than 1, as they explain more variance than a single original variable, so the criterion suggests that the optimal number of factors to retain is four, as indicated by the eigenvalues exceeding the Kaiser-Guttman criterion (eigenvalue > 1). Since the Scree Plot does not exhibit a well-defined elbow, and given the gradual decline in eigenvalues after the first component, the Kaiser-Guttman criterion provides a more

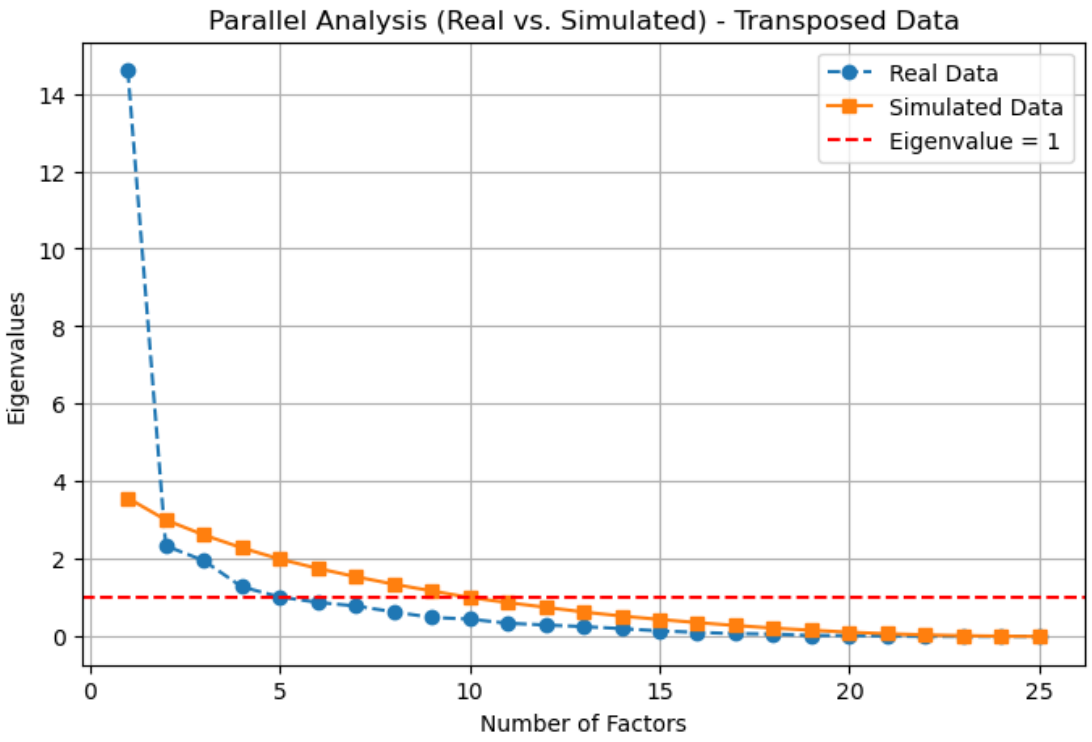
objective cutoff, supporting the retention of four factors. The following table presents the eigenvalues and confirms this selection:

Table 21: Scree Plot



We decided also to give the Parallel Analysis a try. The Parallel Analysis compares the eigenvalues obtained from the real dataset with those derived from a randomly simulated dataset. The general rule is that a factor is retained only if its eigenvalue from the real data is higher than the corresponding eigenvalue from the simulated data.

Table 22: Scree Plot and Parallel analysis



In the provided plot Table 21 we observe that the simulated eigenvalues (orange squares) remain higher than the real eigenvalues for several components, particularly beyond the third or fourth factor. This suggests that, according to Parallel Analysis, fewer factors should be retained. However, this criterion tends to be more conservative and may underestimate the number of meaningful factors, especially when real data exhibit a gradual decline in eigenvalues rather than a sharp drop-off. (Dobriban, E., & Owen, A. B., 2019)

In this case, we decided to opt for four factors, while Parallel Analysis might suggest stopping at three or fewer. Given the dataset characteristics and the lack of a well-defined elbow in the Scree Plot, relying on Parallel Analysis in choosing fewer factors, might lead to an overly restrictive factor selection, potentially omitting useful variance.

This table presents the eigenvalues and variance explained percentages obtained from Principal Component Analysis (PCA). The eigenvalues indicate how much variance each factor captures from the dataset, while the percentage column shows the proportion of total variance explained by each factor.

Explained variance represents the share of total variability in the dataset that each factor accounts for.

Table 23: Variance explained and Eigenvalue

Factor	Eigenvalue	Variance Explained (%)
Factor1	14.5989	56.1498
Factor2	2.3392	8.9969
Factor3	1.9568	7.5261
Factor4	1.2820	4.9309

4.2.5 Exploratory Factor analysis

Exploratory Factor Analysis (EFA) is a statistical technique used to identify underlying latent structures in a dataset by grouping variables that share common variance. Unlike Principal Component Analysis (PCA), which simply reduces dimensionality without assuming underlying factors, EFA aims to uncover the latent constructs that drive the correlations observed among variables. This method is widely used in psychology, social sciences, and other fields where understanding hidden structures is essential.

One critical step in EFA is the choice of a rotation method, which enhances interpretability by adjusting the factor structure to simplify loadings. Varimax rotation, a form of orthogonal rotation, was selected for this study. Varimax maximizes the variance of squared factor loadings, pushing them toward either high or low values, which helps in obtaining a clearer distinction between factors. Unlike Oblimin rotation, which allows for correlation between factors, Varimax assumes orthogonality (no correlation between factors). Given our dataset and research objectives, we opted for Varimax as it provides a more straightforward interpretation, ensuring that each factor captures distinct, independent dimensions of variability in the data.

Before applying factor analysis, we standardized the dataset to ensure equal weighting of all variables, even though it was not strictly necessary as our data was already within a comparable range. Standardization was performed to maintain methodological consistency and to prevent potential scaling biases. This transformation was carried out using:

StandardScaler().fit_transform(data).

To extract factors, we applied EFA with four factors, fitting the model with:

fa.fit(standardized_data)

Once the model was fitted, we extracted the factor loadings matrix, which quantifies the relationship between each participant and the latent factors:

```
factor_loadings = pd.DataFrame(fa.loadings_,
                               index=numeric_df.columns,
                               columns=[f'Factor{i+1}' for i in range(n_factors)])
```

The factor loading matrix can be interpreted following this indications:

- Factor loadings represent the correlation between each participant and the extracted factors.
- A high absolute value (closer to ±1) indicates that a participant is strongly associated with a specific latent construct.
- Values near zero suggest that the participant does not meaningfully contribute to that factor.
- Positive and negative loadings indicate whether the participant aligns positively or negatively with a given factor.

To facilitate interpretation, we generated a **heatmap of factor loadings**, which visually highlights the relationships between participants and the latent factors:

Beyond factor loadings, we computed factor scores, which provide a measure of how much each statement aligns with each extracted factor. Given that the dataset is transposed, factor scores now represent the positioning of statements (items) within the latent structure identified among participants.

