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Expectations and Perceptions on Artificial Intelligence and Innovation in the AEC Sector

A Case Study on Project Managers

AGNES KUBAR AND PONTUS SKOL

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by

Agnes Kubar
Pontus Skol

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Förväntningar och uppfattningar om artificiell intelligens och innovation inom AEC-sektorn

av

Agnes Kubar
Pontus Skol

Examensarbete TRITA-ITM-EX 2024:293
KTH Industriell teknik och management
Industriell ekonomi och organisation
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Approved	Examiner	Supervisor
2024-05-31	Anna Wahl	Monica Lindgren
	Commissioner	Contact person

Abstract

The Architecture, Engineering, and Construction (AEC) sector is one of the least digitized industries and subject to low performance growth and inefficient project management practices, stemming from inherent challenges with managing change. In response to this, the sector is beginning to explore artificial intelligence (AI), expected to be one of the most transformative technologies in the coming decade, and its possibility to streamline processes and increase project productivity.

Given the AEC sector's need for enhanced project management practices and its slow digital transformation, this thesis aims to explore the intersection between AI and project management, and challenges associated with implementing new technology and work methods from the perspective of project managers. To fulfill the purpose of this study, a single case study at the infrastructure department within one of the largest Swedish AEC consulting firms was conducted through a qualitative interview study. A review of relevant literature served as a complement to the primary data retrieved from the interviews, serving as a theoretical foundation to support the analysis.

The results show an overall positive attitude towards AI and reveal several potential application areas in project management and project related work in the AEC sector.
The results show a generally positive attitude towards AI among project managers, viewing it as a tool for enhancing efficiency, quality, and reducing costs by automating labor-intensive tasks and leveraging predictive capabilities. While AI is not seen as a threat to project managers' roles, there are concerns about its impact on other roles within projects. Successful AI integration is expected to increase competitiveness and business capacity through enhanced efficiency within the sector. However, challenges associated with technology implementation and changed work methods include the decentralized organizational structure, lack of top management support, inadequate standardized methods, poor knowledge transfer, and the variable compensation model.

This study contributes to the literature by highlighting potential application areas for AI in project management within the AEC sector as well as corresponding impacts. By providing a nuanced understanding of barriers to technology adoption and change within the sector it further underscores the need for top management support and strategic direction to harness the full potential of technologies as AI. The study further contributes by providing implications for practice to overcome present barriers.

Keywords

Project management, Artificial intelligence, Organizational change, Innovation

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Förväntningar och uppfattningar om artificiell intelligens och innovation inom AEC-sektorn

En fallstudie om projektledare

Agnes Kubar
Pontus Skol

Godkänt	Examinator	Handledare
2024-05-31	Anna Wahl	Monica Lindgren
	Uppdragsgivare	Kontaktperson

Sammanfattning

Arkitektur-, ingenjörs- och byggsektorn (AEC) är en av de minst digitaliserade sektorerna och kännetecknas av låg produktivitetsutveckling och ineffektiva projektledningsmetoder, vilket till stor del orsakas av inneboende utmaningar med att hantera förändring. Som svar på detta börjar sektorn utforska artificiell intelligens (AI), som förväntas vara en av de mest transformerande teknologierna under det kommande decenniet, och dess möjlighet att effektivisera processer och öka produktiviteten i projekt.

Med tanke på AEC-sektorns behov av förbättrade projektledningsmetoder och dess långsamma digitala transformation syftar denna studie till att utforska kopplingen mellan AI och projektledning samt de utmaningar som är förknippade med att implementera ny teknik och nya arbetsmetoder ur projektledares perspektiv. För att uppfylla syftet med denna studie genomfördes en fallstudie vid infrastrukturavdelningen inom ett av de största svenska AEC-konsultföretagen genom en kvalitativ intervjustudie. En granskning av relevant litteratur kompletterade den primära data som erhölls från intervjuerna och utgjorde en teoretisk grund för analysen.

Resultaten visar en övergripande positiv attityd gentemot AI och visar på flera potentiella applikationsområden för AI inom projektledning och projektrelaterat arbete i AEC-sektorn. Projektledarna ser AI som ett verktyg för att öka effektiviteten, höja kvaliteten och minska kostnaderna i projekt genom att automatisera arbetsintensiva uppgifter och utnyttja prediktiva möjligheter. Även om AI inte ses som ett hot mot projektledarnas roller, finns det oro över dess påverkan på andra roller inom projekten. Framgångsrik AI-integration förväntas öka konkurrenskraften och affärskapaciteten genom förbättrad effektivitet inom sektorn. Utmaningarna med att implementera teknik och förändrade arbetsmetoder återfinns i den decentraliserade organisationsstrukturen, bristen på stöd från högsta ledningen, otillräckliga standardiserade metoder, bristfällig kunskapsöverföring och den rörliga ersättningsmodellen.

Denna studie bidrar till litteraturen genom att belysa potentiella applikationsområden för AI inom projektledning i AEC-sektorn samt motsvarande effekter. Genom att ge en nyanserad förståelse för utmaningar kopplade till teknikimplementering och förändring inom sektorn betonar studien vidare behovet av stöd från ledning och en strategisk riktning för att kunna utnyttja teknologier som AI fullt ut. Studien bidrar vidare genom att ge praktiska implikationer för att övervinna nuvarande hinder.

Nyckelord

Projektledning, Artificiell intelligens, Organisatorisk förändring, Innovation

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Abbreviations and Explanations

AEC	Architecture, Engineering, and Construction
AGI	Artificial General Intelligence
AI	Artificial Intelligence
ANI	Artificial Narrow Intelligence
ASI	Artificial Super Intelligence
BIM	Building Information Model
DL	Deep Learning
ML	Machine Learning
OCM	Organizational Change Management
PM	Project Management *or* Project Manager

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1. Introduction

1.1 Background

The Architecture, Engineering, and Construction (AEC) sector represents a significant and important part of the global economy. However, it has long struggled with numerous challenges that have constrained its development (Barbosa et al., 2017). Hindered by lower profit margins relative to other industries, the sector's capacity for investing in new technologies and digitization efforts — stated as key drivers for enhancing productivity — is notably constrained (Regona et al., 2022; Nourbakhsh, 2022; Barbosa et al., 2017). Consequently, the AEC sector has long been characterized as a low-innovation sector, experiencing slow growth in productivity (Javed et al., 2018). Moreover, it ranks among the least digitized sectors worldwide compared to manufacturing, retail, and telecommunications in adopting and advancing new technologies, digital and artificial intelligence solutions (Regona et al., 2022; Mohammadpour et al., 2019; Olsson et al., 2021).

The AEC sector predominantly consists of projects that, while often large and with a substantial impact on societies and their development (Mišić and Radujković, 2015; Caldas and Gupta, 2017; Arefazar et al., 2022, Tatli and Erkan, 2023), frequently encounter substantial criticism on both international and national fronts due to their common issues with delays and budget overruns (Herrmann and Spang, 2020). These projects, characterized by uncertainties and changes, makes them complex and challenging to execute successfully (Masrom et al., 2015; Caldas and Gupta, 2017; Arefazar et al., 2022). High complexity, coupled with their large scale, the participation of numerous stakeholders, and the influence of socio-political contexts, make these projects risky and difficult ventures to manage, plan, and successfully deliver within the stipulated budget, quality standards and timeline (Flyvbjerg, 2003; Kadefors et al., 2019). Previous research on the success factors has underscored project management as an important factor (Herrmann and Spang, 2020; Arefazar et al., 2022; Gil and Pinto, 2018). Effective project management is crucial for achieving the objectives of large infrastructure projects within the AEC sector, and significantly enhances their prospects for success (Herrmann and Spang, 2020). Despite this fact, the AEC sector struggles to embrace innovation and integrate the latest advancements in project management (Barbosa et al., 2017).

In response to the low performance growth and increased expectations on reduced costs and accelerated project delivery, the sector is beginning to explore artificial intelligence (AI) and its possibility to streamline processes and increase productivity (Regona et al., 2022; Nourbakhsh, 2022; Darko et al., 2020). Arguably, Artificial Intelligence (AI) will be the most transformative technology in the coming decade. It has already begun to reshape how people live and work, and its impact is expected to grow even further. The technology's potential within project management (PM) is no exception to this trend and its application within the field has been the subject of extensive research attention in the last years (Fridgerisson et al,. 2021; Taylor, 2021; Auth et al., 2019). The integration of AI in PM is predicted to revolutionize the field, holding significant advancements in best practices, education and economic metrics (Fridgerisson et al,. 2021) and are anticipated to have a significant impact on business operations and job roles with its potential to automate complex tasks and redefine PM (Taylor, 2021). While there is speculation about whether AI will replace project managers (Auth et al., 2019) the broader consensus is that AI will elevate the discipline to higher levels of performance and innovation, improve project outcomes and transform the field of PM (Taylor, 2021; Fridgerisson et al,. 2021).

Considering the importance of effective project management and the slow rate of digitalization and innovation within the AEC sector, partially causing the growth problems in terms of productivity (Barbosa et al., 2017; Maali et al., 2022) investigating the potential of AI within project management emerges as timely. Today, AI is one of the most underutilized technologies in the sector (Nourbakhsh, 2022), but its potential to challenge and disrupt the conventional approaches, as in other sectors, is great and holds significant promise to contribute to more productive projects. However, moving towards a more digitized industry appears to be slow, and there are challenges in the process of adopting new technologies. This study will explore the perceived expectations towards, and challenges of, adopting AI in project management in the AEC sector through a case study at the infrastructure department of one of the largest Swedish AEC consultancy firms.

1.2 Purpose and Research Questions

Given the AEC sector's need for enhanced project management practices and its slow digital transformation, this thesis aims to explore the intersection between AI and project management from the perspective of project managers. The study will focus on the managerial and human factors, rather than technological ones, by exploring project managers' perceptions of AI, the challenges of technology adoption, digital transformation and change, and how these challenges impact the integration of AI in the sector. The purpose of this study is hence to provide insights into the barriers to digital innovation in the AEC sector and contribute to an enhanced understanding of how AI could impact project management practices and provide outlines for the preferred developments of AI in project management by answering the following research questions:

- *How do project managers in the AEC sector perceive and what are their expectations on the introduction of AI in project management?*

- *How do project managers in the AEC sector perceive the challenges associated with implementing new technologies and work methods?*

1.3 Scope and Delimitations

This study is conducted within the context of a large publicly traded Swedish engineering consultancy firm in the AEC sector. The study is limited to a broader qualitative analysis of project management related to AI and change, without delving deeply into technical details. The consultancy firm is divided into several departments, each specializing in specific technical areas. This study focuses on analyzing responses from project managers working in the organization's transportation department, which means that the conclusions may not reflect the situation of the entire organization. Additionally, since all interviewed project managers are based in Sweden, the study's conclusions are limited to the Swedish context, reflecting the local corporate culture and the metrics that measure national development. Consequently, the conclusions drawn in this study may not be entirely applicable to similar companies in other countries.

1.4 Outline of the Report

Chapter 1 Introduction: The report begins with an introduction to the current situation in the AEC industry, highlighting its slow rate of innovation and digitalization, which partially contributes to negative consequences for productivity growth. Following this problem description, the reader is introduced to the study's aim, to explore project managers' perceived expectations and challenges regarding the adoption of AI in project management within the AEC sector. This is done through a case study at the infrastructure department of one of Sweden's largest AEC consultancy firms. The introduction concludes with the study's purpose and a research question.

Chapter 2 Literature: The literature review initially provides a broad overview of the role and challenges faced by project managers, with a specific focus on the AEC sector. It then delves into topics such as organizational change, technology adoption, and the diffusion of innovation within AEC. This is followed by an overview of the concept of artificial intelligence, the current state of AI in project management, and the readiness of organizations to adopt AI.

Chapter 3 Research Methodology: The research methodology includes a detailed description of the research design and process, as well as data collection and analysis methods. It concludes with sections on research quality and ethical considerations.

Chapter 4 Empirical Analysis: The analysis chapter presents the findings from the interviews, divided into chapters related to the themes derived from the data collection. The first chapter is the role of the project manager with subchapter on the project managers challenges. Followed by the chapter AI in project management with subchapters presenting the results of the project managers perceptions and attitudes towards AI, expected AI use cases and impact and risks of AI. The empirical analysis concludes with drivers and barriers for organizational change and technology adoption.

Chapter 5 Discussion: The results from the analysis in chapter 4 is discussed in combination with the literature from chapter 2.

Chapter 6 Conclusion: A summary of chapters 1-5, which is divided into the subchapters theoretical contributions, practical implications and limitations and future research.

2. Literature

2.1 Project Management and Measuring Project Success

The Project Management Institute (PMI, 2024) defines Project Management as: *"the practice of using knowledge, skills, tools, and techniques to complete a series of tasks to deliver value and achieve a desired outcome."* Determining what constitutes a desired outcome or a successful project can be challenging and what constitutes project success in one industry may differ significantly in another (Chan, 2001). The concept of the *Iron Triangle*, also known as the *Triple Constraint*, is one of the earliest frameworks used to measure the success of project management. The triangle can be constrained based on three factors, cost, scope and time (Van Wyngaard et al., 2012; Atkinson, 1999). The three factors of the triangle are interconnected, meaning a change in one inevitably affects the others, impacting the overall quality of the project. If the project is finished on time, within budget, and meets its objectives, it can be considered a success and of good quality (Pollack et al., 2018).

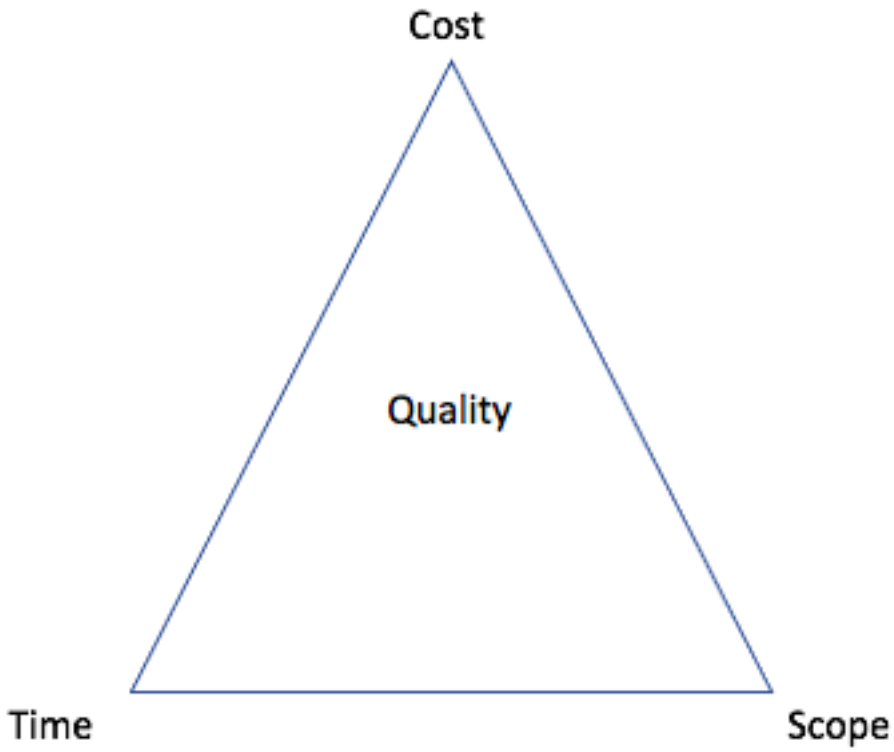

Figure 1: The Iron Triangle

There are various versions of the triangle, where, for example, "quality" replaces "scope" but the literature generally agrees that the factors depicted in Figure 1 are the most suitable for determining quality (Van Wyngaard et al., 2012).