Factor scores were computed using:

```
factor_scores = pd.DataFrame(fa_.transform(standardized_data),
                             columns=[f'Factor{i+1}' for i in range(n_factors)])
```

The factor loading matrix can be interpreted following this indications:

- Factor scores measure how strongly each statement is influenced by the identified participant groups.
- A high factor score for a specific factor means that the statement is closely associated with the group of participants who load onto that factor.
- Factor scores allow us to analyse response patterns, identifying how different statements cluster around distinct participant groups.

Then, we exported both matrices to an Excel file, revisioned the design, and the results are presented in the following tables.

Table 24: Factor Loading

	Factor1	Factor2	Factor3	Factor4
P1	0.578761	0.501377	0.426344	0.191975
P2	0.575789	0.631446	0.375974	0.113459
P3	0.893774	0.246577	0.016283	-0.07157
P4	0.614825	0.691017	0.285851	0.130084
P5	0.558536	0.542911	0.407778	-0.21204
P6	0.091054	0.462949	0.239213	0.777542
P7	0.381503	0.59039	0.30214	0.120477
P8	0.577315	0.498882	0.351819	0.254495
P9	0.837361	0.336334	0.142455	0.194757
P10	0.075321	0.722023	0.36567	0.301237
P11	0.339136	0.607425	0.104618	0.267157
P12	0.449111	0.687286	0.346357	0.177404
P13	0.490586	0.628387	0.350988	-0.03938
P14	0.705981	0.337174	0.203119	-0.00097
P15	0.776047	-0.22851	0.116987	0.357953
P16	0.061937	0.103451	0.958167	0.168738
P17	0.435597	0.469282	0.228064	-0.12173
P18	0.54047	0.201444	0.49997	0.313654
P19	0.061937	0.103451	0.958167	0.168738
P20	0.273364	0.231958	0.613009	-0.2091
P21	0.261452	0.282975	0.198434	0.488323
P22	0.200712	0.473444	-0.0672	0.049809
P23	0.366001	0.762627	0.312823	-0.33544
P24	0.293247	0.267351	0.521383	0.02263
P25	-0.06352	0.765238	0.090539	0.025691

Table 25: Factor Scores

Statements	Factor 1	Factor 2	Factor 3	Factor 4
-1) Effective risk and quality management competencies are crucial for anticipating and mitigating potential failures and drawbacks in projects.	1.181	-0.216	-0.876	2.234
-2) It is important to procure and allocate resources efficiently, considering the cost and infrastructure requirements of technologies and of competences.	1.492	0.213	-0.277	-1.789
-3) The ability of estimating financial revenues and project outcomes is essential for delivering successful projects.	0.477	-0.958	0.473	0.693
-4) Change management and scope control are vital in project management to prevent scope creep and manage requirement changes, ensuring project goals are	1.114	-0.709	-0.379	-1.119
-5) Time and cost management skills are fundamental for meeting project deadlines and managing multiple tasks efficiently.	1.206	-0.661	-0.062	-0.279
6) The team selection and composition is crucial for the success of the project	0.280	-1.107	1.221	0.763
-7) Interpersonal communication skills are key to resolving conflicts and facilitating	0.298	-0.441	1.449	-3.657
8) One of pm key competence is foster motivation in the team	0.828	0.233	-2.177	0.391
-9) Interpersonal and multicultural understanding is crucial for every Pm in order to understand the needs of each team member	0.664	-0.758	-1.791	-0.137
-10) Negotiation skills are essential for project managers to secure favorable terms in agreements and foster beneficial partnerships.	-0.638	0.579	-0.164	0.134
-11) Effective leadership is crucial in guiding teams through complex projects and achieving organizational goals	0.936	-1.677	1.017	0.567
-12) Creativity fuels innovation, allowing teams to find novel solutions to unexpected challenges during projects.	-0.934	0.205	0.837	-1.708
-13) Strong problem-solving skills are essential for overcoming obstacles and keeping projects on track.	0.700	-0.975	1.886	-0.340
-14) Quick and effective decision making is vital to maintaining project momentum and meeting deadlines.	1.123	0.534	-0.395	-0.067
-15) Being flexible allows project managers to adapt strategies and actions when project dynamics change.	-0.592	-0.306	1.449	1.178
-16) Technical expertise in project-related software tools enhances efficiency and	-1.248	0.484	0.239	0.646
-17) Understanding where AI excels and where it falls short is key to maximizing its potential could be very impactful in a project.	-0.475	-1.124	-2.361	3.057
-18) It's important to have someone on the team who can leverage AI and libraries effectively, as they streamline development, simplify complex tasks, and boost	-1.036	0.739	-1.106	0.000
-19) Knowing how to clean data is crucial before using it with AI. Clean data ensures accuracy, reduces errors, and improves the quality of AI outputs, leading to more reliable insights and better decision-making.	-0.882	0.412	-0.102	2.367
-20) Understanding AI and its outputs is essential for informed decision-making. Clear interpretation helps leaders use insights effectively, reduce risks, and make decisions aligned with business objectives.	-0.649	0.240	0.618	-1.788
-21) It is crucial to understand where AI data comes from and recognize potential biases. Awareness of data sources and bias helps ensure fair, accurate AI outputs and supports ethical decision-making.	-0.598	-0.196	0.099	-0.181
-22) Understanding customer needs and market trends is crucial for project strategy, vision and for its success.	-1.069	-0.712	0.790	0.651
-23) Building a comprehensive understanding of global market dynamics allows project managers to anticipate changes and adapt their strategic direction proactively.	-1.871	0.102	0.075	0.042
-24) it is crucial to practice continuous improvement and seek efficiency in order to fine-tune the rusty processes	-0.001	1.109	-0.985	-2.013
-25) For maintaining a long-term perspective each project team member has to ensure that immediate actions are in sync with broader organizational objectives.	-1.632	0.900	-0.808	0.178

Chapter 5: Results

5.1 Findings of the factor analysis

In this section, we present the findings derived from the Q-sort analysis, highlighting the key patterns that emerge from the data. The results provide a structured overview of the perspectives identified, allowing for a clear interpretation of the factors shaping participants' viewpoints.

To interpret the results effectively, the statements are ordered for each factor according to their factor scores. This process allows for a clear identification of the most correlated statements, those that best define each factor, providing a structured basis for interpretation. By examining the top-ranked statements, the key themes and perspectives within the data become evident. This ordered table serves as a crucial tool for extracting meaningful insights and understanding the underlying viewpoints represented in the study.

Table 26: Statement ranked per factor scores per factor 1 and 2

Ranking	Factor 1	Factor 2
#1	-2) It is important to procure and allocate resources efficiently, considering the cost and infrastructure requirements of technologies and of competences.	-24) it is crucial to practice continuous improvement and seek efficiency in order to fine-tune the rusty processes
#2	-5) Time and cost management skills are fundamental for meeting project deadlines and managing multiple tasks efficiently.	-25) For maintaining a long-term perspective each project team member has to ensure that immediate actions are in sync with broader organizational objectives.
#3	-1) Effective risk and quality management competencies are crucial for anticipating and mitigating potential failures and drawbacks in projects.	-18) It's important to have someone on the team who can leverage AI and libraries effectively, as they streamline development, simplify complex tasks, and boost overall
#4	-14) Quick and effective decision making is vital to maintaining project momentum and meeting deadlines.	-10) Negotiation skills are essential for project managers to secure favorable terms in agreements and foster beneficial
#5	- 4) Change management and scope control are vital in project management to prevent scope creep and manage requirement changes, ensuring project goals are met on time and within	-14) Quick and effective decision making is vital to maintaining project momentum and meeting deadlines.
#6	-11) Effective leadership is crucial in guiding teams through complex projects and achieving organizational goals	-16) Technical expertise in project-related software tools enhances efficiency and accuracy.
#7	-8) One of pm key competence is foster motivation in the team	-19) Knowing how to clean data is crucial before using it with AI. Clean data ensures accuracy, reduces errors, and improves the quality of AI outputs, leading to more reliable insights and better
#8	-13) Strong problem-solving skills are essential for overcoming obstacles and keeping projects on track.	-20) Understanding AI and its outputs is essential for informed decision-making. Clear interpretation helps leaders use insights effectively, reduce risks, and make decisions aligned with
#9	-9) Interpersonal and multicultural understanding is crucial for every Pm in order to understand the needs of each team member	-8) One of pm key competence is foster motivation in the team
#10	-3) The ability of estimating financial revenues and project outcomes is essential for delivering successful projects.	-2) It is important to procure and allocate resources efficiently, considering the cost and infrastructure requirements of technologies and of competences.
#11	-7) Interpersonal communication skills are key to resolving conflicts and facilitating teamwork.	-12) Creativity fuels innovation, allowing teams to find novel solutions to unexpected challenges during projects.
#12	-6) The team selection and composition is crucial for the success of the project	-23) Building a comprehensive understanding of global market dynamics allows project managers to anticipate changes and adapt their strategic direction proactively.
#13	-24) it is crucial to practice continuous improvement and seek efficiency in order to fine-tune the rusty processes	-21) It is crucial to understand where AI data comes from and recognize potential biases. Awareness of data sources and bias helps ensure fair, accurate AI outputs and supports ethical
#14	-17) Understanding where AI excels and where it falls short is key to maximizing its potential could be very impactful in a project.	-1) Effective risk and quality management competencies are crucial for anticipating and mitigating potential failures and
#15	-15) Being flexible allows project managers to adapt strategies and actions when project dynamics change.	-15) Being flexible allows project managers to adapt strategies and actions when project dynamics change.
#16	-21) It is crucial to understand where AI data comes from and recognize potential biases. Awareness of data sources and bias helps ensure fair, accurate AI outputs and supports ethical	-7) Interpersonal communication skills are key to resolving conflicts and facilitating teamwork.
#17	-10) Negotiation skills are essential for project managers to secure favorable terms in agreements and foster beneficial	-5) Time and cost management skills are fundamental for meeting project deadlines and managing multiple tasks efficiently.
#18	-20) Understanding AI and its outputs is essential for informed decision-making. Clear interpretation helps leaders use insights effectively, reduce risks, and make decisions aligned with	- 4) Change management and scope control are vital in project management to prevent scope creep and manage requirement changes, ensuring project goals are met on time and within
#19	-19) Knowing how to clean data is crucial before using it with AI. Clean data ensures accuracy, reduces errors, and improves the quality of AI outputs, leading to more reliable insights and better	-22) Understanding customer needs and market trends is crucial for project strategy, vision and for its success.
#20	-12) Creativity fuels innovation, allowing teams to find novel solutions to unexpected challenges during projects.	-9) Interpersonal and multicultural understanding is crucial for every Pm in order to understand the needs of each team member
#21	-18) It's important to have someone on the team who can leverage AI and libraries effectively, as they streamline development, simplify complex tasks, and boost overall	-3) The ability of estimating financial revenues and project outcomes is essential for delivering successful projects.
#22	-22) Understanding customer needs and market trends is crucial for project strategy, vision and for its success.	-13) Strong problem-solving skills are essential for overcoming obstacles and keeping projects on track.
#23	-16) Technical expertise in project-related software tools enhances efficiency and accuracy.	-6) The team selection and composition is crucial for the success of the project
#24	-25) For maintaining a long-term perspective each project team member has to ensure that immediate actions are in sync with broader organizational objectives.	-17) Understanding where AI excels and where it falls short is key to maximizing its potential could be very impactful in a project.
#25	-23) Building a comprehensive understanding of global market dynamics allows project managers to anticipate changes and adapt their strategic direction proactively.	-11) Effective leadership is crucial in guiding teams through complex projects and achieving organizational goals

Table 27: Statement ranked per factor scores per factor 3 and 4

Ranking	Factor 3	Factor 4
#1	-13) Strong problem-solving skills are essential for overcoming obstacles and keeping projects on track.	-17) Understanding where AI excels and where it falls short is key to maximizing its potential could be very impactful in a project.
#2	-15) Being flexible allows project managers to adapt strategies and actions when project dynamics change.	-19) Knowing how to clean data is crucial before using it with AI. Clean data ensures accuracy, reduces errors, and improves the quality of AI outputs, leading to more reliable insights and better decision-making.
#3	-7) Interpersonal communication skills are key to resolving conflicts and facilitating teamwork.	-1) Effective risk and quality management competencies are crucial for anticipating and mitigating potential failures and drawbacks in projects.
#4	-6) The team selection and composition is crucial for the success of the project	18) It's important to have someone on the team who can leverage AI and libraries effectively, as they streamline development, simplify complex tasks, and boost overall productivity.
#5	-11) Effective leadership is crucial in guiding teams through complex projects and achieving organizational goals	-15) Being flexible allows project managers to adapt strategies and actions when project dynamics change.
#6	-12) Creativity fuels innovation, allowing teams to find novel solutions to unexpected challenges during projects.	-6) The team selection and composition is crucial for the success of the project
#7	-22) Understanding customer needs and market trends is crucial for project strategy, vision and for its success.	-3) The ability of estimating financial revenues and project outcomes is essential for delivering successful projects.
#8	-20) Understanding AI and its outputs is essential for informed decision-making. Clear interpretation helps leaders use insights effectively, reduce risks, and make decisions aligned with business objectives.	-22) Understanding customer needs and market trends is crucial for project strategy, vision and for its success.
#9	-3) The ability of estimating financial revenues and project outcomes is essential for delivering successful projects.	-16) Technical expertise in project-related software tools enhances efficiency and accuracy.
#10	-16) Technical expertise in project-related software tools enhances efficiency and accuracy.	-11) Effective leadership is crucial in guiding teams through complex projects and achieving organizational goals
#11	-21) It is crucial to understand where AI data comes from and recognize potential biases. Awareness of data sources and bias helps ensure fair, accurate AI outputs and supports ethical decision-making.	-8) One of pm key competence is foster motivation in the team
#12	-23) Building a comprehensive understanding of global market dynamics allows project managers to anticipate changes and adapt their strategic direction proactively.	-25) For maintaining a long-term perspective each project team member has to ensure that immediate actions are in sync with broader organizational objectives.
#13	-5) Time and cost management skills are fundamental for meeting project deadlines and managing multiple tasks efficiently.	-10) Negotiation skills are essential for project managers to secure favorable terms in agreements and foster beneficial partnerships.
#14	-19) Knowing how to clean data is crucial before using it with AI. Clean data ensures accuracy, reduces errors, and improves the quality of AI outputs, leading to more reliable insights and better decision-making.	-23) Building a comprehensive understanding of global market dynamics allows project managers to anticipate changes and adapt their strategic direction proactively.
#15	-10) Negotiation skills are essential for project managers to secure favorable terms in agreements and foster beneficial partnerships.	-14) Quick and effective decision making is vital to maintaining project momentum and meeting deadlines.
#16	-2) It is important to procure and allocate resources efficiently, considering the cost and infrastructure requirements of technologies and of competences.	-9) Interpersonal and multicultural understanding is crucial for every Pm in order to understand the needs of each team member
#17	- 4) Change management and scope control are vital in project management to prevent scope creep and manage requirement changes, ensuring project goals are met on time and within budget.	-21) It is crucial to understand where AI data comes from and recognize potential biases. Awareness of data sources and bias helps ensure fair, accurate AI outputs and supports ethical decision-making.
#18	-14) Quick and effective decision making is vital to maintaining project momentum and meeting deadlines.	-5) Time and cost management skills are fundamental for meeting project deadlines and managing multiple tasks efficiently.
#19	-25) For maintaining a long-term perspective each project team member has to ensure that immediate actions are in sync with broader organizational objectives.	-13) Strong problem-solving skills are essential for overcoming obstacles and keeping projects on track.
#20	-1) Effective risk and quality management competencies are crucial for anticipating and mitigating potential failures and drawbacks in projects.	- 4) Change management and scope control are vital in project management to prevent scope creep and manage requirement changes, ensuring project goals are met on time and within budget.
#21	-24) it is crucial to practice continuous improvement and seek efficiency in order to fine-tune the rusty processes	-12) Creativity fuels innovation, allowing teams to find novel solutions to unexpected challenges during projects.
#22	-18) It's important to have someone on the team who can leverage AI and libraries effectively, as they streamline development, simplify complex tasks, and boost overall productivity.	-20) Understanding AI and its outputs is essential for informed decision-making. Clear interpretation helps leaders use insights effectively, reduce risks, and make decisions aligned with business objectives.
#23	-9) Interpersonal and multicultural understanding is crucial for every Pm in order to understand the needs of each team member	-2) It is important to procure and allocate resources efficiently, considering the cost and infrastructure requirements of technologies and of competences.
#24	-8) One of pm key competence is foster motivation in the team	-24) it is crucial to practice continuous improvement and seek efficiency in order to fine-tune the rusty processes
#25	-17) Understanding where AI excels and where it falls short is key to maximizing its potential could be very impactful in a project.	-7) Interpersonal communication skills are key to resolving conflicts and facilitating teamwork.