Cost: The cost factor as a component/factor of the iron triangle concerns the anticipated expenses for the project and its budget allocation. Cost is a critical factor throughout the project lifecycle. It begins with an initial estimate, which can vary in accuracy depending on the client's input. Managing expectations and budget

constraints, especially when dealing with fixed budgets, is a key aspect of a project manager's responsibilities (Wysocki, 2019)

Scope: Scope covers all the requirements and work that the project is set to involve. The scope is the foundation of all project work, it describes not only the work that needs to be done but also what not to be done (Wysocki, 2019).

Time: Time is constrained by the duration within which the project must be completed. Time and cost are often inversely correlated to one another, if the project time is reduced, it will most likely be more expensive to finish the project in the shortened time-window (Wysocki, 2019).

Within the AEC industry, the criteria for what constitutes project success have evolved over time. Initially, the traditional success factors included cost, schedule, quality, and safety. However, these have been expanded to also include additional factors such as customer satisfaction, functionality, satisfaction with the project manager and team members, and environmental friendliness. Safety is of particular importance in the construction industry, as accidents can result in significant financial costs for both the client and the contractor, and may also lead to projects being delayed or completely terminated. As for the architectures, functionality may be seen as an important success factor, which refers to ensuring that a building is functional means that it not only meets aesthetic and structural standards but also enhances the quality of life for those who interact with it (Rani et al., 2013; Pc et al., 2001).

2.2. The Responsibilities and Challenges of a Project Manager

The Project Management Institute (PMI, 2024) defines the Project Manager as someone who *"is critical to the success of projects. And their skills are highly sought after to help organizations achieve their goals."* Similarly, the Project Management Body of Knowledge (PMBOK, 2021) defines the role of the project manager as someone who *"plays a critical role in the leadership of a project team in order to achieve the project's objectives."*

Project Managers bear a significant responsibility, with their leadership and organizational skills often being critically tested throughout the entire project life cycle (PMBOK, 2017). Their task is complex and unique mainly because it's based on short-term tasks where roles or job titles within an organization do not have a permanent or officially recognized status within the organization's hierarchical structure (Lutas et al., 2020). Additionally, given the trend of escalating project complexity, the project manager's task of successfully executing their role of responsibility becomes increasingly challenging, not least due to the current traditional project management approach which is becoming less effective in today's fast-paced dynamic environments (San Cristóbal, 2017; Sohi et al., 2016). According to Udo et al. (2004), the complexity of projects escalates with their size and Ribeiro et al. (2021) observed that this increase in complexity is also attributed to a more volatile and dynamic society, a change partly caused by digitalization, a trend commonly associated with Industry 4.0.

The main roles of the project manager (PMI, 2024) consists of eight areas:

1. Identifying the project goals & scope.
2. Planning and documenting project tasks.
3. Ensuring deliverables are delivered on-time.
4. Managing all project resources.
5. Effectively communicating with stakeholders.
6. Eliminating blockers and potential risks.
7. Documenting project process using various project management tools.
8. Ensuring top-quality results and project success.

On top of this, Zeiher (2015) highlights that project managers fulfill an additional, and perhaps less evident, role beyond the conventional duties of managing and monitoring tasks, maintaining the project within budget and timelines, and establishing success criteria. This supplementary role involves acting as a connector or bridge across different parts of the organization, providing them with a unique perspective and overview that is absent in many other roles.

2.2.1 Core Competencies of a Project Manager

A skilled project manager should possess competencies primarily from three areas: Knowledge, Personal, and Proven Experience (Udo et al., 2004)

The first area, Knowledge, indicates that the individual should have a fundamental understanding of project management, including methods and tools. Additionally, they should exhibit strong leadership qualities, such as the ability to create a vision for the project team, articulate why the project is important, and provide clear direction regarding the project's objectives. Within leadership, a project manager should also possess soft skills, enabling them to identify when team members, stakeholders, or external parties are resistant to change or specific project aspects.
Leadership also involves the ability to manage conflicts. A project manager must have the ability to empathize with team members' situations and emotions, and be attentive to effectively resolve conflicts that could potentially jeopardize the outcome of a project.

The Personal aspect emphasizes the importance of adaptability to efficiently manage changing and unexpected situations. This includes maintaining calmness under stressful circumstances and the ability to earn the respect and trust of others, which is critical for effective communication with stakeholders. It also involves possessing sensitivity, where the project manager has the ability to discern when it is and isn't the right moment to manage.

Lastly, Proven Experience refers to previous experience of leading a project to success. This involves not just carrying out project tasks, such as completing the project on time, within budget, and meeting the existing expectations, but also inspiring and guiding the project team towards achieving the project's goals.

2.2.2 Project Management in the AEC Sector

Managing large-scale projects in the AEC sector is rarely a simple task. They are characterized by several distinct features: they are unique in their kind, span long durations, are technically complex, involve numerous stakeholders, and usually have significant connections to regulatory authorities (Kumar et al., 2024). There's a trend that the larger the project, the greater the complexity. Due to the extensive scope of such projects, it becomes challenging for project managers to possess all the relevant knowledge required for a successful outcome (Lu et al., 2015). The project manager has to have the ability to capture the relevant 'silent knowledge' and filter knowledge that is excessive or unnecessary for the project's purpose (Liikamaa, 2015). Large-scale projects often result in delays and higher costs than initially anticipated (Lu et al., 2015).

According to Tatli et al. (2023), there are particularly two reasons for the increasing complexity of projects: the involvement of a larger number of stakeholders, along with the need to keep pace with ongoing technological advancements. The first issue is the project manager's (PM) struggle to maintain and manage good communication with multiple stakeholders at the same time. Poor stakeholder management can lead to complicated conflicts of interest, where misunderstandings and differing opinions on what should be done are common. On the other side, stakeholders also have a responsibility towards the project manager. If stakeholders do not address uncertainties and risks at the beginning of a project, the project's outcome risks being negatively affected (Nguyen, 2018). The second issue, concerning technological advancements, is that in large-scale projects, a wide variety of technologies are often employed, which tend to be the most modern. Utilizing the latest technology, which is not always thoroughly tested, often presents challenges (Tatli and Erkan, 2023).

Another complicating factor for the project manager is due to "scope creep," which refers to the situation where the scope of the project changes during its course due to new requirements. At the beginning of any construction project, both owners and contractors share an interest in establishing the complete scope of the project. However, as the project advances, scope creep may go unnoticed, gradually integrating into the project's scope as expectations shift, leading to significant adverse impacts such as increased financial costs and project delays (Ajmal et al., 2021).

2.3 Organizational Change

According to Aldossari et al. (2021), an organizational change can be explained as "the strategic implementation of a process, technology or tool that is new to an organization" and the high failure rate is due to the lack of an efficient organizational change framework. This issue is particularly pronounced in the AEC sector, characterized by its slow pace of organizational transformation, and in particular, digitalization and technology adoption. For this reason, an AEC organization's capability to adapt flexibly and navigate changes efficiently, thereby aligning with the dynamic market demands, has emerged as a key competitive edge (Aldossari et al., 2020; Maali et al., 2022).

Lines and Vardireddy (2017) outlined six strategies for managing organizational change in the AEC sector effectively to ensure successful adoption. These organizational change management (OCM) strategies include: the deployment of change agents, a strong commitment from senior leadership, effective communication, setting a realistic timeframe for the change process, the implementation of benchmarking practices, and the importance of adequate training resources.

The Deployment of Change Agents
Technological shifts have been an important part of the industry, for example, the transition to the use of the Building Information Model (BIM) tool (Lines and Vardireddy, 2017). In the case of the transition to BIM, change agents are described as a key to success for organizational change. Change agents can take the form of a designated person(s) who takes responsibility for assisting others throughout the implementation, ideally being influential figures but not necessarily senior executives. Additionally, as detailed in the case study by Vass and Gustavsson (2017) public actors who, by deciding to implement the technology themselves, can act as a catalyst for other actors within the AEC industry to start using the same technology, while also providing support with introduction and training (Vass and Gustavsson, 2017; Lines and Vadireddy, 2017).

A Strong Commitment from Senior Leadership
A strong commitment from senior leadership is similar to, but differs from change agents in that these individuals do not serve as active supporters. Instead, they demonstrate their positive attitude towards the change throughout the entire change process, indicating that this change is necessary and will lead to greater success for the organization (Lines and Vadireddy, 2017).

Effective Communication
Communication is also described as an important factor for organizational change. Explaining the benefits of new technology to employees helps them see what's in it for them, making them more open to change and less hesitant about new things (Lines and Vadireddy, 2017).

The implementation of Benchmarking Practices
Another way to encourage change in the organization is through benchmarking. By setting clear goals, we can show not only how changes improve profits but also make work easier for those on the front lines. This is crucial in fields like architecture, engineering, and construction, where it's important to demonstrate that changes will

both boost the organization's operational level and simplify daily tasks for employees (Lines and Vadireddy, 2017).

Setting a Realistic Timeframe for the Change Process
Following a reasonable timeline for implementation is also an important aspect. Changes that occur over too short a period can risk encountering greater resistance from employees. There are tendencies within the AEC sector to underestimate the time it takes for large-scale changes, which can lead to a naive view having a counterproductive effect (Lines and Vadireddy, 2017).

Importance of Adequate Training Resources
Another major cause of resistance to change is the lack of adequate change-related training, which can create uncertainty and anxiety among employees about their ability to adapt to new ways of working. Which has also been seen to be important in the adoption of BIM, where it is necessary for employees to feel sufficiently confident to effectively use the tool in their projects for a sustainably successful implementation (Vass and Gustavsson, 2017; Lines and Vadireddy, 2017).

2.4 Technology Adoption and Diffusion of Innovation in AEC

There is a slow, yet noticeable, shift from traditional, labor-intensive work processes to the adoption of more automated workflows within the AEC sector due to the digital transformation (Manzoor et al., 2021; Barbosa et al., 2017). Lavikka et al. (2018) and Emaminejad and Akhavian (2022) attribute the slow transition to the industry's knowledge gap in capitalizing financially through the implementation of digitalization, and small profit margins cause AEC practitioners to be more hesitant to adopt new technology without proven cost-saving prospects, causing uncertainty among industry decision-makers about which technology to invest in and how to manage the transition to a digitized supply chain (Lavikka et al., 2018).

The slow diffusion of systemic innovation that is digitalization within the AEC is moreover attributed by the organizational structures. The project based nature of the AEC sector, characterized by short term economic perspective and short term relationships with little focus on improvements both within and between projects are impeding factors for the diffusion of innovation according to Lindgren (2016) and Olsson et al. (2021). These characteristics are influencing project- and site managers, who are key actors in the diffusion of innovation, to lean towards a risk averse behavior where choices on known products, technologies and ways of working precede the new due to the tight margins the projects are operated within (Lindgren, 2016; Eriqat et al., 2023). The industry's adherence to conventional methods to averse risk greatly impedes the innovation and technology adoption needed to achieve higher project excellence (Eriqat et al., 2023). According to Olsson et al. (2021), this stresses the need for new contract models within the sector to mitigate the risk of adopting new technologies.

Moreover, the transient nature of relationships within construction projects where temporal social networks are developed can hinder the spread of innovation. Given the instability of construction projects considering the frequent change of conditions and participants, the connections between those creating the innovations and those

implementing them tend to be weak. This situation is further complicated by the decentralized nature of work and the distribution of responsibility, leaving decisions dependent on individuals (Larsson et al., 2006; Zomer et al., 2021). In such an environment, the dynamic and often fragile relationships can slow down or complicate the process through which new innovations are adopted and integrated into standard practices (Larsson et al., 2006; Barbosa et al., 2017).

The organizational structure's influence on the diffusion of innovation was further discussed by Dubois and Gadde (2002) who viewed the AEC sector as a loosely connected system with loose connections between projects but strong connections within projects. While this structure allows for independent adjustment within projects without impacting the wider system, the loose organizational connection impedes the diffusion of broad innovation. Taylor (2006) discussed how boundary strength between trades and the span of trades, i.e different professions, affect the spread of innovation and found that strong boundaries and the greater the span of trades causes innovation to spread slowly, while more fluid boundaries and smaller span of trades facilitates the spread. Lindgren (2016) presents similar findings and highlights that established roles, distinct disciplines, strong boundaries between projects, working in phases with clear boundaries and traditional cultures impedes the diffusion of innovation in the AEC sector.

Another central aspect regarding innovation processes is knowledge and learning which needs to flow in order for innovation to diffuse (Lindgren, 2016). Organizational variety, boundaries between trades, and span of trades influences the ability of knowledge to flow within an organization (Taylor and Levitt, 2005). The organizational structures within the AEC sector and the project-based work model dominating the sector, with every construction project being unique in some dimension, complicates the management of innovation as the discontinuous nature of working in projects repeatedly results in broken learning and feedback loops. Hence, the absence of formal knowledge transfer systems between projects present one of the main barriers to the diffusion of innovation in the sector (Lindgren, 2016; Maali et al., 2022; Eriqat et al., 2024; Olsson et al., 2021).

Because of the project-based work model, innovations are usually introduced and implemented within individual projects, leading to an adoption dynamic at the firm level and a separate learning dynamic at the project level while at the same time making project managers key actors for implementation (Lindgren, 2016; Vass and Karrbom, 2017). Davies and Harty (2013) further concluded that the project-based work often leads to ad hoc or improvised solutions in projects which implies challenges for innovations to become established as standardized solutions and work methods. The absence of standardized approaches often reflects a broader issue within the organizational hierarchy, notably a lack of commitment, support and vision from top management, which impedes the direction of innovation efforts and its potential to evolve into standardized practice (Eriqat et al., 2023). Bag et al. (2020) concludes that strong support and a clear vision from top management towards technology adoption alleviates fears and fosters collaboration, while its absence is identified as one of the most significant barriers to technology adoption by Wu et al. (2021).

It is further evident in literature that human factors are influential in the diffusion of innovation as beliefs, perceptions, habits and old ways of working both at individual and team-level influences the decisions to adopt new ideas and innovations and how

these are received and adopted (Harty, 2008; Taylor, 2006). Taylor (2006) also highlighted the level of compatibility of new ways of working with current methods as important as big changes in processes and work activities poses a challenge to the adoption, which is further supported by Vass and Karrbom (2017) and Eriqat et al. (2023).

2.4.1 The Case of BIM Implementation

Building Information Modeling is the current state-of-the-art technology in the AEC sector and is considered to be the most transformative digital solution, and technology shift, introduced in the sector in the last decade (Zomer et al., 2021; Abioye, 2021). The technology has been central to driving industry change, contributing to increased digitization and enhancing the integration of various processes within the sector (Vass and Karrbom Gustavsson, 2017; Abioye, 2021). As a visualization tool, BIM stands out for its benefit of facilitating communication and collaboration among stakeholders by simulating representations of planned constructions (Mesáros et al., 2022; Manzoor et al., 2021). According to Noghabaei et al. (2020), the proportion of projects in AEC companies using BIM in 2021 has reached 90%. However, the implementation of BIM technology in the sector has been, and still remains, challenging (Abioye, 2021; Vass and Karrbom, 2017; Zomer et al., 2021). Challenges encountered are diverse and are according to Vass and Karrbom Gustavsson (2017) related to differences in, and lack of, competence and skills among workforce, the variety of roles, responsibilities and distribution of decision making power within the sector, as well as different attitudes and beliefs towards technology, cultural opposition and a shortage of demand regarding technology implementation from its clients. These challenges are not specific or unique to BIM implementation but are common challenges faced in the implementation of new technology in the sector, according to Dossick and Neff (2010). Thus, literature on the challenges and strategies associated with BIM implementation can be considered relevant for the implementation of AI as well.