5.2 Factor 1

The first factor emerging from the analysis underscores the technical and traditional competencies required for effective project management. The highest-ranked statements emphasize resource allocation, time and cost management, risk mitigation, and decision-making as fundamental capabilities, aligning with well-established project management standards (PMI, IPMA, APM).

A defining characteristic of this factor is the strong emphasis on efficiency and control in resource and scope management. The highest-ranked statement (#1, -2) highlights the necessity of procuring and allocating resources efficiently, considering infrastructure and technological requirements. Similarly, time and cost management (#2, -5) is considered a crucial skill for ensuring projects remain on schedule and multiple tasks are handled efficiently. The presence of change management and scope control (#5, -4) further reinforces the structured, process-oriented nature of traditional project management methodologies, stressing the need to prevent scope creep and manage requirement changes effectively.

Moreover, risk and quality management (#3, -1) emerge as key competencies, underlining the importance of project managers anticipating and mitigating potential failures. This is closely tied to quick and effective decision-making (#4, -14), which is seen as vital for maintaining project momentum and ensuring timely execution. Together, these elements highlight a clear prioritization of structured decision-making, risk mitigation, and operational efficiency in this factor.

An interesting insight from this factor is the inclusion of leadership (#6, -11) despite the otherwise strong technical orientation of the ranked statements. Effective leadership is perceived as a crucial skill for guiding teams through complex projects and achieving organizational goals. Its presence within this factor suggests that leadership is viewed as the most essential soft skill in project management—so much so that it is ranked alongside traditional technical competencies rather than with interpersonal or strategic skills. This implies that leadership, in this framework, is understood not in a broad, transformational sense, but as an operational function necessary for executing structured project plans effectively.

Supporting this perspective, other interpersonal competencies such as team motivation (#7, -8) and problem-solving skills (#8, -13) are ranked relatively high, reinforcing the view that soft skills are valued primarily in their ability to support structured project execution rather than as independent leadership capabilities.

This factor does not suggest a holistic or interdisciplinary approach to project management but rather reinforces the importance of traditional PM competencies rooted in structured execution and technical control. Even though some AI-related competencies appear lower in the ranking (#14, -17; #16, -21; #18, -20), their placement suggests they are viewed as tools to enhance traditional PM functions rather than as transformative elements. Instead, financial estimation (#10, -3), negotiation skills (#17, -10), and technical expertise in project-related software (#23, -16) rank higher, further reinforcing a classical project management perspective.

Overall, Factor 1 represents a technically grounded approach to project management, where structured processes, risk control, and operational efficiency define success. The inclusion of leadership within this technical framework suggests that effective project managers are expected not only to possess strong analytical and managerial skills but also to lead teams with a structured, execution-driven mindset.

Factor 1 accounts for 56.15% of the total variance, indicating that it is the dominant perspective in project management. Its high explanatory power suggests that technical execution and efficiency remain the most critical concerns for practitioners.

Table 28: Factor 1, top 10 statements

Ranking	Factor 1
#1	-2) It is important to procure and allocate resources efficiently, considering the cost and infrastructure requirements of technologies and of competences.
#2	-5) Time and cost management skills are fundamental for meeting project deadlines and managing multiple tasks efficiently.
#3	-1) Effective risk and quality management competencies are crucial for anticipating and mitigating potential failures and drawbacks in projects.
#4	-14) Quick and effective decision making is vital to maintaining project momentum and meeting
#5	- 4) Change management and scope control are vital in project management to prevent scope creep and manage requirement changes, ensuring project goals are met on time and within
#6	-11) Effective leadership is crucial in guiding teams through complex projects and achieving organizational goals
#7	-8) One of pm key competence is foster motivation in the team
#8	-13) Strong problem-solving skills are essential for overcoming obstacles and keeping projects on
#9	-9) Interpersonal and multicultural understanding is crucial for every Pm in order to understand the needs of each team member
#10	-3) The ability of estimating financial revenues and project outcomes is essential for delivering successful projects.

5.3 Factor 2

Factor 2 highlights a visionary and efficiency-oriented approach to project management, where long-term strategic alignment and operational excellence take precedence. Unlike Factor 1, which focused on technical execution and traditional project management skills, this factor emphasizes continuous improvement, structured decision-making, and negotiation capabilities as fundamental elements of project success.

A striking aspect of this factor is the prominence of strategic vision and operational efficiency, reflected in the highest-ranked statements. The most significant statement (#1, -24) emphasizes the importance of continuous improvement and efficiency-seeking behaviours, reinforcing the idea that project success is not just about execution but about ongoing optimization.

Equally notable is the second-ranked statement (#2, -25), which highlights the necessity of maintaining a long-term perspective, ensuring that immediate project actions align with broader organizational goals. The strong positioning of these statements suggests that modern project managers place a high value on vision and strategic alignment, viewing them as central to effective leadership.