A substantial proportion of the technology implementation has been found to occur at an operational level (Mäki and Kerosou, 2015). While this implementation approach has proven effective in engaging a wider range of project actors and in mitigating resistance to change, it has at the same time been found to be reliant on active involvement and support of a few top managers possessing in depth knowledge in BIM (Vass and Karrbom Gustavsson, 2017). Xu and Lu (2022) concluded a mismatch in the fit between human and technology in organizational BIM adoption and found that lack of competence among professionals in BIM in combination with difficulties in learning and handling the software led to the discouragement of BIM use and hence, only the most simple BIM functions were implemented. This resulted in the BIM adoption remaining slow and with a negative return on investment. According to Eriqat et al. (2024), the adoption of new technologies in the AEC industry is significantly challenged by the scarcity of essential knowledge and skills among professionals. Considering the industry's status as one of the least digitized, the requisite level of skill and knowledge might not be available and hence, not easily obtained. Various other researchers have also identified this expertise gap as a substantial barrier to technology adoption in the sector (Gamil and Rahman, 2019; Ahuja et al., 2020), further stressing the challenge of skills and competence related to technology implementation.

Moreover, the implementation of BIM has been largely dependent on project managers acting as early adopters as lack of implementation guidelines has caused

implementation to rely on the individual capacities and responsibilities of project managers to adapt BIM within their projects (Mäki and Kerosou, 2015). However, the dependency on project managers has suggested challenges in collaboration. As project groups are often organizationally isolated, this separation can cause the creation of 'silos,' where different groups work independently, leading to difficulties in achieving a unified implementation across the organization as a result of ineffective collaboration between these groups (Dossick and Neff, 2010).

Furthermore, Vass and Karrbom Gustavsson (2017) concluded that another challenge in BIM adoption lies in the conflicting expectations surrounding its implementation. The expectations are on one hand for the technology to align and integrate seamlessly with the existing and preferred ways of working, while there are at same time expectations on BIM to transform the industry's standard practices, which is also concluded in the research by Davies and Harty (2013), and a dichotomy that is further evident as Hartmann et al. (2012) found that contractors tend to favor BIM only when it complements their existing methods and ways of working. According to Vass and Karrbom Gustavsson (2017) this puts the task of fostering an environment that does not impede the implementation on project managers, aligning with previous research concluding project managers role as key actors in terms of change management within the sector (Lindgren, 2016; Mäki and Kerosou, 2015), who needs to provide motives that aligns with the user's expectations, which are often (unrealistic) expectations on the technology to result in the gain of immediate benefits. Moreover, the implementation is often impeded by the fact that individuals involved in projects may face conflicting priorities related to their specific roles, project demands, and organizational goals (Dossick and Neff, 2010).

Considering the importance for new technology to align with existing work practices, Hartmann et al. (2012) found that a technology pull strategy for BIM enhanced the implementation of the technology. This approach offered advantages to the more commonly applied technology push strategy which involves introducing new technologies to support and improve as many business processes as possible across the organization without consideration of current work practices, often lending to resistance from employees. The technology pull strategy on the other hand is rather focused on the possibilities to align technology with existing work practices. As BIM showed great possibilities to be configured and adapted to existing tools and work practices, this strategy proved successful as managers could align the technology without the need to implement great changes of processes and hence avoid many of the socially related issues as resistant to change compared to the technology push strategy. Resistance to change was recognized as the most critical barrier when adopting new technology by Demirkesen and Tezel (2021) and Chan et al. (2017), stressing the importance of a solid implementation strategy.

Moreover, the technology pull strategy reduces the risk of replacing current processes that are already efficient solely to accommodate new technology adoption (Hartmann et al., 2012). Difficulties in understanding the effects of changes in work processes that the implementation of new technology entails often tend to result in decreased productivity within the implementing organization (Brynjofsson, 1993). Therefore, according to Hartmann et al. (2012), implementation through technology pull has the potential to prevent this technology paradox.

2.5 Artificial Intelligence

The modern concept of AI emerged in the 1950s and originated from the groundbreaking contributions of Alan Turing who proposed that intelligent machines, when utilizing available information, could have the possibility to replicate the reasoning process of humans to make decisions and solve problems (Holzmann et al., 2022) and serve as a representation of cognitive human calculations rather than of pure mathematical calculi (Fridgeirsson, 2021).

Numerous definitions of AI have emerged over the years, yet none have gained universal acceptance across the foundational disciplines like mathematics and computer science, leaving a standardized definition of the technology yet to be defined. However, it is possible to establish a context-specific definition (Abbass, 2021). In this thesis, the authors have chosen the definition according to Schmidt et al. (2023) in the US National Security Commission on Artificial Intelligence, defining the concept as "*AI is the ability of a computer system to solve problems and perform tasks that would otherwise require human intelligence"* and the definition according to the English Oxford Living Dictionaries (n.d.), defining AI as *"the theory and development of computer systems able to perform tasks normally requiring human intelligence"*. According to these definitions, AI involves making machines think and behave like humans, enabling them to perform tasks that humans do and to adjust or interact with its surrounding environment. Hence, the above stated definitions are chosen as they align and fit well with the application of AI in project management.

AI systems vary in their degree of specialization and intelligence. Artificial Narrow Intelligence (ANI) also known as weak AI, refers to systems designed for specific tasks, and that are capable only of performing what they are designed for and focuses on excelling in a specific task within a limited context. Artificial General Intelligence (AGI) also known as strong AI, on the other hand, represents systems with the ability to understand, learn about and solve any type of problem and possess intelligence and self-awareness to a degree where they can outperform humans in various tasks (Deloitte, 2018; Holzmann, 2022; Taylor, 2021). The highest form of AI, Artificial Super Intelligence (ASI), refers to systems that will exceed the intelligence and capabilities of humans and are defined as systems with an intellect that will outperform the human mind across a variety of cognitive domains (Müller and Boström, 2016) and are expected to be the form of AI that will rapidly advance and overtake human capabilities in all fields, such as science, cognitive reasoning and social capabilities (Butt, 2018). However, as of today, the existing AI systems are by definition considered weak AI as they are designed to perform specific tasks and do not possess the broad, adaptable intelligence that characterizes strong AI which the current technology has not yet achieved (Bartneck et al., 2021; Taylor, 2021).

In order to fully comprehend how AI can enable and equip computers and machines with the capability to imitate human cognitive processes and perform different types of tasks, it is important to be familiar with the two fundamental concepts within AI; machine learning and deep learning (Sarker, 2021). These concepts represent two distinct, yet interconnected subsets of AI that provide the foundational mechanisms enabling machines and computers to process, analyze and act upon information in a manner similar to humans. AI and its subsets are shown in Figure 2 below and will be presented in the upcoming chapters.

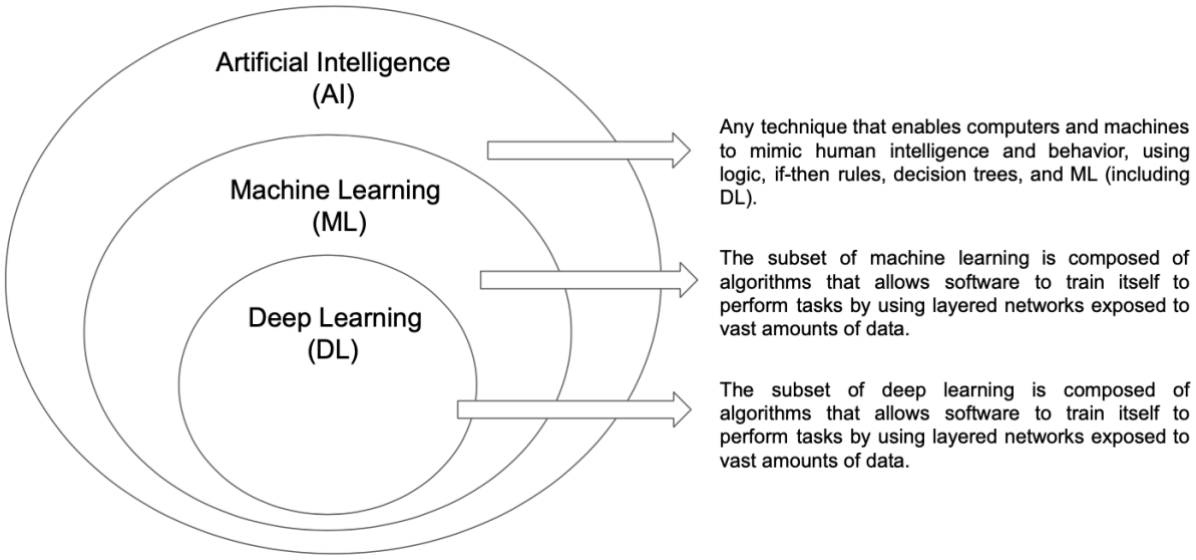

Figure 2: Elaboration on Sarker (2021) and Mateis (2018)

2.5.1 Machine Learning

Machine learning (ML) is an important subset of AI which is characterized by the ability of machines or systems to acquire knowledge and learn over time through the use of algorithms, making it associable with human intelligence as it aims to automating analytical model building to perform cognitive tasks (Helm et al., 2020; Janiesch et al., 2021; Agrawal et al., 2023). ML systems use algorithms to process extensive data sets and identify relationships, so called patterns, between the data to enable decision making and predictive capabilities, and these algorithms improve automatically as they gain experience (Janiesch et al., 2021; Taylor, 2021). Through repeated training cycles, the accuracy of these algorithms is enhanced to an extent where the machine or system is capable of taking input and generating outputs, so called predictions, based on the given data. The outputs are then compared against known outcomes to evaluate the algorithm's accuracy, which is then repeatedly refined and adjusted to improve its prediction capability (Helm et al., 2020).

Machine learning algorithms are generally categorized into three types: supervised, unsupervised, and reinforcement learning (Janiesch et al., 2021). Supervised learning uses a training dataset with examples that include both the input data and the correct output or answers, so called labels (Taylor, 2021; Janiesch et al., 2021). These labels are hence defined by humans and are pre included in the dataset. The model learns from these examples to understand how the input relates to the output. Once trained, it can predict the output for new input data. Supervised learning can predict numbers, known as regression, or categories, known as classification (Janiesch et al., 2021).
Unsupervised learning, on the other hand, involves the system finding patterns in the data without being given any predefined labels (Taylor, 2021; Janiesch et al., 2021). It only uses input data to discover how the data is structured or grouped, like identifying clusters of similar items or simplifying complex data into simpler forms, and hence this type of learning needs to find the relationship between inputs and provide the labels on its own (Janiesch et al., 2021).

The last, and not as widely mentioned type, reinforcement learning is a method where, instead of training with direct input-output pairs, the system learns by trial and error to achieve a specific goal (Taylor, 2021; Janiesch et al., 2021). This is done by setting up an environment in which the system will operate, defining a goal and listing allowable actions and their constraints in the environment against which the system then tries different actions, using the principle of trial and error, and learns from the results to maximize the reward. This method has worked well in games, as this is a closed world environment, but is also used in more complex settings like electronic markets (Janiesch et al., 2021).

The machine learning field has experienced rapid growth in recent years due to the vast and increasing data resources, increased computing power with decreasing prices, improved algorithms, and investments from both the public and private sectors. The expansion in machine learning has led to advancements across various areas in AI, and particularly deep learning, a subset of machine learning, has particularly benefited from increased data volumes and improved computing capacity (Nourbakhsh, 2022). However, for machine learning to work effectively, it primarily needs two things: a large quantity of training data and high-quality training data. If the data is of poor quality, the algorithm will learn from these inaccuracies and faults in the data, which will lead to suboptimal performance. Many machine learning algorithms do not achieve their intended results primarily because of poor or incorrect training data (Redman, 2018).

2.5.2 Deep Learning

Deep learning is a subset of ML (and hence, AI) that works with layers of neural networks, or deep neural networks, which are often described to operate in a way similar to the human brain (Casey, 2019; Taboada et al., 2023; Taylor, 2021). As illustrated in Figure 3 below, a neural network begins with various input features which then move through multiple layers and where each of these layers form connections to these features (Liu and Han, 2022; Casey, 2019). It is these layered structures that enable the neural network to organize and control the final output (Helm et al., 2020). The distinction between traditional machine learning and deep learning is that in machine learning, the algorithm analyzes a series of specific features that have been predefined, but in deep learning, the algorithm processes raw data and autonomously determines which features are important by itself (Casey, 2019).

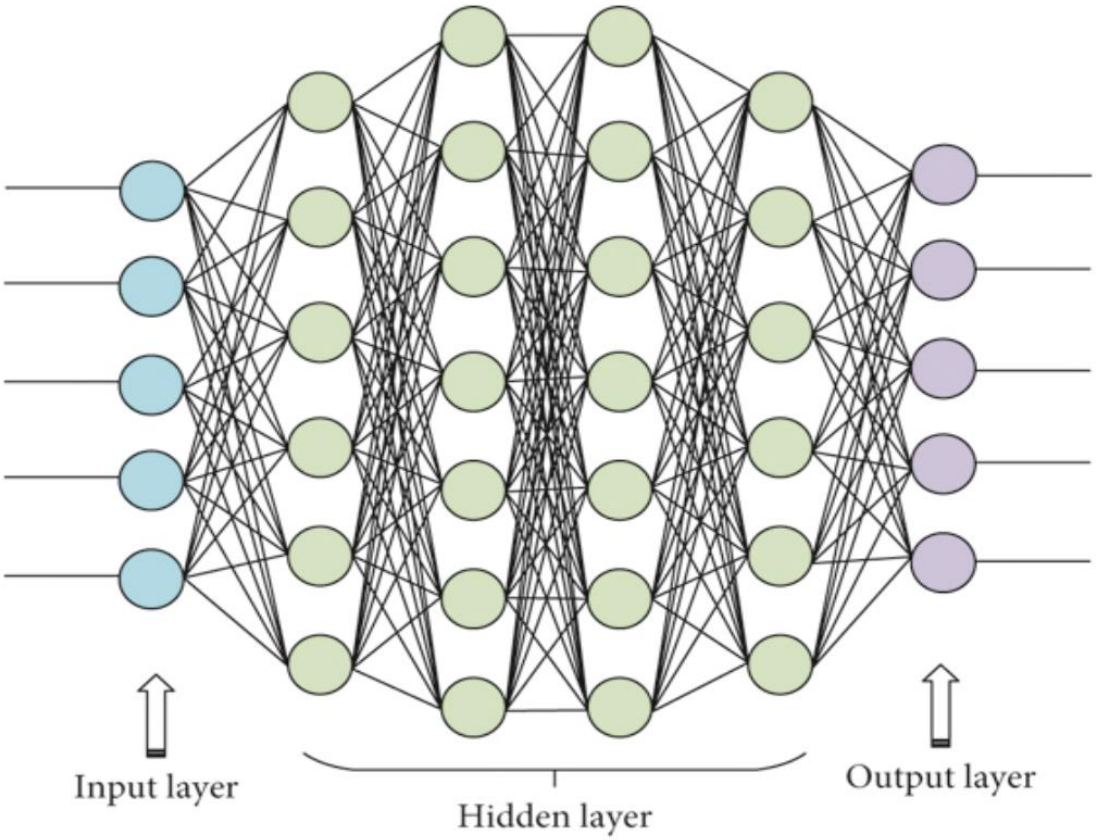

Figure 3: Composition of a neural network (Liu and Han, 2022)

2.6 AI in Project Management

There is a unified consensus among recent literature that AI is one of the major breakthroughs that will disrupt and change the discipline of project management and the role of the project manager (Taylor, 2021; Al-Sarraj and Al Najjar, 2018; Holzmann et al., 2022). Gartner (2018) states that AI will automate traditional project management tasks like data collection, tracking and reporting, which will result in an elimination of up to 80% of the current workload in the project management field by 2030. With this absorption of project management tasks by AI, the role of the project manager will shift from managers to leaders as most manual tasks will be replaced by the competencies of leadership, strategy and value creation (Taylor, 2021). Therefore, incorporating AI into new methods and processes will necessitate and facilitate a greater emphasis on project management tasks that require soft skills. This will lead to a shift towards higher value adding activities, ultimately resulting in a higher success rate for projects (Al-Sarraj and Al Najjar, 2018; Taylor, 2021). Taylor (2021) states that "*AI is the opportunity that will allow the truth that projects are about people to become a reality*".

Al-Sarraj and Al Najjar (2018) identify two main organizational advantages of applying AI in project management. Firstly, as mentioned above, the ability AI has to take over routine administrative tasks that project managers today dedicate most of their time to. This will enable a greater focus on higher valued activities for project managers which will lead to *cost reductions and improved efficiency,* which is further concluded by Skinner (2021). Secondly, organizations can benefit from the fundamental capabilities provided by AI and leverage it for predictive analysis, recommendations and support in risk management, which can provide the organization with *greater insights and actionable data to facilitate strategic decision making*. These benefits were further supported in the study "Global Survey on Artificial Intelligence Impact in Project Management 2020" conducted by PwC Romania and International Project Management Association (IPMA), concluding that the main drivers for AI adoption in project management were increased performance and productivity together with improved decision making (IPMA, 2021).

According to Gil Ruiz et al. (2021), the AI technology currently applicable to project management is primarily Artificial Narrow Intelligence (ANI), which is designed to solve specific problems. This is further supported by Taylor (2021) and Skinner (2021), who argues that machine learning, a subset of ANI, is the branch of AI that will most likely dominate AI applications in project management in the near future. By utilizing data from previous projects, machine learning can estimate various project parameters, such as time, resources, scheduling, budget, and risk. Hence, despite its promising capabilities, the current generation of AI, being narrow AI, cannot replace project managers but rather serve as a complement to existing systems and approaches, to enhance project monitoring and control (Gil Ruiz et al., 2021). However, given the continuous advancements in the technology, the combination of several AI technologies to assist project management in their work is expected to emerge, leading towards autonomous projects requiring minimal oversight from project managers (Taylor, 2021; Gil Ruiz et al., 2021). Al-Sarraj and Al Najjar (2018) lists the five key ways in which AI will transform project management in the near future in their report, which are illustrated in Figure 4.

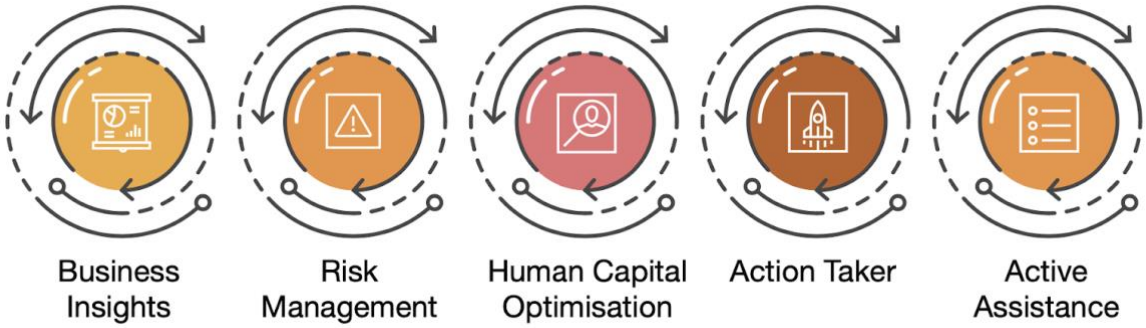

Figure 4: The five key ways AI will transform project management in the near future (Al-Sarraj and Al Najjar, 2018)

Auth et al. (2019) explored AI in Autonomous Project Management (APM) and presented an overview of different AI approaches and the current applications used to automate project management tasks and identified three main categories of AI development in project management: Data-Driven Project Management, AI Platforms for Project Management, and Project Management Chatbots.

1. Data Driven Project Management: The essence of data driven project management as an approach is the use of data to enhance decision making, and the more relevant data available, the more reliable decisions. It involves using data analysis and statistical methods to predict and improve project outcomes and has evolved from traditional techniques using mathematical-statistical approaches project monitoring and controlling to include predictive analytics, which integrates AI methodologies like machine learning, to support project managers in making decisions and forecast outcomes (Auth et al., 2019). The ability to predict outcomes and success of projects is one of the biggest promises AI holds in the field of PM (Taylor, 2021), and is expected to be the most disruptive innovation in project management in the coming years, leading to improved business insights, risk management and human capital optimization (Al-Sarraj and Al Najjar, 2018).

2. AI platforms for Project Management: In response to the demand for big data and advanced analytics required in data driven project management, cloud based AI platforms for project management have emerged. As the development of such platforms requires significant implementation effort for individual companies due to the complexity and resource intensity, both in financial terms and data management terms, required to integrate AI technologies, certain vendors have created cloud-based service platforms and made advanced AI capabilities more accessible and manageable for companies by reducing the need for the extensive in-house infrastructure and expertise otherwise required. These platforms offer functions as predictive analytics for project success and risk as well as functions for forming project teams based on data analysis of qualifications and work adaptability (Auth et al., 2019). According to Taylor (2021), integrating people data into predictive project analysis holds potential for identifying potential issues like overworking, stress, and the development of silos within a team as these factors pose a significant risk to project success, potentially even more so than extended timelines. Therefore, the integration of people data into project predictions will be a leap in terms of project success and

represents an important part of project management (Taylor, 2021) which is further supported by Al-Sarraj and Al Najjar (2018), listing human capital optimization as one of the key ways in which AI will transform project management.

3. Project Management Bots: Project Management Bots are intelligent software tools focused on assisting project management tasks, acting as "projects assistants". These can be standalone software for project management, built-in extensions in existing software, as for example chatbots in microsoft teams, or add-ons, but are all designed to automate and streamline project management processes (Auth et al., 2019). These bots are also listed by Al-Sarraj and Al Najjar (2018) as transformative in project management the coming years, providing active assistance and action taking. Taylor (2021) further points out chatbots as valuable assistants in project management as replacement for routine tasks such as for example organizing meetings, tracking progress, and emails and are an important application of AI in terms of communication within project management.

2.7 Organizational AI Readiness

For an organization to fully benefit from digital technologies, there must be a two-way adaptation process. It's not just about the organization adopting the technology, it must also be aligned with the organization's culture, structure, values, goals and processes (Holmström, 2022).

When it comes to adopting AI, the challenges increase further. The rapid and dynamic development of AI technology, lack of necessary infrastructure, misalignment between the people deciding to use AI and those who actually have to make it work, along with its diverse applications, often leads many organizations to struggle with effective implementation (Holmström, 2022; Jöhnk et al., 2020; Tehrani et al., 2024; Agrawal et al. 2023). Within the AEC sector, approximately 85% of data-intensive projects fail in their use of AI, primarily due to poor communication between those who decide on the use of AI and those who are tasked with implementing it. This lack of effective communication results in misunderstandings regarding what AI is intended to solve and what it is actually capable of solving (Agrawal et al., 2023).

To facilitate the adoption of AI, the concept of "AI-readiness" has gained increasing popularity. “AI-readiness” serves an important purpose as it introduces a new perspective on technology adoption, framing it as a process rather than just a one-time event, enabling the organization to identify and understand the reasons why it is struggling with adoption of AI (Uren and Edwards, 2023). Further elaborating on this, Polisetty et al. (2023) describes organizational AI-readiness as *“the ability of an organization to effectively adopt and utilize artificial intelligence (AI) technologies to improve its operations, decision-making processes, and overall performance”*. By assessing an organization's AI readiness, the likelihood of making thoughtful and informed decisions regarding the technology increases, thereby enhancing its potential impact (Jöhnk et al., 2020). Several AI-readiness frameworks are presented in the literature, aimed at assisting organizations in more effectively implementing AI-tools. Agrawal et al. (2023) constructed their LeanAI framework, which primarily focuses on identifying existing business needs and then determining if AI can indeed fulfill those requirements. Another framework for AI readiness is described by Jöhnk et al. (2020), where they categorize organizational AI readiness into five levels: Strategic *Alignment, Resources, Knowledge, Culture, and Data,* each including essential factors for successful implementation.

Strategic Alignment
AI-Business Potentials assess how suitable an organization is for adopting AI technologies, crucially involving the comparison of AI systems' advantages over other options across potential applications where AI could strategically offer the most benefits. *Customer AI-Readiness* concerns how well customers receive AI-based solutions. There's a risk that customers lacking sufficient knowledge or general acceptance of AI may be skeptical that such integrations can meet their needs. Due to AI's complexity and broad range of definitions, it might be challenging for customers to understand the technology's benefits. *Top Management Support* refers to the critical need for senior management to lead and fully commit to the adoption of AI. By demonstrating their strong commitment and belief in the role AI can play, this attitude will influence all levels of the organization. *AI-process fit* highlights the need for process standardization over individualized processes within an organization. Given that AI operates most effectively in environments that are standardized and

predictable, having well-defined and standardized processes is essential for the successful integration of AI. The last factor under Strategic Alignment is *Data-driven decision-making* which means that the organization's decision-making process should primarily be based on data analysis. Making decisions based on data not only improves the organization's performance but also aligns with enhanced AI readiness (Jöhnk et al., 2020).

Resources
Financial Budget concerns the resources available for investing in AI systems that are well-suited to the organization's needs. Adequate resources are necessary throughout the use of the technology and specifically important to overcome initial concerns about what an AI implementation can actually bring in terms of value. *Personnel* emphasizes the importance of having a diverse staff in terms of professions, with an advantage of having business analysts and AI specialists whose combined expertise can identify the best applications of AI to deliver the most value to the organization. Implementing AI also demands a robust *IT Infrastructure,* which needs to have sufficient capacity and storage space to handle the vast amount of data required for training the AI in order for it to provide accurate outcomes (Jöhnk et al., 2020).

Knowledge
The third category is *Knowledge*, where the factor *AI awareness* is developed by giving employees an insight into AI's cognitive functions. By cultivating AI awareness, employees are enabled to understand the numerous applications of AI, as well as its limitations, leading to adequate expectations. In addition, AI-awareness involves the acknowledgement of the importance of inputting high-quality data in order to achieve high-quality outcomes. *Upskilling* involves providing employees with a fundamental understanding of using AI, including statistics and data analysis, due to the shortage of AI specialists. This is necessary for the organization to fully benefit from the tools. The final factor of the category is *AI ethics*. There is a risk that the data output could be biased or unethical due to biased input. Therefore, measures must be implemented to minimize this risk and make the output as accurate as possible (Jöhnk et al., 2020).

Culture
The fourth category is *Culture,* where the first factor is *Innovativeness,* which concerns the attitude of the organization's employees towards innovation. It's crucial for the organization to comprise individuals who are proactive, innovative in their thinking, and willing to take sufficient risks with technology in general to ensure the AI implementation is as successful as possible. The second factor, *Collaborative Work,* deals with how different departments with varying expertise within the organization collaborate in cross-functional teams to prevent knowledge from being isolated in so-called "silos" and to allow for efficient knowledge transfer to maximize AI application. The third factor, *Change Management*, addresses how the organization can engage its employees positively towards transitioning to AI use without prejudices and fears that could hinder adoption. Fears might include the worry of losing one's job or that their work processes are complicated rather than facilitated (Jöhnk et al., 2020).

Data
The final category is *Data*, with the first factor being *Data Availability,* which demands that the available data be relevant and composed of various types of data to best train AI models for optimal outcomes. The type of data is crucial, it should ideally be structured data, such as data stored in tables, rather than unstructured data like images

or videos. The second factor, *Data Quality*, implies that the level of quality of the input data often correlates with the quality of the output data. The data should be processed and accurate, as this factor is also critical for training models to maximize their functionality. The third factor, *Data Accessibility*, means that employees need to easily access the necessary data to efficiently utilize AI. Management can simplify data accessibility, for instance, by centralizing all data in one location rather than having it dispersed and hard to access. The last factor is *Data Flow,* which concerns the process of moving data from its storage location to training the model with it. An efficient data flow also requires the data to be in the right format and quality for its intended use (Jöhnk et al., 2020).

3. Methodology

3.1 Research Purpose and Approach

This study adopts a qualitative case study methodology approach with an exploratory purpose to investigate project managers' perceptions and expectations of AI in project management within the AEC sector and the main challenges related to implementing new technologies and work methods. Yin (2008) describes an exploratory study as suitable when the study aims to explore situations where there is not a clear or a single set of answers, and Saunders et al. (2015) describes an exploratory study as suitable when the existing body of knowledge on a topic is limited, not well understood, or has not been systematically investigated. As the purpose of this thesis is to explore the expectations and perceptions of project managers, and as the concept of AI and the phenomenon of AI in project management within the AEC sector is still relatively under-researched and evolving, an exploratory approach can be motivated as suitable.

A qualitative case study methodology approach is suitable when a deep, contextual, and comprehensive understanding of a complex phenomenon within its real-life setting is required (Saunders et al., 2015; Baxter and Jack, 2008). Moreover, as this study relies on the perceptions of individuals experiencing the studied phenomenon it is framed within the interpretive paradigm (Shah and Corley, 2006) which according to Greener (2008) motivates the use of a qualitative method with semi- structured interviews to capture these perceptions. Given that the research questions in this study are inherently contextual and complex, relying on individual perceptions and expectations, and are formulated in a way that may not have clear answers, a qualitative approach can be regarded as suitable.

The research approach used in this thesis was abductive as it involved continuous review of data and theory. This approach is particularly useful for exploring the phenomenon under study and allows for identifying and explaining themes and patterns as they emerge (Saunders, et al., 2015). The choice of this approach was due to the problem formulation and theory not being established before starting the research. This approach suits situations where there is limited knowledge about the subject, making it difficult to create a hypothesis in advance (Saunders et al.,l 2015). Furthermore, according to Conaty (2021) this approach facilitates the reflection on theory and empirical data, enhancing the study's ability to capture the complexity of the research problem.

3.2 Research Design

The chosen design for this study is a case study methodology which according to Yin (2008) is an appropriate research design when "how" and "why" questions constitute the questions for the study and is a suitable strategy for gaining an in-depth understanding of a problem, facilitating a detailed exploration into what is happening and why. Furthermore, according to Saunders et al. (2015) a case study approach can provide insights that suggest possible actions and contribute to theory development and Yin (2008) states that the richness of the phenomena and its close connection to real-life contexts make the case study approach suitable. The study is a single case study, which is characterized by a focus on one person, group or event (Yin, 2008), and as this study focuses on project managers within one organization it is framed as a single case study. This single case study is set within the infrastructure & transport

department at a large and experienced consultancy firm in the AEC sector in Sweden, chosen for its industry experience and the complex nature of its project based operations. Hence, this setting provides a unique environment to explore how AI is perceived in project management practices and for capturing how the challenges associated with the implementation of technology is perceived in a real-world context. The unit of analysis is project managers of large infrastructure projects at the AEC firm.

3.3 Research Process

The research process in this study initially began with an exploratory pre-study to gain insights and get familiarized with the chosen field to support direction of the research and the formulation of the problem, the purpose of the study and initial research questions. The pre-study was conducted through a broad literature review together with unstructured interviews with different professions at the organization to get an holistic view of the theoretical field and the context of the case study in order to identify gaps in current literature where this study could make a contribution. This phase supported the arrival at the problem formulation and direction of the study and laid the foundation for the following main literature review. The literature review was the next step of the process where a more in depth review of relevant literature and theoretical fields was conducted which laid the foundation for the empirical study by serving as the basis for the interview guideline. The literature review is described further in the following section *3.4.1*. The literature review later continued in parallel with the empirical study, consisting of 12 semi-structured interviews, and the analysis as new insights gained during the interviews required a continuous revisit and refinement of the theory. The empirical study and the analysis is further described in following sections *3.4.2* and *3.5*.

3.4 Literature Review

The literature review was developed based on the findings from the pre-study and subsequently expanded to provide a more in-depth exploration of relevant topics. The primary focus areas included project management, organizational change, technology adoption, AI, and AI adoption, with a particular focus on the AEC sector. Literature specifically addressing AI in project management within the AEC sector was however found to be scarce, which indicated an opportunity for further research in this area.