This finding is particularly interesting because we would typically expect traditional project management competencies (such as planning, risk control, and scope management) or soft skills (such as leadership and teamwork) to dominate. Instead, this factor indicates that contemporary project managers highly prioritize vision and operational excellence, recognizing that short-term execution must always be evaluated in the context of long-term strategic impact.

The importance of structured, effective decision-making is also evident in this factor, with statement (#5, -14) emphasizing the role of quick and effective decision-making in maintaining project momentum and meeting deadlines. This reinforces the idea that managers within this perspective value agility and efficiency in execution, ensuring that projects progress without unnecessary delays.

Additionally, negotiation skills (#4, -10) are ranked highly, highlighting their role in securing favourable terms and fostering beneficial partnerships. This suggests that external collaboration and stakeholder management are crucial components of this vision-driven approach, as project managers must navigate complex agreements and ensure alignment with organizational interests.

Moreover, technical expertise in project-related software (#6, -16) is acknowledged as an enabler of efficiency and accuracy. While this factor does not emphasize specific project management methodologies or AI-related skills, the presence of technical proficiency indicates that digital tools and structured methodologies remain essential for achieving operational excellence.

Factor 2 represents a modern project management perspective that places a strong emphasis on strategic vision and operational excellence. Unlike Factor 1, which was more technically grounded, this factor prioritizes long-term alignment, continuous improvement, and negotiation skills, suggesting that contemporary project managers increasingly value big-picture thinking over purely technical competencies or soft skills alone.

Factor 2 accounts for 8.99% of the total variance, making it a secondary but significant perspective. This suggests that while strategic vision and operational excellence are

valued, they are not as dominant as technical execution but still play a crucial role in modern project management.

Table 29: Factor 2, top 10 statements

Ranking	Factor 2
#1	-24) it is crucial to practice continuous improvement and seek efficiency in order to fine-tune the rusty processes
#2	-25) For maintaining a long-term perspective each project team member has to ensure that immediate actions are in sync with broader organizational objectives.
#3	-18) It's important to have someone on the team who can leverage AI and libraries effectively, as they streamline development, simplify complex tasks, and boost overall productivity.
#4	-10) Negotiation skills are essential for project managers to secure favorable terms in agreements and foster beneficial partnerships.
#5	-14) Quick and effective decision making is vital to maintaining project momentum and meeting deadlines.
#6	-16) Technical expertise in project-related software tools enhances efficiency and accuracy.
#7	-19) Knowing how to clean data is crucial before using it with AI. Clean data ensures accuracy, reduces errors, and improves the quality of AI outputs, leading to more reliable insights and better decision-making.
#8	-20) Understanding AI and its outputs is essential for informed decision-making. Clear interpretation helps leaders use insights effectively, reduce risks, and make decisions aligned with business objectives.
#9	-8) One of pm key competence is foster motivation in the team
#10	-2) It is important to procure and allocate resources efficiently, considering the cost and infrastructure requirements of technologies and of competences.

5.4 Factor 3

Factor 3 presents a people-centered approach to project management, where soft skills such as problem-solving, flexibility, communication, teamwork, and leadership are prioritized over purely technical competencies. This perspective suggests that modern project managers view interpersonal and adaptive abilities as crucial to handling project complexities, overcoming challenges, and driving success.

The highest-ranked statement (#1, -13) emphasizes strong problem-solving skills, highlighting their importance in overcoming obstacles and keeping projects on track. This suggests that resilience and the ability to navigate unforeseen challenges are considered the most critical competencies for project managers in this framework.

Closely following, flexibility (#2, -15) is also highly valued, reinforcing the idea that effective project managers must be able to adapt strategies and actions in response to changing project dynamics. This underscores a dynamic, agile mindset, where adaptability is not just a beneficial trait but a fundamental requirement.

In addition, interpersonal communication skills (#3, -7) are recognized as essential for resolving conflicts and facilitating teamwork, further reinforcing the focus on collaboration, negotiation, and effective stakeholder management as key drivers of project success.

Beyond communication and adaptability, team selection and composition (#4, -6) ranks high in this factor, suggesting that managing human resources effectively is perceived as critical for ensuring project success. Leadership (#5, -11) is also considered essential, not in a technical sense (as seen in Factor 1), but rather as a guiding force for navigating complexity, inspiring teams, and achieving organizational goals.

Interestingly, creativity (#6, -12) appears in a prominent position, indicating that problem-solving is not just about structured approaches but also about fostering innovation to address unexpected challenges. This suggests that project managers in this perspective are expected to think beyond rigid methodologies and encourage novel solutions within their teams.

While this factor is heavily weighted toward soft skills, some elements of strategic and business awareness are still present. Understanding customer needs and market trends (#7, -22) indicates that project managers must align their work with external demands and business strategies. Additionally, while AI-related competencies (#8, -20), financial estimation (#9, -3), and technical expertise in project-related software (#10, -16) appear, their lower rankings suggest that they are seen as supportive tools rather than primary competencies for effective project management.

Factor 3 strongly reinforces the centrality of soft skills in modern project management, particularly problem-solving, adaptability, communication, leadership, and teamwork. Unlike Factor 1, which focused on technical competencies, and Factor 2, which emphasized vision and operational excellence, this factor suggests that the ability to navigate human dynamics, resolve conflicts, and adapt to challenges is perceived as the defining characteristic of a successful project manager.

Factor 3 explains 7.53% of the variance, indicating that soft skills and adaptability are important but supplementary to technical and strategic concerns. While problem-

solving, communication, and flexibility are recognized as essential, they do not define project management as strongly as execution-driven or strategic perspectives.

Table 30: Factor 3, top 10 statements

Ranking	Factor 3
#1	-13) Strong problem-solving skills are essential for overcoming obstacles and keeping projects on track.
#2	-15) Being flexible allows project managers to adapt strategies and actions when project dynamics change.
#3	-7) Interpersonal communication skills are key to resolving conflicts and facilitating teamwork.
#4	-6) The team selection and composition is crucial for the success of the project
#5	-11) Effective leadership is crucial in guiding teams through complex projects and achieving organizational goals
#6	-12) Creativity fuels innovation, allowing teams to find novel solutions to unexpected challenges during projects.
#7	-22) Understanding customer needs and market trends is crucial for project strategy, vision and for its success.
#8	-20) Understanding AI and its outputs is essential for informed decision-making. Clear interpretation helps leaders use insights effectively, reduce risks, and make decisions aligned with business objectives.
#9	-3) The ability of estimating financial revenues and project outcomes is essential for delivering successful projects.
#10	-16) Technical expertise in project-related software tools enhances efficiency and accuracy.

5.5 Factor 4

Factor 4 presents a technology-driven perspective on project management, where AI literacy and data proficiency are the most critical competencies. Unlike previous factors, which emphasized technical execution, strategic vision, or soft skills, this factor highlights the necessity of understanding AI, managing data effectively, and leveraging AI-driven automation as key drivers of project success.

The highest-ranked statement (#1, -17) underscores that understanding where AI excels and where it falls short is essential for maximizing its potential in projects. This suggests that AI is not simply viewed as a supplementary tool but as a transformative element that requires project managers to develop a nuanced understanding of its capabilities and limitations.