The literature review formed the foundation for the interview study and influenced the direction of the research. Insights gained from the literature were used to develop the interview guide, ensuring that the interviews were grounded in existing research. The literature review also continued in parallel with the interview study, allowing for ongoing refinement and revision as new insights emerged. This iterative process ensured that the research was aligned with both academic and practical perspectives, and the literature served as the theoretical basis for the analysis and was used to cross-verify and validate the results against.

The primary databases used for the literature search included Web of Science, ScienceDirect, and Google Scholar. While Google Scholar is sometimes viewed with skepticism compared to the other two databases, it was utilized due to its broad coverage and accessibility, as it includes a wider range of sources. Additionally, the journal Construction Management and Economics was specifically consulted due to its relevance to the industry. The snowball method was employed to identify relevant

articles through the reference lists of already obtained papers, which was particularly useful for finding influential and widely cited studies within the field. Industry-specific reports and publications related to AI were also reviewed to gain practical insights and current trends which supported the development of a comprehensive understanding of AI's application in project management.

3.5 Data Collection

An advantageous aspect of conducting case study research lies in the ability to utilize multiple sources for data collection. According to Yin (2008), employing multiple data sources can lead to enhanced results by facilitating deeper insights and enabling triangulation. In this study, data collection comprised primary sources through semi-structured interviews. The data from the primary sources was analyzed in parallel with the literature review to triangulate the results (Carter et al., 2014), in order to enhance the understanding of the phenomena under investigation and reduce the risks of bias associated with relying solely on a single method. The methods used for data collection are described in the following sections.

3.5.1 Interviews

According to Blomkvist and Hallin (2014) interviews provide an opportunity to understand the reasoning and perceptions of individuals more deeply and is a widely used methodology in social sciences. As it enables the exploration and discovery of different insights and perspectives on a complex phenomena (Yin, 2009) it is a suitable method for this qualitative study of the interpretive paradigm (Greener, 2008).

Due to the exploratory nature of this study, the semi-structured methodology was chosen as the approach for the interviews. By following a pre-specified structure of themes the semi-structured approach allows greater flexibility (Blomkvist and Hallin, 2014). The interviews followed the order of the themes in the interview guide and the questions asked to the respondents followed the same concept throughout all interviews. The semi-structured approach led to different follow-up questions depending on the respondents answers which led to the interviews being able to reveal different nuances and aspects outside the interview guide through complementary discussions. The interview guide consisted of three major themes: Project management, Perceptions and expectations on AI, and Organizational change. Questions related to project management in the industry were crucial to gain a foundational understanding of this area, as it serves as the basis for comprehending the integration of AI into project management. Hence, this is included in the findings even though it is not directly related to the purpose and research questions of the study.

The selection of interview participants was made in consultation with the study's contact person from the organization. Key considerations in selecting the respondent group included ensuring diversity in gender, age, and years of experience in project management, to avoid a homogeneous sample. A total of 11 interviews were conducted with project managers, including one group interview with two project managers. This group interview was initiated based on the recommendation of the originally selected project manager, who suggested that a colleague with relevant experience and interest in digital solutions would provide valuable insights. Following the initial interviews, a final interview was conducted with an individual working with the development of data coordination and BIM, as well as AI initiatives within the organization. This interview

was deemed valuable for incorporating an additional perspective on organizational change and technology implementation, given this individual's direct involvement with these areas in their professional role.

A summary of the interviews, and the anonymization codes used in the results is presented in Table 1 below.

Table 1: The subjects interviewed

Code	Role	Date	Time
PM1	Project Manager	2024-04-15	58 min
PM2	Project Manager	2024-04-16	56 min
PM3	Project Manager	2024-04-17	1h 10 min
PM4	Project Manager	2024-04-24	1h
PM5	Project Manager	2024-05-07	57 min
PM6	Project Manager	2024-05-08	1h 5 min
PM7	Project Manager	2024-04-15	52 min
PM8	Project Manager	2024-04-19	42 min
PM9	Project Manager	2024-04-11	1h 2 min
PM10	Project Manager	2024-04-11	56 min
PM11 & PM12	Project Managers	2024-04-19	1h 2 min
TM	Technology Manager	2024-05-07	1h

3.6 Data Analysis

The data obtained from the interviews was systematically analyzed using a thematic analysis approach, as described by Saunders et al. (2015). This method is suitable for identifying themes within large and varied data sets and it provides a structured approach that generates rich descriptions. The recorded interviews were first transcribed using the transcription tool Klang AI. To ensure correct accuracy of the transcriptions they were reviewed afterwards while simultaneously listening to the recordings to correct any errors. This process allowed the researchers to familiarize themselves with the data and to gain an overall understanding of the content. Quotations representing initial recurring themes based on the interview guide were then marked. The three initial themes were project management, AI, organizational change and implementation of new working methods/technology.

Following this initial familiarization, the data was subjected to a thematic coding process. The thematic analysis guidelines provided by Saunders et al. (2015) were applied as follows:

1. Familiarizing with the data.
2. Coding the data.
3. Searching for themes.
4. Evaluating these themes against existing theory.

In the next steps following the initial familiarization, the marked quotations were carefully examined and noted with keywords that summarized the main points of the interviewees' experiences and perceptions. These keywords were then grouped into broader categories connected to the main themes, or codes, that reflected common ideas across the different interviews. These codes were further organized into overarching themes to highlight patterns and connections within the data. In order to ensure a comprehensive understanding, both researchers individually analyzed all the interviews. This individual analysis was followed by collaborative discussions to compare and refine the identified themes, leading to a cohesive and unified analysis ensuring a common interpretation of the analysis. This collaborative process helped mitigate individual biases and to enhance the reliability and credibility of the findings.

3.7 Research Quality

In this study, the researchers' involvement included designing the research framework, developing the research questions, and interpreting the findings. As each researcher contributed their unique perspectives, experiences, and biases, this has an influence on the study. According to Maxwell (2012), the researcher's influence is a critical aspect of qualitative research, impacting how data is collected, analyzed, and interpreted. The academic backgrounds and prior knowledge of the researchers has shaped the study. While previous research experience likely enhanced the study's quality, an initial lack of expertise in the specific subject area might have introduced some limitations that could weaken the quality of the research.

Interactions with interviewees and the interpretation of their responses were also shaped by the researchers' pre-existing understandings and biases regarding the subject matter. Morrow (2005) emphasizes the importance of reflexivity in qualitative research, which involves being aware of and critically examining one's own biases and how these might affect the research. By maintaining a reflexive approach throughout the research process, the researchers aimed to mitigate potential biases and improve the credibility of the findings. This was achieved through careful formulation of interview questions, ensuring they were objective and not influenced by the researchers' personal views to avoid leading the interviewees.

Several strategies were employed to ensure the quality and reliability of the research. Data source triangulation and researcher triangulation were used to gain a comprehensive understanding of the phenomenon and to cross-validate the findings. Involving both researchers in the data analysis process, at first independently and later jointly, helped mitigate individual biases and ensured a more balanced and thorough analysis, thereby enhancing the credibility and reliability of the results. According to Denzin (1978) and Baxter and Jack (2008), such triangulation strengthens the credibility and validity of qualitative research. Furthermore, feedback sessions with supervisors provided external review and input, further enhancing the quality of the research. Moreover, the thorough description of the research design, process and context facilitates the replication of the methodology, and interpretation of the level of transferability, for other researchers (Saunders et al., 2015).

However, the single-case study approach used in this research raises concerns about generalizability. Focusing on one specific case limits the ability to generalize the findings to other contexts as insights gained from one specific context only may not be applicable to other settings or situations, for example in other countries, which limits the wider relevance of the study. However, studying a single case in depth allows for detailed insights that broader studies might miss (Wikfeldt, 1993). While the results may not be widely applicable, they offer valuable, context-specific understanding that can benefit stakeholders involved in similar projects. This depth of analysis can reveal nuanced aspects of the research topic that are particularly relevant to the AEC sector and the adoption of AI in project management and organizational change.

3.8 Ethical Considerations

Adhering to ethical principles is important to ensure that the research is conducted responsibly and in an ethical manner in order to protect and respect the integrity of the participants. According to Saunders et al. (2015), key ethical principles include avoiding harm, protecting privacy, ensuring voluntary participation, obtaining informed consent, and maintaining confidentiality. These principles were applied towards all respondents throughout this study. It is further important to address the ethical responsibilities related to data analysis, data compliance, and the safety of researchers.

In advance of each interview, participants were informed about the research topic in question, their anticipated role in the research, and the intended use of the information they would provide and that their participation was entirely voluntary, anonymous, and could be withdrawn at any time. Informed consent was obtained from all participants before commencing the interviews, ensuring they were fully aware of the purpose of the study and their involvement. To protect privacy, all collected data has been anonymized before being presented. Confidentiality was maintained throughout the research process, ensuring that personal information was securely handled and not disclosed in any part of the report. These measures were applied in order to maintain trust and integrity of the research process, ensuring participants felt safe and respected.

4. Empirical Analysis

This chapter outlines the empirical analysis by presenting the findings from the interviews in relation to theory. Our data collection and analysis reveals three key areas: Project Management in the AEC Sector, AI in Project Management and Organizational Change and Technology Adoption.

4.1 Project Management in the AEC Sector

4.1.1 The Role of the Project Manager

The findings from the interviews indicate that the role of the project manager in major infrastructure projects is primarily defined by their responsibility to ensure successful delivery of the client's project. The main task of the project manager is to act as the highest authority responsible for coordinating and delivering the project according to the client's stipulated requirements and expectations, which aligns with PMI's (2024) description of the primary role of a project manager.

My primary responsibility and role is to ensure that we deliver the client's project. - PM10

As the project manager, I bear the ultimate responsibility for the contract with the client and towards my organization. It's my responsibility that we deliver and profit from it. - PM3

The project manager's role is central to maintaining the cohesion of the project and directing project activities. Forecasting and risk management are ongoing responsibilities for project managers, which include the identification and strategic planning of potential risks to the project's timelines, budgets, and resources. Planning for various scenarios and proactive risk assessment are highlighted as essential for anticipating challenges and ensuring the project stays aligned with its objectives. This also involves a significant focus on continuous monitoring within the project to ensure that strategies and plans are executed as intended and modifications are made in response to emerging challenges.

There's a significant amount of strategic work involved. We develop strategies to manage the task... This might include various scenario plannings where we develop multiple solutions simultaneously to save time ultimately. - PM9

A large part of the job involves forecasting... Lots of risk management and strategic work to advance the project planning... Ensuring we have the right, and sufficient, resources in the project. - PM10

Then comes the follow-up. It's one of the most crucial parts for me. Just because we devise a strategy and decide to proceed in a certain way, if you don't monitor what people are doing, you won't know what's actually happening. Being able to think strategically and proactively requires that I do these follow-ups. It's a significant part

of my job, and I spend a lot of time coaching others in this because it's so critical. - PM9

Communication is a recurring theme in the role and responsibilities of a project manager, including both internal communication within the project and external communication with the client to ensure that both ongoing and final project outcomes meet the client's expectations. Effective communication strategies are described as essential both internally and towards the client. Ensuring that all project members are kept informed and that the client is continuously updated on the project's progress helps prevent misunderstandings that could potentially lead to deviations from the project's objectives. This statement is underscored by Tatli et al. (2023) describing that poor communication management may lead to misunderstandings, thereby increasing the risk of negative outcomes for the project.

It's a lot about communication. Getting people to talk to one another. Nearly all problems in a project stem from some failure in communication. That's why it's important for me to ensure that we have the necessary channels of communication and information to facilitate and capture these aspects. - PM3

Communication I must say is essential for success in keeping everything together... Maintaining dialogue with the client to ensure their satisfaction, as well as ongoing discussions with all technical areas in the project. It's about constantly ensuring everything is on track and maintaining cohesion in the project, both internally and externally. - PM2

Coordination and integration among various disciplines within the project are further described by project managers as an area of responsibility for the project manager. This is to ensure a shared comprehensive understanding of the project and its objectives across different disciplines and groups within the project, to prevent various groups from acting in isolation based on their individual roles. Anchoring this overall understanding is described as highly important for the progress and outcomes of the project.

It's about having a comprehensive grasp. We need everyone to see the big picture... Each discipline might think, you know, without a tunnel, there's no subway, but without the track, it's just a tunnel. But nothing works unless we work together, and we must make sure everyone understands this. We need everyone to consider their work as part of the whole. It's not just about these individual packets. There's a lot of coordination and planning involved. - PM1

To achieve a shared understanding among all parts within the project, a significant aspect of the project manager's role involves coaching project members and building a strong project and work culture to promote collaboration and efficiency. Consequently, the importance of leadership and the ability to motivate and support the team, which may consist of several hundred employees, emerges as central.

To be honest, a lot of my job is about fostering a positive culture. Creating a supportive culture in our projects. - PM1

A considerable part of my role is coaching. I'm constantly coaching to foster a good project culture and to provide continuous support to the team. - PM9

And then leadership. Much of my work involves understanding people... It's my responsibility to ensure that those working with me are well and capable of handling their tasks. - PM2

The results indicate that the scale and complexity of the large infrastructure managed by the interviewed project managers cause a shift in the project manager's role from a more administrative and detail-oriented work to a more holistic role with the ability to see and manage the broad perspective necessary to handle the overarching responsibility of the role. This includes a significant responsibility and focus on leading and promoting cooperation and efficiency in large teams, managing stakeholder relationships, and ensuring that the project achieves its long-term goals and is profitable for the organization.

4.1.2 Project Management Challenges

A recurring theme for project managers is the challenge of managing people in a project.

I would still like to say that the biggest challenge is always the people in some way. It's always the people who make it successful. But it's also always the people who can cause problems. - PM9

Successfully coordinating all aspects of a project within the team and ultimately delivering results that meet customer expectations is presented as a great challenge. To succeed, project managers must maintain a comprehensive perspective and ensure that every component of the project harmonizes with others, despite individual team members' specific responsibilities. This task presents challenges in engaging all participants, both internal and external stakeholders, to understand and negotiate common objectives rather than focusing solely on their separate tasks. As a project manager, aligning all stakeholders and uniting them around a shared vision can be challenging, given that people often have differing perceptions and priorities.
Furthermore, the project leaders state that the size of the project leads to more variables to consider, and managing the complexity is posing a challenge. This is also noted by Kumar et al. (2024), who argue that large-scale AEC projects are difficult to manage due to extensive technical complexities and the numerous stakeholders that must be considered, often over a long period of time.

It's classic that there are ten people sitting in a meeting, and when you walk out of the meeting room, you end up with ten different interpretations of what was said in there. Because we are humans... I need to make sure we have a common understanding in the team. - PM9

It's the scale. There are many variables involved. And the challenge in almost all of these projects is managing the interfaces. The water engineer focuses on their part, and the bridge engineer on theirs. But I need to ensure that everything integrates smoothly. - PM6

We work with people. And, as I said, we have maybe 40-50 different items to follow up on in these projects. And we have at least 20-30 responsible forecast owners... I

need to get them to work in the same way. Or I need to understand how they think. And I have to guide them to think in the right way. They need to see beyond two months, they need to see the full two years ahead. - PM8

Project managers moreover describe a pitfall with clients who tend to push projects forward without recognizing the importance of thorough planning in the initial phase. A significant emphasis should be placed on planning during this phase because small initial mistakes can lead to larger quality issues, time overruns, and increased costs later in the project. Well-thought-out planning eases the management of resource allocation and budget overruns, which are highlighted as challenges in project management. Regarding resource allocation, assigning resources that meet the client's needs can often be problematic. For instance, allocating personnel may require several attempts to find suitable candidates that satisfy the client. This becomes even more complicated when the client's demands for experience and qualifications are not clearly specified in the early stages.