Closely related, statement (#2, -19) highlights the importance of knowing how to clean data before using it in AI systems, emphasizing that ensuring data accuracy, reducing errors, and improving AI output quality are crucial skills for project managers. This

reinforces the idea that AI-driven decision-making is only as effective as the data supporting it, making data literacy an indispensable PM competency.

Additionally, having AI-competent team members (#4, -18) is recognized as vital, further suggesting that AI adoption is not just about technology but also about ensuring the right talent is in place to leverage AI tools effectively.

AI as a Catalyst for Decision-Making and Efficiency

Factor 4 accounts for 4.93% of the variance, showing that AI literacy and data proficiency are emerging themes in project management but are not yet dominant. While AI is seen as valuable, its lower variance explanation suggests that it is still considered a supporting competency rather than a core driver of project success.

Table 31: Factor 4, top 10 statements

Ranking	Factor 4
#1	-17) Understanding where AI excels and where it falls short is key to maximizing its potential could be very impactful in a project.
#2	-19) Knowing how to clean data is crucial before using it with AI. Clean data ensures accuracy, reduces errors, and improves the quality of AI outputs, leading to more reliable insights and better decision-making.
#3	-1) Effective risk and quality management competencies are crucial for anticipating and mitigating potential failures and drawbacks in projects.
#4	18) It's important to have someone on the team who can leverage AI and libraries effectively, as they streamline development, simplify complex tasks, and boost overall productivity.
#5	-15) Being flexible allows project managers to adapt strategies and actions when project dynamics change.
#6	-6) The team selection and composition is crucial for the success of the project
#7	-3) The ability of estimating financial revenues and project outcomes is essential for delivering successful projects.
#8	-22) Understanding customer needs and market trends is crucial for project strategy, vision and for its success.
#9	-16) Technical expertise in project-related software tools enhances efficiency and accuracy.
#10	-11) Effective leadership is crucial in guiding teams through complex projects and achieving organizational goals

5.6 Summary of factor analysis results

The factor analysis reveals four distinct perspectives in project management, each explaining a different proportion of the total variance. The distribution of variance explained provides insight into the relative importance of these perspectives within the dataset:

Table 32: Summary of factors interpreted

Factor #	Theme	Explanation of the factor	Variance explained
1	Technical Execution & Efficiency	The dominant factor, indicating that structured execution, risk control, and efficiency-driven project management are the primary concerns of practitioners.	56,15%
2	Strategic Vision & Operational Excellence	A secondary perspective, emphasizing long-term alignment, continuous improvement, and high-level strategic thinking, though not as dominant as execution-oriented skills.	8,99%
3	Soft Skills & Adaptability	Suggests that interpersonal skills, problem-solving, and flexibility are valued in project management, but they are not the primary defining characteristics of the field.	7,53%
4	AI & Data Proficiency	Indicates that AI-driven project management and data proficiency are emerging themes but are not yet seen as fundamental to project success.	4,93%

The dominance of Factor 1 highlights that project management is still primarily understood through a structured, efficiency-driven lens, with a strong focus on resource allocation, cost and time control, risk management, and decision-making. This suggests that technical competencies remain the foundation of effective project execution.

However, the presence of Factor 2 suggests that a strategic, vision-oriented approach is gaining traction. This factor shifts the focus from short-term efficiency to long-term organizational alignment, emphasizing continuous improvement, structured decision-making, and external stakeholder negotiations. While this is less dominant than technical execution, it signals a shift towards a broader, business-aligned approach to project management.

Factor 3 introduces a people-centered perspective, where problem-solving, communication, and adaptability become key drivers of success. The variance explained is lower than in Factors 1 and 2, suggesting that while soft skills are widely recognized, they are not perceived as the core foundation of project management but rather as supporting elements that enable execution and strategic success.

Finally, Factor 4 highlights the emergence of AI and data proficiency as an evolving but not yet dominant trend. While project managers increasingly recognize the importance of understanding AI capabilities, ensuring data quality, and leveraging AI-driven automation, this factor's lower variance explanation suggests that AI is still perceived as a tool rather than a transformative force in project management.

The low variance explained by this factor indicates that AI-related competencies are not yet widely integrated into project management mindsets. This could stem from the fact that AI teams and AI literacy in organizations are still highly underestimated. As a result, many project managers may not yet feel fully prepared to integrate AI-driven solutions into their workflows, potentially leading to hesitation or a lack of urgency in developing AI expertise.

Additionally, the findings suggest that AI is not widely perceived as either a threat or a competitive advantage in project management. Instead of viewing AI as a disruptive force that could either replace or significantly reshape project management roles, it appears that many project managers see AI as a neutral technological evolution—an inevitable step that will eventually benefit everyone equally. This perception could explain why some professionals do not feel the need to proactively develop AI-specific skills, as they may assume that AI adoption will be industry-wide and non-differentiating, rather than a source of competitive differentiation for those who master it early.

5.7 Participant analysis

Before delving into the demographic analysis, it is essential to examine the distribution of participants across the identified factors. This provides insight into how individuals align with the extracted perspectives and highlights potential trends in how different project managers perceive key competencies.

The table below presents each participant's predominant factor and their corresponding loading value, which indicates the strength of their association with that factor. The predominant factor is determined by identifying the highest absolute loading score for each participant across the four extracted factors. This method ensures that each participant is classified under the factor that best represents their perspective on project management.

The values range from approximately 0.47 to 0.96, signifying varying levels of alignment with their predominant factor. Higher values suggest a stronger association, while lower values indicate a more moderate alignment.

Table 33: Participants sorting for factor

Partecipant	Predominant factor	Secondary factor	Loading of predominant factor
P1	Factor1	Factor2	0.57876129
P2	Factor2	Factor1	0.631445642
P3	Factor1	Factor2	0.893773731
P4	Factor2	Factor1	0.691017292
P5	Factor1	Factor2	0.558536113
P6	Factor4	Factor2	0.777542257
P7	Factor2	Factor1	0.590389604
P8	Factor1	Factor2	0.577315196
P9	Factor1	Factor2	0.837360663
P10	Factor2	Factor3	0.722023096
P11	Factor2	Factor1	0.607424742
P12	Factor2	Factor1	0.687285713
P13	Factor2	Factor1	0.628387475
P14	Factor1	Factor2	0.705981287
P15	Factor1	Factor4	0.776046626
P16	Factor3	Factor4	0.958167092
P17	Factor2	Factor1	0.46928172
P18	Factor1	Factor3	0.540469744
P19	Factor3	Factor4	0.958167088
P20	Factor3	Factor1	0.613009184
P21	Factor4	Factor2	0.488322619
P22	Factor2	Factor1	0.473443815
P23	Factor2	Factor1	0.762627451
P24	Factor3	Factor1	0.521382876
P25	Factor2	Factor3	0.765238146

The table below presents the distribution of participants across the four identified factors, illustrating how many individuals predominantly align with each perspective. This classification is based on the highest loading value for each participant, ensuring that they are assigned to the factor that best represents their project management mindset.

Table 34: Summary of predominant factor per participant

Predominant factor	
Factor	**Number of partecipants**
Factor1	8
Factor2	11
Factor3	4
Factor4	2

The table below presents the distribution of participants across their secondary factors, illustrating how many individuals show a moderate alignment with an additional perspective beyond their predominant factor. This classification is based on the second-highest loading value for each participant, ensuring that they are assigned to a secondary factor that also influences their project management mindset.

Table 35: Summary of secondary factor per participant

Secondary factor	
Factor	**Number of partecipants**
Factor1	11
Factor2	7
Factor3	3
Factor4	3

The distribution of participants across the four factors aligns with the explained variance, reinforcing the validity of the factor analysis results. Factor 1, which accounts for the highest variance (56.15%), includes a significant number of participants (8 out of 25), confirming that the technical execution and efficiency perspective is the dominant approach in project management. This suggests that a substantial proportion of respondents strongly identify with structured execution, risk control, and efficiency-driven methodologies.

Factor 2, despite explaining a much lower share of variance (8.99%), has the highest number of participants (11). This discrepancy suggests that while many individuals align with strategic vision and operational excellence, their levels of agreement or differentiation within this perspective may be more dispersed, leading to a lower overall contribution to variance. The broad distribution of participants under this factor indicates that long-term alignment and continuous improvement are widely recognized but not as sharply defined as technical execution skills.

Factor 3, which explains 7.53% of the variance, is associated with 4 participants. This aligns with the idea that soft skills such as problem-solving, adaptability, and communication are important but do not define project management as strongly as technical execution or strategic vision. The smaller number of participants linked to this factor suggests that interpersonal skills are seen as complementary rather than the central focus of project management competencies.

Factor 4, which represents AI and data proficiency, accounts for the lowest share of variance (4.93%) and has only 2 participants predominantly aligned with it. This further supports the notion that AI is an emerging but not yet widely established competency in project management. The fact that very few participants strongly identify with this factor suggests that AI is still perceived more as a tool rather than a defining capability that differentiates project management approaches.

A deeper examination of the full factor loading matrix reveals additional insights beyond the primary factor alignments. While each participant is assigned a predominant factor based on their highest loading, many also exhibit moderate alignment with secondary factors, which provides a more nuanced understanding of how project managers integrate different perspectives.

Participants tend to show stronger secondary alignment with Factors 1, 2, and 3, while Factor 4 remains more isolated. This indicates that technical execution, strategic vision, and soft skills often overlap in project management mindsets, whereas AI-driven project management remains less integrated. The fact that few participants demonstrate strong secondary associations with Factor 4 further supports the idea that AI is not yet perceived as an essential differentiator but rather as a neutral industry shift that will eventually affect all project managers equally.

This perspective is critical because if AI were seen as a key competitive advantage, we would expect more participants to show at least moderate secondary alignment with Factor 4, even if it was not their predominant factor. Instead, the data suggests that many project managers may still view AI as a general trend rather than an urgent capability to develop, potentially underestimating its impact.

Chapter 6: Discussion

6.1 Statistical Results

The factor analysis reveals four distinct yet interrelated perspectives shaping contemporary project management. Factor 1 (Technical Execution)—the dominant viewpoint—stresses structure, efficiency, and risk management, while Factor 2 (Strategic Vision) places greater emphasis on continuous improvement and aligning project-level decisions with broader organizational objectives. Notably, these two factors are relatively close in focus: both highlight a systematic approach to project control and operational excellence, although Factor 2 adds a layer of long-term, vision-oriented thinking that extends beyond purely technical competencies.

Factor 3 (Soft Skills) underscores the significance of problem-solving, adaptability, and effective communication. Although it explains a smaller share of the variance, it emphasizes the people-centric nature of project management, suggesting that interpersonal competencies, while often supporting rather than defining the project, are crucial for team coordination and overcoming unforeseen challenges.

Factor 4 (AI Literacy) highlights the emerging but not yet dominant influence of AI, data proficiency, and automation on project management practices. Its relatively low explanatory power and the small number of project managers who strongly identify with it suggest that AI is widely viewed as an inevitable trend rather than an immediate source of competitive differentiation.

From a practical perspective, these findings confirm that technical and strategic competencies remain foundational for most practitioners. Yet, there is a growing appreciation for broader vision and human-centric skills, as reflected in the close alignment of Factors 1 and 2 and the rising importance of people-oriented capabilities in Factor 3. Additionally, while many project managers currently regard AI as a neutral, industry-wide evolution, early adopters of advanced AI and data competencies may be better positioned to navigate future shifts and lead increasingly tech-driven initiatives. Overall, this multidimensional landscape underscores that success in project management demands technical rigor, strategic foresight, collaborative leadership, and a proactive mindset toward new technological possibilities.

6.2 Use of AI in qualitative questions

The qualitative analysis of the survey responses indicates that the majority of participants (17 out of 25) already leverage some form of AI in their daily professional tasks. Overall, these respondents view AI primarily as a practical facilitator rather than a disruptive force. Notably, widely adopted AI tools—such as ChatGPT, Microsoft Copilot, or basic predictive models—generally require little to no specialized training; users commonly employ them for tasks like drafting documents, summarizing reports, or performing preliminary data analyses. In turn, AI serves to enhance efficiency without necessitating advanced technical expertise.

Despite the varied workplace contexts represented, there is no indication that any respondents perceive AI as threatening to job security or project success. On the contrary, many describe how AI relieves them from repetitive or low-value tasks, allowing them to focus on more strategic responsibilities and value-added activities. Given this, AI is widely embraced as an enabling technology that complements existing skill sets.

6.3 Theoretical Implications

This study contributes to the existing literature on project management competencies by reinforcing the continued relevance of traditional methodologies, even in an era of increasing digitalization and AI integration. The findings align with prior research suggesting that core project management competencies, such as strategic alignment, risk management, and leadership skills, remain central to effective project execution despite the availability of AI-driven tools.

First, the results confirm that project managers continue to prioritize well-established project management techniques, a trend consistent with the findings of Denni-Fiberesima (2024). The study highlights how competencies such as project life cycle management and strategic planning remain indispensable, as they provide the structural and decision-making frameworks necessary for project success. AI, while increasingly present, is primarily viewed as a supporting tool, enhancing efficiency in repetitive tasks and data analysis rather than fundamentally transforming how projects are managed.

Furthermore, the findings align with Prasetyo et al. (2024), who argue that AI adoption in project management is often constrained by organizational culture and resistance to change. This study supports that perspective by demonstrating that, while AI-powered tools such as predictive analytics and resource optimization algorithms offer tangible benefits, they are not perceived as replacements for established methodologies. Instead, AI is integrated selectively, reinforcing the theoretical understanding that technology adoption in project management follows an evolutionary, rather than revolutionary, path.

Another theoretical contribution of this study is its focus on strategic alignment as a key factor influencing project success. The results support Bäckelin (2024), who emphasizes that AI's effectiveness in project management is highly dependent on its alignment with an organization’s strategic vision. Without a clear strategic direction, AI tools risk being underutilized or misaligned with broader business objectives, leading to minimal long-term impact. The study extends this perspective by highlighting that, while AI can improve decision-making and forecasting, the fundamental responsibility for long-term project strategy and organizational alignment remains with human decision-makers.