The other thing that I think has a significant impact on costs is the need to take time at the beginning of a project to plan and try to have a good plan. It usually backfires because then you end up having to redo everything. - PM9

In the latest assignment that I have been involved in the startup phase, human resources are a major challenge. Because sometimes when you get the resource and send it on to the client, it is not approved. - PM7

Additional challenges that project managers must handle also involve the softer values, once again putting emphasis on the human aspect. This means that the project manager not only manages project-specific tasks but also engages in the well-being and workload of the staff by communicating with individual employees and their managers to adjust their involvement and workload as needed. Moreover, a positive organizational culture and culture within the project are crucial success factors for the project. This perspective is supported by Jöhnk et al. (2020), who describe organizational culture as essential for innovation. It's important that there's a culture in the project where everyone feels safe to raise concerns if they notice or anticipate deviations, which in turn leads to a reduction in future errors.

That there is a culture in the project where people feel that they can raise issues so that things aren't discovered too late. That some questions are missed or that a technical solution falls through the cracks because a collective responsibility wasn't taken to address the issues and matters that arise. - PM3

4.2 AI in Project Management

4.2.1 Perceptions and Attitudes Towards AI

The results of the interviews reveal a generally positive attitude towards AI among project managers. All respondents expressed optimism regarding the potential of AI to streamline and automate work processes, as well as to improve quality.

I am positive about anything that can simplify and eliminate boring tasks. - PM10

My perception of it [AI] is that there are tremendous opportunities... It's very exciting. - PM3

If we can eliminate repetitive tasks that don't add much value, that would be beneficial. I also believe AI will enhance the quality of these tasks. - PM9

I have a strong drive to do things faster, more efficiently, and with high quality at the same time... So I look forward to the development of AI and when it really takes off with us. - PM11

All project managers demonstrated a fundamental understanding of what the technology entails and the principles behind it. Although all project managers have experimented with the organization's internal GPT model, none have significantly integrated it into their daily work routines.

I understand what it's about and I'm familiar with the concept, but I'm not deeply involved. I know I've tried our GPT model a few times, but I don't use it often. So, I haven't really seen or experienced the major benefits. I've used it to summarize long email chains a few times... It can do impressive things, but I haven't felt comfortable using it extensively in my projects. - PM2

I don't know enough about it. I understand the principles behind it, but I'm not an expert... However, I think it's fascinating. You can definitely see the potential... I tested our GPT model, but that was mostly when it first came out. - PM5

There is a noted variability in the depth of understanding and engagement with the technology among different project managers, which is influencing their specific attitudes and expectations for AI use in their projects. This variation is particularly evident across different age groups, with less pronounced engagement and visions observed among older project managers compared to their younger counterparts. The older project managers argue that, although AI is likely to have a significant impact on the industry, it is not their responsibility to take the lead for an implementation and increased usage. Instead, this is expected to be driven by the younger generation and by more tech-oriented roles within the organization. This highlights a disparity in technical comfort and adaptability among different generations within the professional group.

I know what AI is, but I'm not particularly well-versed in it. It's partly a generational issue I think, as I'm a bit older in the game... I'm not the first to embrace new

technologies. However, I ensure that I have people around me who are proficient with digital tools... The younger generation will drive the adoption of AI. - PM9

It's more in line with the younger generation, so to speak. They are the ones who eagerly embrace the latest technologies. - PM8

Among two project managers working on a project where the use of automated financial management, scheduling and time planning is significantly more extensive than typical projects, a notably positive view of AI's future potential is observed. These managers have witnessed clear benefits from current automation and emphasize AI as a crucial element in the future development of project management practices, seeing potential to increase efficiency and reduce errors caused by human factors.

Since we're working on a very large project, we've received funding to automate significant parts of our scheduling and financial management... This has made all the information much easier to process and has helped us tremendously. We've ensured quality and reduced the impact of human error. So now, when we talk about AI truly arriving and being able to develop this even further, everyone thinks it's incredibly positive. - PM1

Despite the overall positive attitude towards AI among all project managers, one manager noted an increased concern among project members about the implications of automation and AI for their job security. Some tasks have already been replaced by automation, indicating that the issue of social implications of automation related to job security has been observed in certain projects.

This past year, there has almost been a wave of concern, like, should we be doing this? When will I no longer have a job? I almost feel like there's some resistance. - PM1

However, project managers do not perceive AI as a threat to their roles. Although AI might replace a significant portion of work in projects, their roles, which involve overarching responsibility for the projects, will remain central.

The human element will always be a significant part of the project... The interaction, understanding everything between the lines in a project... managing people... won't be replaced by AI. That's where my role is central. - PM2

4.2.2 Expected AI Use Cases and Impact

One of the project managers emphasizes that despite advancements in automation and AI, human elements remain crucial. The value-creating aspect of the project management role, particularly in communication, strategic decision-making and managing people is perceived as irreplaceable, something that is considered beyond the current capabilities of AI today.

You can certainly use AI for that in the future, but it's not something we have seen now. However, what is value-creating will still involve people in some way, in my opinion, for a very long time. A lot of effort is put in by project managers, design managers, project directors, or anyone in a leading project management position, focusing on communicating, getting the right things done, thinking ahead, and helping to make strategic decisions. - PM1

However, there is a consensus among the project managers that AI has the potential now and within the next few years to work as a supporting tool, automate repetitive tasks, and workflows. According to Al-Sarraj and Al Najjar (2018) and Taylor (2021) this will lead to project managers having more time to devote to higher value adding activities. Such as allowing project managers to put more focus on "soft" values such as informal information, unofficial dialogues, follow up and coordination which are critical for the success of projects and relating to the most important aspects of the project management role; The human aspect and managing people. This aligns with Liikamaa's (2015) assertion that project managers must have the ability to capture relevant 'silent knowledge' within the project.

And then it would become even more about these softer values, the unofficial information that can be handled differently and where more effort should be placed… The time to be able to read between the lines. It's about gathering informal information to build a probable reality for one or two years ahead, among all the stakeholders. Getting a sense of that… It's about getting something meaningful out of the dialogues you have. - PM1

More planning and management. Essentially, you become more time-efficient. But I should say that it allows you to spend your time on more value-creating activities. Simply put, it's about people and involvement in many of our roles. Again, a lot of what we ultimately fail at in our projects is synchronization and coordination. That's where it often fails. You can spend even more energy on making that part run smoothly [the interaction between people]. - PM6

Project managers identified several potential applications for AI in enhancing various aspects of project management. One area is the automation of administrative tasks with the help of AI, particularly the generation and controlling of monthly reports to the customer. The potential for AI to compile contributions from multiple writers, including forecasts, deviation reports, and work dairies to save time and enhance the quality and accuracy of these reports by eliminating the human factor and subjectivity is highlighted. Other administrative tasks mentioned among several respondents are meeting administration as notes and summaries, generating project descriptions and automating time reporting. These areas have also been identified by Gartner (2018) as

potential areas where AI is expected to reduce workload in project management in the future.

For me, the administrative work involves searching through the documents we have produced during the month to create our monthly reports. It is very much about gathering information from various sources. Using AI to collect and compile these things for the monthly report would save a lot of time. I also think it would improve the quality, reducing the risk of things falling through the cracks due to missed details. - PM10

Forecasting and risk management are other areas where project managers see the potential of AI. The respondents emphasize AI's role in improving forecasting accuracy by analyzing current progress and future projections among different areas in the projects where AI can help the project manager to predict risks and enhance overall project planning. Consistent reporting from various technical disciplines however poses a significant challenge today. Project managers describe a struggle with resistance from these disciplines, as providing forecasts entails additional administrative work. One project manager has spent many years developing a comprehensive forecasting template, which has become a key success factor in his project. However, it is stated that it was extremely difficult and time-consuming to get all technical areas to report in accordance with it. Even with the application of AI to enhance forecasting, it is essential that people first and foremost provide the necessary information. Project managers believe this requires simpler, more user-friendly tools that are not perceived as complicated or time-consuming, encouraging greater willingness to contribute, but at the same time it necessitates a systematic effort from project managers to engage and persuade team members, working consistently and methodically to ensure everyone is on board and committed to the process.

I would like to have better tools to produce reliable forecasts. Based on the team's efforts, I want to make more accurate assessments of the project's status so I can provide better forecasts to the client. However, it's also a struggle to get people to report their status. If we could find a tool that people feel comfortable using for frequent forecast updates—an easier system where they can provide more detailed information without it taking too much time—I think we could connect it to our GPT model. - PM4

I think it would be great if we could use AI for forecasting. We aren't very good at forecasting today... But that's because it's so difficult to get all the technical areas to submit their forecasts. - PM9

Forecasting, that's what I think. Analyzing our current status... How the progress looks across all areas. What the future outlook is. Also, risk management, to be able to predict what the upcoming risks are. - PM10

For example, I have created a forecasting file that I require my technical managers to use. They think I am mean for giving them so much administrative work... Yet, it's one of our success factors that we actually work this way. Would they do it voluntarily every month? No. We send out emails, call meetings, and follow up with them. So, it's systematic work... Systematic implementation, systematic collaborative efforts where we get people to see the benefits. - PM11

Verification and controlling of deliverables and documents against requirements is another area where AI could be applied. Verifying project deliverables against client databases is currently a labor intensive task that AI could streamline, ensuring compliance, quality and reducing administrative workload. This application could leverage existing textual documents to automate the review process.

Using AI to verify our deliverables against all the requirements… There can be 800 requirements for different technical areas. Being able to use AI to verify our database against the client's and generate this verification… And it's just an administrative task, this verification. It doesn't give us anything. I don't even know what it gives the client… It's incredibly tedious and takes a lot of time. - PM10

I think about cross-reviewing. When it comes to self-inspection and quality assurance, the quality assurance should really always be done against a governing document. You could use AI to review it against this governing document… Review it against large amounts of data… I believe you could gain significant efficiency from that. It's work that isn't particularly enjoyable. It doesn't really drive things forward [create value]. - PM12

AI could also improve information accessibility and knowledge transfer within projects. Project managers envisions AI breaking down information barriers, making project data and related information easily searchable and accessible to all team members, thereby saving time and enhancing collective understanding. They see the potential of AI aiding in quicker information retrieval and learning from previous similar projects and also speeding up onboarding processes for new project members which could enable bringing in individuals to assist with specific tasks in projects that have increased resource requirements for shorter periods of time.

Being able to search for how to start a project or a task, and then getting a step-by-step guide. Using it in this way, instead of calling a colleague to ask how to do something. Having a bit more experience transfer available. Being able to search for challenges and see other projects that have faced similar problems. Seeing how they handled it and how they succeeded would be very helpful. - PM7

If it were possible to quickly get people up to speed on what they need to do [when you only need a resource for a short period]. How do you make the onboarding process super smooth, so it's crystal clear what they need to do? You're going to work 15 hours on this project. This is exactly what you need to do. If they have questions, they can ask AI, which should answer their questions. They shouldn't need to bother any project manager or technical manager. - PM5

Another aspect of accessible information that is mentioned is locating and getting access to specific expertise within the organization.

If I want to know about or find someone who knows about timber bridges, AI could help me search through everyone who has written something about timber bridges and suggest people to contact. Instead of relying on people remembering to note that they are skilled in timber bridges, which makes it hard to find them. Right now, it involves a lot of untangling and calling around to find knowledgeable people. - PM5

Al-Sarraj and Al Najjar (2018) and Taylor (2021) emphasizes human capital optimization as an application for AI in project management, and AI's potential in optimizing resource allocation is also highlighted by project managers. One respondent discusses using AI to identify and allocate the right resources more efficiently and optimize the utilization of human capital in the organization. This could involve AI helping to match project needs with available expertise or employees currently not fully staffed, smoothing out workload distribution, and increasing overall productivity and debit rate. Human capital optimization is

It would be convenient if I could say, next week I need 28 hours of this type of resource and 14 hours of that type. If it were possible to quickly get people up to speed on what they need to do [with the help of AI]... And for me to find these people [with the help of AI]... Deliver those hours in that project and then move on from that project. This would allow us to balance the workload and still ensure project delivery. It might also make it easier to fill in one's own time when there's a lull. Often, people aren't fully booked every week. This way, they could help out 15 hours in one project and 10 hours in another without needing a client interview. It would be great if it were easier to supplement various projects with specific contributions when extra resources are needed, optimizing human capital. This would likely also increase the billing rate. - PM5

The aspect of language processing and removing language barriers is further noted and project managers suggest that AI will significantly facilitate international collaboration with offshore employees. This potential has already been observed, as international resources have successfully generated accurate project plans and descriptions using the firm's GPT. This experience demonstrates how AI has broken down language barriers in an organization where Swedish is the working language, and project managers believe it will further enhance cooperation with offshore teams in the future.

And he works with AI tools. We feed a lot of Swedish documents and materials into the system, and he puts together our project plans, design descriptions, and so on based on these. I believe that AI can really enhance how we handle language within projects as well. It can break down language barriers. - PM6

Finally, one specific application area for AI mentioned by several respondents, specific for their organization, and described by one as "*the low-hanging fruit for us*" is the application of AI in the development of system documentation and railway plans within railway projects. These processes currently take a substantial amount of time, often several months, as they involve determining the geographical positioning of the railway based on a large set of different parameters. This requires the involvement and assessment of various technical disciplines before a finalized document can be produced.

I believe AI has great potential when it comes to system documentation and railway plans. It's clear that we gather an incredible amount of data from all technical areas... Having an AI that can handle all these parameters simultaneously and find the optimal route... So, in all types of early-stage investigations, I think this is the low-hanging fruit for us [in terms of AI]. - PM4

The current approach is time-consuming and resource-intensive, as it necessitates continuous assessments based on a large number of parameters. The lack of

collaboration among the different technical areas often leads to numerous revisions during the process due to emerging changes. Several project managers see AI as a potential solution to this challenge. They believe that AI could assist in creating system documentation and railway plans by analyzing and evaluating all these parameters against predefined requirements. In this way, AI could assist in arriving at the optimal solution for system documentation and railway planning, by considering all relevant parameters. This would mean that AI could handle the "heavy lifting," allowing project members to focus more on the qualitative review and fine-tuning of the solutions. As a result, significant time savings could be achieved while ensuring the quality and accuracy of the final output, and resulting in higher efficiency through predictive analysis which is stated as one major impact potential with AI according to Al-Sarraj and Al Najjar (2018) and Skinner (2021).

But if you use AI to develop a proposal [for system documentation and railway plans] based on all the requirements and parameters... then you have something to start with. You can focus on fine-tuning it instead of starting from scratch every time a detail is missed or different technical areas haven't been coordinated... Eliminate the human factor and everyone's personal opinions from the process. You know, all the technicians think their areas are the most important... AI would provide a more objective assessment: This is the optimal solution. - PM5

In summary, project managers see AI as a tool that can enhance efficiency, accuracy, and quality in various aspects of project management. By automating routine tasks, improving forecasting and risk management, making information more accessible, providing optimization analyses and optimizing resource allocation, AI could significantly contribute to the effectiveness of project workflows, which further aligns with the conclusions of Al-Sarraj and Al Najjar (2018) and Skinner (2021) regarding the impact of AI in project management. The respondents discuss how increased automation and the use of AI could potentially transform the organization's business model in the long run towards a more service-based model, which according findings of Olsson et al. (2021) promote innovation in the sector. However, initially, with reduced hours needed for certain tasks, the organization could handle more projects simultaneously, thereby expanding its customer base and increasing business volume. This shift might also lead to a move towards winning a larger amount of fixed-price contracts, as the organization can more accurately predict costs and labor due to efficiencies gained through AI and leave competitive prices as man-hours can be replaced.

So, automation gives us a competitive advantage. We can complete our tasks more efficiently because of our automation processes. For fixed-price projects, we can offer lower prices, win more contracts, and achieve higher margins. For variable-price projects, we can provide smarter, more efficient solutions and win more contracts. - PM4

We are a knowledge-based organization that sells our hours at the lowest hourly rate. That's not a good combination. We need to shift to selling expertise, providing competence as a service. Ultimately, I believe automation and AI can help us get there. - PM11

The potential higher profit margins from fixed-prices through automation and AI may provide stronger incentives for the organization to further focus on the development

and streamlining of its services. This would, as a result, allow staff to concentrate more on knowledge-intensive and quality assurance activities as time consuming and repetitive tasks were replaced by AI.