Similarly, this research reinforces the arguments made by Ferraz (2025), who underscores the importance of strategic alignment in integrating digital competencies into leadership practices. The findings suggest that, rather than relying solely on technological advancements, successful project management continues to depend on a balance between process optimization, risk management, and the ability to anticipate and respond to industry changes. These insights contribute to the broader discussion on how AI fits into the evolving landscape of project management, reinforcing the idea that its impact is contingent on human leadership and decision-making.

Finally, the study confirms the continued emphasis on soft skills as critical competencies for project managers. The role of communication, leadership, and stakeholder engagement remains pivotal, as demonstrated by Hussain et al. (2024), who argue that AI cannot replace interpersonal competencies essential for managing teams and navigating complex project environments. Similarly, Barach (2025) highlights that, while AI tools can improve efficiency in resource management and workflow coordination, they do not substitute the ability to build trust, resolve conflicts, or foster

collaboration. This research further supports that view, reinforcing the theoretical distinction between AI-enabled efficiencies and the inherently human aspects of project management.

These findings provide valuable theoretical insights into the role of AI in project management, suggesting that while AI enhances certain aspects of project execution, it does not replace fundamental management principles. Future research should further explore how AI literacy among project managers evolves and whether increased familiarity with AI-driven tools leads to a shift in competency priorities over time.

6.4 Practical Implications

From a practical standpoint, this study provides valuable insights for project managers and organizations seeking to effectively integrate AI tools while maintaining a strong foundation in traditional project management competencies. The findings offer guidance on balancing AI adoption with core managerial principles, ensuring that project teams can leverage technology without compromising strategic decision-making and leadership dynamics.

A key takeaway from this research is that AI implementation should be approached as a complementary tool rather than a fundamental shift in project management philosophy. The results indicate that technical execution, strategic vision, and soft skills remain central to project success, with AI serving as an enabler rather than a driver of change. Managers should prioritize AI investments in areas that enhance efficiency without disrupting established workflows, ensuring that AI adoption supports rather than replaces critical project management functions.

The study also highlights the importance of investing in the right skills. While AI tools can optimize project planning and execution, their effectiveness depends on how well project managers and teams can integrate them into existing processes. The findings suggest that organizations should focus on developing AI literacy among project managers and team members, ensuring that AI adoption is guided by a clear understanding of its capabilities and limitations.

Another important consideration is the role of organizational culture in AI adoption. As indicated by Prasetyo et al. (2024), the effectiveness of AI tools in project management

is often hindered by resistance to change and a preference for familiar methodologies. To address this challenge, managers should foster a culture of adaptability and continuous learning, ensuring that teams are equipped to integrate AI solutions effectively. This requires a proactive approach to change management, where project managers play a key role in bridging the gap between technological advancements and practical implementation.

The study further underscores the importance of strategic alignment when adopting AI in project management. AI tools, such as predictive analytics and automated reporting, can provide valuable insights, but their impact depends on how well they are aligned with broader business objectives. Managers should ensure that AI implementation is integrated into the overall project strategy, rather than being treated as an isolated initiative. This perspective aligns with Bäckelin (2024), who argues that AI adoption must be tied to long-term business goals to be truly effective.

Additionally, the findings highlight that AI adoption should not come at the expense of interpersonal skills. Effective project management continues to rely on leadership, communication, and collaboration, competencies that AI cannot fully replicate. As noted by Hussain et al. (2024), while AI-driven tools can enhance workflow automation and task delegation, they do not replace the need for human interaction, team motivation, and conflict resolution. Managers should therefore strike a balance between AI-driven efficiencies and the essential human elements of project leadership.

6.5 Limitations

This thesis encountered several constraints that may influence the reliability and generalizability of its findings. First and foremost, the final sample included only 25 participants, as opposed to the 40 originally intended. The reduction in the number of respondents was primarily driven by time limitations inherent to thesis work, where rigid deadlines often dictate the extent and scope of data collection. This smaller sample size, while sufficient for exploratory analysis, may limit the robustness of statistical correlations and the breadth of perspectives captured.

Second, this study provides a “snapshot” of a particular moment in time, reflecting the viewpoints, market conditions, and technological contexts relevant during the data-collection period. As these factors evolve, there is a potential for shifts in individual

opinions, organizational priorities, or external environmental variables—meaning the results reported here could change if measured again in the future.

Furthermore, the restricted timeframe forced a narrower scope than would have been ideal for a more comprehensive investigation. A larger and more diverse sample could not be achieved within the given period, potentially restricting the transferability of the findings to other contexts or industries.

An additional consideration relates to participant demographics (industry background and years of experience). While it would have been insightful to explore correlations between these demographic factors and each participant's predominant factor, this analysis was not included because the sample was both too small and too homogeneous to yield meaningful statistical relationships. For simplicity and due to the limited variability in participant profiles, these demographic correlations were omitted from the final discussion.

To address these limitations, future research should consider expanding the participant pool to capture a broader range of experiences and perspectives, possibly incorporating longitudinal or repeated-measure designs. Such approaches would allow for monitoring how opinions, practices, and technological factors change over time, thereby enhancing the explanatory power and applicability of the results.

It would be particularly insightful to extend this investigation by interviewing more technical project managers, such as engineers or designers, to determine whether there exist AI-driven tools that require specialized competencies. This additional perspective could clarify whether certain fields demand more advanced technical knowledge to harness the full potential of AI, potentially underscoring differences in how AI is adopted and perceived across various types of project management roles.

Moreover, it would also be highly valuable to shift the focus beyond project managers themselves and instead interview team members to assess whether AI has more practical rather than strategic implications. Exploring AI's role from the perspective of those directly involved in project execution could reveal whether AI is primarily leveraged to streamline and accelerate repetitive tasks rather than influence high-level decision-making. If AI's primary function within projects is to optimize efficiency in routine

operations rather than reshape managerial approaches, this could provide an alternative explanation for why AI appears to be undervalued in the study's findings. Such insights could help distinguish whether the current perception of AI in project management underestimates its practical contributions, particularly in task automation, data processing, and workflow optimization, rather than its strategic influence at the leadership level.

Chapter 7: Conclusions

These studies reinforce the idea that even in an environment where AI is becoming increasingly pervasive, soft skills will continue to be essential. AI adoption does not eliminate the need for human interaction but rather modifies its nature, requiring PMs to develop new capabilities to manage a hybrid environment of technology and people.

The findings of this research raise several important questions about the future of project management. While AI is transforming how projects are managed, it is evident that traditional and human competencies remain central to the profession's success.

This reluctance toward indiscriminate AI adoption can be interpreted in two ways:

- A cautious approach: PMs may simply prefer to adopt technology gradually, ensuring it does not compromise work quality or team management.
- Technological limitations: Despite its advancements, AI is not yet capable of managing the complexity of interpersonal and organizational dynamics inherent to project management.

Given these findings, future research could explore:

- The most effective ways to integrate AI without compromising human competencies.
- The evolution of soft skills in an increasingly digital environment.
- The optimal level of automation in PM processes to maximize both efficiency and strategic control.

This research confirms that, while AI can and already enhance project management in various ways, PMs continue to prioritize competences linked to traditional methodologies, strategic alignment, and soft skills as fundamental pillars of their profession. AI, therefore, is not a replacement but rather a complement to human competencies, and the future of project management will likely be characterized by a balance between technological innovation and human expertise.

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