4.2.3 Risks of AI

The main concern related to AI expressed by project managers is the risk of incorrect or misleading answers, especially when interpreting and applying specific technical terms or concepts that have varying meanings depending on the context. Despite these concerns, there is a prevailing belief that errors due to human factors are more frequent than those made by AI. There is also worry about over-reliance on AI's responses without critical review, which could lead to misunderstandings and the spread of inaccurate information to clients or other stakeholders. This belief is partly motivated by the societal tendency to undervalue critical thinking, particularly regarding information obtained digitally. The managers emphasize the importance of verifying AI-generated information with other sources to ensure its relevance and accuracy. They also stress the need to account for how conclusions are reached and to continually monitor and check the parameters that AI uses to ensure its reliability over time. This is in line with the findings of Jöhnk et al. (2020), who argue that incorrect or misleading answers from AI can stem from biased input, or bad quality data, necessitating careful and thorough verification processes.

Yes, what has it done, how did the AI come to its conclusions? You will always need to be accountable for that. Even if you report to another unit, when you're asked, 'How did you come to this conclusion?' you need to be able to explain it. - PM1

No, it's more about the general human risk. I think it affects our trust in truth. There's a risk of developing an overreliance on what the AI generates without thinking critically. - PM6

But there's a lot of talk about building up sources of error. That's obviously a risk, and I'd say it's the biggest risk. But I still believe that the human eye is more prone to error when it comes to what we do. - PM4

Another potential concern raised in the context of AI integration is the impact on skill development. If AI takes over the fundamental tasks and employees transition to more supervisory roles, there is a question of how individuals will learn the basic components of the work. Without a solid understanding of these foundational aspects, it may become challenging for employees to effectively oversee and evaluate the outputs generated by AI.

Yes, you still need expertise and knowledge for the analysis and final conclusions. One of the problems is skill development. Today, you often build competence by working with the basics behind the data. How will you achieve that if everything is AI-driven? How will you be able to review things in the long term without fundamental knowledge? - PM6

Additionally, one project manager points out risks that come with the gap between those who manage the AI process and those who input data. He stresses that the people

entering the data heavily influence the results, highlighting the need for tight control. He also warns against outsourcing these tasks to low-cost countries, as it could lead to a lack of oversight over what's entered into the AI and how it's processed. To prevent these issues, he suggests keeping a close watch on the AI's management.

If you take it a step further, I think it could mean that we end up using cheap hours in India, which also controls automation or AI. That could be dangerous because the control becomes too distant. If we aim to make it extremely cheap and use low-cost resources to feed parameters into the AI, the risk is that you lose track of what is being input, and you get an output that you don't fully understand and don't know what it's based on. - PM11

Furthermore, another project manager identifies the risk of information leakage if the servers are not secure, which is a concern with increased digitalization, especially when AI is involved, as it may be harder to control. He believes it is crucial to carefully consider and investigate how to manage this risk to prevent the disclosure of trade secrets, sensitive infrastructure information, and other confidential data to the public.

The risk exists if we don't have secure servers and our internal information leaks out. We need to carefully consider this risk and how to address it. - PM7

In addition to the risks previously mentioned regarding automating work tasks, another project manager believes that tasks may become overly simplistic, potentially affecting worker well-being. While AI has the potential to eliminate tedious tasks, there is also a risk that more engaging tasks might disappear. This could lead to higher staff turnover, as employees might not feel fulfilled in their roles. Workers might come to rely heavily on AI to handle the bulk of their work, reducing their role to merely overseeing, reviewing, and verifying that outputs are correct. This shift could lead to contentment and increase the likelihood of errors being overlooked.

But if I still have to sit and monitor it, if I still have to hold the steering wheel and be ready for something to happen, it becomes quite tedious. So, that's a risk. As a designer, having to sit and oversee what the AI is doing instead of designing myself. - PM5

4.3 Organizational Change and Technology Adoption

4.3.1 Drivers for Organizational Change and Technology Adoption

Project managers state that a key driver for organizational change and technology implementation is the streamlining of work processes, arguing that an organization cannot compete in the market if it is not efficient and not capable of creating added value to customers. An organization must develop and adapt to new technologies and tools to remain competitive. This is further reinforced by a statement by pointing out that one of the motivations behind driving automation and adoption of AI is to meet their business needs to become more competitive in fixed-price contracts. Successfully completing fixed-price contracts more quickly and cost-effectively can lead to more assignments and greater gains in projects, as the organization can offer lower prices to customers.

If you're not efficient, you don't exist. So, you constantly have to work on making our workflows more efficient. Otherwise, we will be outcompeted. It's incredibly short-sighted to avoid thinking about automation or efficiency just because we might lose billable hours. - PM6

The business need, I would say, is that we need to become more competitive in fixed-price projects. If we can automate and reduce the number of hours, we will have a greater competitive edge because we can offer lower prices on our fixed-price projects. It's a race... Everyone is working on this [Automation/AI]. If we don't participate, we are guaranteed to lose... No, we need to get so good that we win more contracts. So that we can get more hours, grow, and hire more people. Because we cracked the code. So far, we haven't. And we don't know where our competitors stand. You get a pretty good benchmark in fixed-price evaluations. And recently, our competitors were 60% below our price in the latest evaluation. They are a much smaller organization, but they win a lot of fixed-price projects. Then you start wondering, have they figured it out? What are they doing differently? - PM4

Additionally, the technology manager emphasizes the potential of AI in business development. He emphasizes how AI can be used to create new business opportunities and improve existing offerings by leveraging data and sees AI as a tool to enhance processes, increase efficiency, and develop new services and products. This perspective highlights the possibility of AI not only in enhancing operational efficiency but also in driving innovation and expanding the organization's business propositions. He further speaks about an uncertain future where the organization, as a mega-organization, could be threatened by new entrants from entirely different industries breaking into their market. Although the organization is currently protected by its size, extensive expertise, and long-standing experience, TM argues that there is a finite period during which business as usual will be effective. When that time comes, the organization must have transformed to remain competitive. The competitive landscape and new business opportunities are hence viewed as drivers for change.

I often talk about how we should leverage our data to create new business opportunities. It's not just about improving and streamlining our processes, but also about developing new services and expanding our business... We're not immune to

threats from other players. It's happening in every other industry, and we won't be an exception... Who will start claiming our business? Will it be Amazon or some agile startup?... In my role, I have to address that we need to start looking into this and that we must transform and broaden our business. Business as usual will only work for so long. When it no longer works, we must have turned around and transformed this mega-organization. - TM

According to one of the project managers, there is another driving factor for change initiatives, which primarily stems from reactions to external expectations, such as demonstrating to shareholders that the organization is proactive and innovative. This sometimes happens without actually fulfilling a practical or strategic purpose within the projects, indicating a disconnect between perceived needs at the top of the organization and those at the operational level. This can be contrasted with changes gradually initiated from the ground up, including the implementation of new systems or work methods that arise from employees' daily experiences and needs. These types of changes have a significantly greater impact because they are driven by direct needs. Currently, innovation and the implementation of new technologies and work methods are primarily driven by specific projects and at the individual level. They almost exclusively arise from necessity and rarely because of new proposals from management or project leaders. This supports a decentralized model where change initiatives often start in daily work situations where the need for more efficient solutions becomes apparent. The strong need to drive development within the line, where it is driven and implemented based on perceived needs, supports Hartmann et al. (2012) findings that a technology pull implementation, where technology adoption is driven by actual needs and adapted to existing work methods, enhances implementation.

Yes, when initiatives come from the top, it's often about showing that changes are being made. Like, 'Now we're thinking in a new way. Look, shareholders, how great we are.' Sometimes it feels disconnected from the reality of the projects. - PM2

I feel that the major work happens within the projects and at the individual level... I don't see the significant development being driven at the corporate level in a collective sense. It's more about the needs within the projects that drive the development of solutions. - PM3

Implementing new technologies can also eliminate monotonous and repetitive tasks, allowing employees to focus on more stimulating and enjoyable work. This, in turn, can reduce the high staff turnover described as draining for the organization and the entire industry, thereby reducing the risk of skill and resource shortages.

And it's also about looking long-term. If we can automate boring tasks so our employees get more challenging and interesting work, we can retain them longer and reduce our staff turnover. Unfortunately, we have a high turnover rate, but so does the entire industry. It's not unique to us. But if we can eliminate boring tasks, giving employees more enjoyable and developmental jobs, we'll save a lot of money by keeping our staff. - PM4

Furthermore, as Lines and Vardireddy (2017) advocate for the role of "change agents" in technological shifts, two respondents similarly propose the concept of "automation/AI ambassadors." These ambassadors would promote the use of AI and automation within the organization, facilitating technological adoption and

innovation. They acknowledge the challenge of convincing staff that changes and technological implementations are beneficial, which can require substantial time and effort to devise smart solutions and motivations. During the implementation process, these ambassadors should actively showcase the benefits of the technology, train others, and simplify its usage to help everyone become proficient and independent users. One of the project managers also suggests that the organization should introduce "innovation missions," where one of the main objectives in that project is to develop new solutions and refine work processes within AI/automation. He argues that support and incentives from management are important parts of this process. The success of implementing new technologies and methodologies is significantly influenced by management's belief in innovation and their efforts to communicate its advantages to the entire organization.

Many times, it's about finding ambassadors for much of the technology. They are the ones driving the effort to showcase the advantages. And when you have them, or at least in my experience, you get more people on board. - PM6

And then I think we need ambassadors within the projects. That we should initially have x number of ambassadors in the projects who will drive the push towards automation... But this requires a willingness to invest in it and get approval from above, and once again, to look more long-term. - PM4

Project managers highlight that another driver for increased automation and AI in projects is the potential to secure innovation bonuses from clients. These bonuses are awarded for developing smart solutions, which is part of the client's effort to advance the industry. This incentive encourages companies to innovate and implement smart solutions. Additionally, including automation and smart solutions in bids can enhance value propositions, leading to higher scores in the "added value" criteria and potentially resulting in a discount on the quoted price, increasing the likelihood of winning contracts. By integrating automation, project costs can be reduced due to fewer required hours, making projects more cost-effective. Al-Sarraj and Al Najjark (2018) underscore this point, noting that such integration leads to higher-value activities that increase a project's success rate. Clients appreciate these efficiencies, recognizing that smart solutions contribute to a more competitive and efficient project delivery. Furthermore, TM has observed that project managers increasingly seek his assistance when drafting bids to identify areas within projects where automation can be developed and showcased.

But we've also had some innovation bonuses. Trafikverket wants us to come up with new ideas and develop further, so they offer innovation prizes. And within these we have developed some smart solutions that we've received funding for. - PM10

As I've mentioned, we are very dependent on Trafikverket. They have been quite slow in their requirements until recently when they started focusing on added value. They ask us to explain what we can do beyond our hourly rates. This can ultimately determine if we win a bid. For example, if we can show how we use data in our processes, whether through pure automation or AI, and make a strong case for it, that could lead to winning the contract. And this, I have noted, has resulted in project managers increasingly reaching out to me, asking to review these added value propositions to see what we can highlight to improve our chances of winning. It's very positive that they are starting to think more in this direction. - TM

4.3.2 Barriers for Organizational Change and Technology Adoption

The results of the interviews reveal several barriers to organizational change and technology adoption. These obstacles exist at various levels—organizational, group, and individual — and collectively pose significant challenges in relation to change and technology adoption.

One barrier found at the organizational level is the need for continuous education and awareness-building about the importance and benefits of implementing new technologies. Despite efforts to inform stakeholders, there remains a lack of understanding and long-term commitment and direction regarding AI and automation, which can restrict the cultivation of AI-awareness among employees (Jöhnk et al., 2020). All respondents emphasize that there is no clear long-term goal or clear direction from the top management in these aspects, which according to Wu et al. (2021) and Bag et al. (2020) presents one of the main barriers to successful technology adoption. This lack of direction results in each project working independently and achieving different levels of automation, where the responsibility of the implementation of automations largely depends on the actions of individuals. This findings supports the conclusions of Larsson et al. (2006) and Zomer et al. (2021) research, stating that the decentralized nature of work with a high dependency on individuals for innovation and technology implementation impedes spread of innovation. Additionally, project managers often face challenges due to the organization's focus on short-term goals and immediate financial results. This short-term perspective, driven by annual budgets and immediate profitability, limits the willingness to invest in long-term technological advancements. This finding aligns with Lavikka et al. (2018) and Emaminejad and Akhavian (2022), who attribute the slow transition to digitalization to the industry's knowledge gap and hesitation to adopt new technologies without proven cost-saving prospects, causing uncertainty among decision-makers. The current approach, which involves informing project managers without imposing strict requirements, results in a superficial commitment to technological change.

We have a budget. We have an annual financial report... So the focus is always on the here and now. Right now, our focus is on the billing rate. We're a few percentage points below target in our division. So now everyone is chasing the billing rate. How much will automation and development be talked about then? None. And when we start talking about wanting to automate because we believe it will have a long-term effect, several years into the future, it's not as interesting either. Because we're in this year right now, and this year's profitability is what matters to me. - PM4

To overcome these barriers, some of the respondents describe a need for higher management to enforce stricter requirements for adopting AI and automation from the outset of projects. Moreover, a strategic shift towards a long-term perspective is needed, where the benefits of automation are recognized and prioritized beyond immediate financial metrics. A more committed and clearly communicated, top-down approach is important in order to speed up the adoption of AI and automation. According to Lines and Vadireddy (2017) this factor is imperative for driving change in the sector and is according to Jöhnk et al. (2021) important for the adoption of AI.

Then, unfortunately, I believe there needs to be stricter demands from the top. Projects need to be a bit more forced... [there needs to be stricter requirements at the beginning of projects]... I really think a more long-term perspective is lacking [from the management]. - PM4

The necessity for stricter requirements and clearer direction from upper management is not universally accepted among project managers. Due to the project-based nature of their work, some argue that imposing such development directives from the top is impractical. They believe that the unique needs of each project necessitate development initiatives driven from within the projects themselves, rather than through top-down mandates. This perspective highlights a potential reason for the perceived lack of top-down direction in these matters.

"What we get from higher up doesn't work. What we do in the projects. We can't afford to spend time on things that aren't used immediately and don't have an immediate impact. We develop what is used... It's much better to drive development within the projects. Then it's action right away. If there's no immediate action, it becomes a shelf product. We shouldn't bother with it. It must be driven in the operations where it will be used." - PM11

Furthermore, TM provides additional insights into the absence of stringent top-down control, suggesting that it is not inherent to the organization's culture to impose rigid directives. Instead, mandates are typically decentralized and situated within the projects. TM also suggests that the organization has not yet firmly decided its position on the AI adoption curve—whether to be early adopters or laggards. The organization's size, extensive expertise, and substantial experience enable it to undertake projects that few others can manage. Consequently, there is a belief that the business-as-usual approach will remain viable for a longer period, as they feel relatively unthreatened in their specific types of assignments.

This is how our model works. We make our decisions quite far out in the units. We are structured to function this way, and when it comes to development, it's not typical for [our organization] to adopt a top-down approach... This is also common for other large organizations in Sweden, especially in the construction sector... Another point is that business as usual still works for us. There aren't many competitors with our CV or capabilities that can threaten us... So, we are moving forward cautiously in terms of AI and automation... I'm not sure if there is a clear goal from our organization about where we want to be on that curve [early adopters or laggards]. - TM

There are divergent views among project managers regarding their role in driving AI and automation initiatives. Some argue that project managers are key figures in driving this change, emphasizing their strategic position and the responsibilities that come with their role. They see project managers as vital links between the organization, the project, and the client, playing a crucial part in business development and thus believing their role should encompass greater involvement in AI and automation. Lines and Vardireddy (2018) argue that change agents are essential figures in organizational change and that these change agents should be influential individuals, and these results suggest there is evidence that project managers would be well-suited for this role. Conversely, other project managers are reluctant to take on this responsibility,

believing that these initiatives are better and more effectively managed within the operational line. They argue that the scope of their role should not extend to driving technological change, and once again emphasizes that the integration of AI and automation should be handled by those more directly involved in day-to-day operations.

Another challenge lies in the business and compensation model, which in this study has shown to be one of the main barriers in terms of increased efficiency through technology adoption. As previously mentioned, the organization's business model is based on selling consulting hours, with a large proportion of projects under variable-price contracts. Currently, the organization makes the most money by selling as many hours as possible. Project managers argue that this discourages automation, as it would result in fewer billable hours. Consequently, project managers and consultants focus on maximizing billable hours for clients rather than investing time in developing and implementing new technologies and processes internally. This supports the findings of Olsson et al. (2021), who highlights the need for new contract models within the sector to mitigate the risks of adopting new technologies. Furthermore, with innovation in automation and AI depending on individual initiative, this requires personal motivation to drive and implement new technologies. At the case organization, employees belong to specific groups where performance is evaluated based on results tied to billable hours. This focus on billable hours is tied to bonuses, which are determined based on the group's overall performance. This creates a potential barrier to innovation as individuals may prioritize activities that increase their billable hours over those that generate innovation, indicating conflicting priorities at the individual level. As a result, the motivation regarding personal and group benefit can overshadow motivation to develop and implement new solutions that might not be billable presents yet another complicating aspect, in this specific case, regarding the dependency on individuals in innovation and development (Larsson et al., 2006; Zomer et al., 2021) and the conflicting priorities of individuals as an impeding factor for the implementation of technology which was also highlighted in the research by Dossick and Neff (2010).

It's very much up to the individual... And that can definitely be a dilemma. You also have to consider the group's performance. And that's bonus-based [on billable hours], which creates an incentive for everyone to maintain the highest possible billable rate. - PM6

Organizational development is not a priority within individual projects. This presents a dilemma in a large project-based organization, where the core business is conducted through projects, yet organizational development is disconnected from these projects. As mentioned above, project managers claim that development must occur within the projects themselves, as top-down initiatives are ineffective. However, organizational development is not a core concern in projects, where the classical project triangle (time, cost, scope) is the primary focus. This disconnection leads to sporadic and uncontrolled development efforts. This finding supports the research of Lindgren (2016) and Olsson et al. (2021) concluding that the limited focus on improvement and development both within and between projects impedes innovation and change in the sector.

Moreover, the decentralized, project-based structure results in each project having a unique way of working, making it difficult to implement uniform and standardized

methods and processes. Hence, many solutions and innovations developed within specific projects remain exclusive to those projects and are not spread throughout the organization as the solutions developed are often too "project-specific" to be applicable elsewhere. This result aligns with the findings of Davies and Harty (2013), concluding that ad hoc or improvised solutions developed within individual projects impedes innovation as these solutions rarely become established or transferred as standardized solutions or work methods, and specifically presents a barrier to AI adoption for which the standardization of processes is a prerequisite according to Jöhnk et al. (2020). One factor explaining the lack of unified and standardized work methods is the lack of time and funding, as project managers describe that there is often no opportunity to evaluate and leverage solutions after a project is ended, as team members are quickly reassigned to new projects. This not only means that development efforts fail to generate long-term value for the organization but also leads to significant challenges in knowledge transfer. The organization struggles to learn from and transfer knowledge across projects, resulting in expertise being retained by individual employees rather than benefiting the entire organization, which according to (Lindgren, 2016; Maali et al., 2022; Eriqat et al., 2024; Olsson et al., 2021) constitutes yet another barrier to the diffusion of innovation in the sector. Consequently, this continuous cycle of "reinventing the wheel" impedes efficiency development and technological advancement. The spread of knowledge is further, according to Jöhnk et al. (2020), important to develop AI awareness among employees when adopting AI, and hence the lack of efficient knowledge transfer within the organization presents a barrier for AI adoption.

We have a budget and an annual financial statement. Then we forget about the rest. We rarely look into the next year's financial results. So, it becomes very short-term focused. Right now, our emphasis is on billing rates. We're a few percentage points below target in our division. Now everyone is chasing billing rates. This means we don't spend any time automating or refining processes. - PM4

The focus now is on automation and digitalization. At the same time, there's the question of the pricing model. How do we charge for this?... The market we sell to charges per hour. And then, for example, when we've developed administrative tools, we earn less because we spend less time. But we gain accuracy and can spend time on something meaningful that moves the project forward. However, I've had some strange conversations [from higher up in the organization] saying it's great that you're using these tools, but we make more money if we don't use them. And I'm left wondering, how does that make sense?... Personally, my job is to deliver on time and within budget. But there's really nothing motivating me to set aside four hours a week to think about how I could do things smarter, which would actually reduce our shareholders' profits... It's incredibly short-sighted not to think about automation just because we make more money without it. But that's a little how it works. - PM1

It has to be adaptable. Not all projects are entirely different, but to some extent, they are unique... You must always be able to scale up, scale down, and adapt in various ways... But that's our problem. What is developed isn't adaptable. Or we simply don't have the time to modify and adjust solutions from previous projects. So, we end up reinventing the wheel repeatedly, often unnecessarily... It's about adaptability. It's a bit like Darwin. The product that is adaptable will survive. If it isn't adaptable, it will become obsolete after that specific project or type, group of projects is completed. - PM11

Project managers further highlight challenges in developing and implementing new ways of working or innovations within projects due to the conservative nature of clients and rigid contract structures. Even when such solutions offer long-term cost savings and efficiency improvements, clients strictly adhere to contract terms that emphasize hourly billing, limiting flexibility and hindering innovation. A shift to value-based service models, such as offering automated solutions, could address these issues, once again reinforcing the conclusions of Olsson et al. (2021) regarding the need for new business models. However, communicating the mutual benefits of these models to conservative clients remains challenging. This conservatism and inflexibility posed by clients reluctant to deviate from traditional contracting models impedes change and technological advancement, hence the development of greater project efficiency. This further indicates a shortage of demand, and limited AI- readiness, from customers which according to Vass and Karrbom Gustavsson (2017) and Jöhnk et al. (2020) presents a challenge.

With the new business model, if I approach my client and say that I have automated another 50 tasks and we can reduce our budgets by 3,000 hours, is it just a direct reduction? Or how do I explain to my client that they will benefit, and I will benefit too? Yes, I developed the solution, but that doesn't mean 3,000 hours disappear; it means 2,000 hours disappear. So I retain a small profit, but you also get a piece of the pie. However, this is how we should currently approach our clients and discuss it, considering our time and material contracts. But it is a struggle you know, they are conservative. - PM1

It can be difficult to see the immediate benefits of implementing new technology and new ways of working, especially in variable-price projects. It's hard to motivate people if they don't see an immediate payoff. In our projects, where we bill our clients, every hour is expected to deliver value. It can be challenging to get the client on board [understanding the benefit of automated solutions and partly pay for the development] - PM4

At both the organizational and group levels, previous experiences with the implementation of BIM have encountered obstacles due to traditional processes and fragmented workflows, issues that remain relevant today. It is pointed out that there is a strong tradition in the construction industry of following established methods and processes. This tradition often means that work is divided into many steps, with each step handled by different parties: planning, design, construction, and maintenance. After each phase, there is a handover to the contractor, who has their unique way of working. This leads to inefficient information flow and sometimes forces teams to work in a traditional manner because the recipient does so. This finding is similar to the findings of Lindgren (2016) that the division of work in distinct phases and traditional cultures impedes the spread of innovation in the AEC sector.

There is a very traditional way of working within the construction industry. Many of our processes involve numerous steps. You have a planning phase, a design phase, a contractor, and a handover at each stage from the designed solution to the contractor who will build it, to the party that will manage it, and so on. This results in a highly fragmented process with inefficient information flow and numerous interruptions... I believe that this has prevented us from fully leveraging the potential of BIM. - PM6

Another barrier to organizational change and technology adoption at the individual level, according to two project managers, is a diminished capacity and willingness to change among employees. This finding is consistent with previous research concluding that human factors, such as beliefs, perceptions, habits and old ways of working impacts change and the spread of innovation (Harty, 2008; Taylor, 2006; Vass and Karrbom Gustavsson, 2017). This reduced capacity for change can result from a lack of skills and resources, where staff members do not possess the knowledge and abilities required to use and maintain new technologies. Additionally, a decreased willingness to change often stems from a fear of change. This fear can cause employees to resist new technologies and processes, preventing the organization from fully utilizing their potential. This fear may arise from concerns about not being able to handle the new technologies, losing control over their tasks, or not being able to maintain the same quality of work as before.

People are not inclined to change. They're not eager for new technology, I think. It's also about fear. Fundamentally, it's fear. They have something that they know works and has worked for a long time. Why should I embrace this new, unknown thing? - PM12

People. Not technology. Always people… [That is the most challenging part with change]. - TM

Connected to this, and as previously mentioned in chapter *4.2.1* one project manager suggests that age can be a barrier to change. He believes it is more challenging to convince older employees to adapt to new ways of working, and they may struggle to embrace new things and new systems. This is further confirmed by some of the senior project managers, stating that it will be up to the younger generation and more technology oriented roles to implement AI.

5. Discussion

In this chapter, the theoretical framework on organizational AI-readiness, literature review, and empirical findings are brought together. By comparing theoretical perspectives with practical insights, the analysis together with discussion creates a foundation for the study's conclusions. Additionally, the authors present personal reflections and discuss the implications of the results. The discussion aims to answer the research questions by providing insights into the barriers to digital innovation in the AEC sector and contribute to an enhanced understanding of how AI could impact project management practices. It also outlines the preferred developments of AI in project management.

5.1 Implications for Literature

5.1.1 AI Use Cases and Impacts

To answer the research question "How do project managers in the AEC sector perceive and what are their expectations on the introduction of AI in project management". This study has identified key areas where AI can be applied in project management in the AEC sector and the corresponding impacts as discussed by project managers and supported by literature. The key application areas for AI and corresponding impacts extracted from the results of the study are summarized in Table 2.

Table 2: Key application areas for and impact of AI in PM

Key Application Areas for AI in PM	Impacts
Automation of Administrative and Repetitive Tasks	• Saves time and enhances quality by reducing human error. • Enables project managers to focus on higher value-adding activities such as communication, strategic decision-making, and managing people. • More stimulating tasks lead to lower employee turnover.
Forecasting and Risk Management	• Improves accuracy of forecasts and risk predictions. • Assists in better project planning, and enhances coordination among technical disciplines.
Verification and Controlling of Deliverables	• Streamlines verification of project deliverables against requirements, ensures compliance and quality. • Reduces administrative workload, and eliminates time consuming manual tasks.

Information Accessibility and Knowledge Transfer	• Breaks down information barriers • Makes project data easily searchable and accessible • Saves time, enhances collective understanding. • Speeds up onboarding processes • Facilitates expertise localization within the organization.
Human Capital Optimization	• Helps in identifying and allocating the right resources efficiently. • Balances workload, increases productivity, and optimizes resource utilization, which enhances billing rates.
Language Processing and Removing Language Barriers	• Facilitates international collaboration. • Improves the accuracy of project plans and descriptions. • Enhances cooperation with offshore teams by breaking down language barriers.
System Documentation and Railway Plans	• Reduces time and resources required for system documentation and railway planning, handles large sets of parameters efficiently. • Ensures quality and accuracy, and allows project members to focus on activities such as critical thinking and strategic adjustments that require human judgment.

The application areas presented in Table 2 indicate that project managers have future visions based on their current knowledge and perception of how AI can be utilized. However, it is evident that, at present, there is no systematic use of AI on a large scale in the organization, as such usage would have been highlighted in the results. These identified areas are where they foresee the most significant impact on project management and project-related work within their sector. Consequently, they could serve as guidelines for where companies within the AEC sector should focus their AI efforts.

The combination of identified potential AI application areas and the current low usage rate suggests that early adopters of this technology can gain a competitive edge through increased efficiency, enhanced decision-making and project outcomes as supported by Al-Sarraj and Al Najjar (2018) and Skinner (2021). Additionally, this reduces the risk of an organization suddenly being outcompeted by a rival that has made significantly more progress in AI development and leveraged the benefits by offering a more attractive proposition to customers. It can also be noted that despite AI's capabilities, maintaining a human-centric approach to project management remains essential. Ensuring that AI tools enhance and support rather than replace human judgment, interaction is key to successful integration. This, in turn, can lead to the necessity for project managers to develop skills that complement AI technologies, which includes strategic thinking, emotional intelligence, and the ability to manage and leverage AI tools effectively which aligns with the predictions of Taylor (2021) and Al-Sarraj and Al Najjar (2018). Implementing and utilizing AI in project management will also

involve addressing ethical considerations. According to Jöhnk et al. (2020), this will require organizations to place significant emphasis on ensuring transparency, fairness, and accountability in AI-driven decision-making processes. This means that decisions made by AI, or project requirements verified by AI, should be further reviewed and validated by an external human party to ensure that every step taken during the decision-making process is accurate.

5.1.2 Barriers for Digital Innovation in the AEC Sector

The Decentralized Organization
The results of the case study reveal a decentralized organization where decision-making occurs at lower levels of the organizational structure, with development and implementation of new technologies heavily relying on individual initiatives at the operational levels. Upper management acts more as a catalyst, indicating areas where development is desired, which is then expected to be driven by the line organization. However, the lack of engagement and direction from upper management is a significant barrier, as clear directives and plans from higher organizational levels are essential for driving change and technology implementation (Lines and Vadireddy, 2017; Larsson et al., 2006; Zomer et al., 2021), and concerning AI (Jöhnk et al., 2020). As a result, innovation, especially in automating work processes, tends to be sporadic, random, and uncontrolled, driven by immediate project needs. Larsson et al. (2006) and Zomer et al. (2021) argue that decentralized decision-making and reliance on individual initiatives hinder the diffusion of innovation and new working methods. Hartmann et al. (2012) demonstrated that the implementation of new methods and technologies primarily occurs based on immediate project needs, a finding further supported by the results of this study.

The Lack of Standards and Inadequate Knowledge Transfer
Furthermore, the study confirms the challenges highlighted by Eriqat et al. (2023), Davies and Harty (2013), Lindgren (2016), Maali et al. (2022), and Olsson et al. (2021). The findings of this study also show that the lack of standardized working methods and the difficulties in achieving such standards, along with inadequate systematic knowledge transfer within the organization, hinder efforts to increase digitalization and automated work processes. The absence of standardized methods and challenges with knowledge transfer can be attributed to the uniqueness of each project combined with high fragmentation, lack of time and resources, and staff turnover within projects. This leads to the phenomenon of "reinventing the wheel" in each new project due to insufficient time and resources to leverage and modify developments from previous projects. Consequently, the organization struggles to capitalize on and translate the value generated, such as automated efficiency solutions in projects, into long-term value for the organization.

The Impact of Business and Contract Models
Olsson et al. (2020) argue that new business models are needed in the sector to mitigate the risks associated with adopting new technologies. This is perhaps one of the most significant barriers to transitioning to more automated workflows in projects, as highlighted by the results of this study, where compensation model challenges are evident at individual, organizational, and external levels. The prevailing variable compensation model in projects means that the organization earns less by increasing efficiency through automation in projects, which undermines incentives at the organizational level. Furthermore, the bonus model for the teams, to which all

individuals belong, is based on billing rates. This creates a conflict in individual priorities, as development activities that are difficult to bill are not prioritized, highlighting the problem of conflicting priorities as noted by Dossick and Neff (2010). This is particularly challenging as development and innovation within the organization is largely dependent on individuals. Both organizational and individual conflicts lead to a continued short-term economic perspective within the sector, which, according to Lindgren (2016) and Olsson et al. (2021), impedes development and diffusion of innovation.

Additionally, there is an external challenge, as the largest public client is seen as conservative and inflexible in terms of contributing to development in projects by partially accepting service-based compensation for potential solutions developed, even if it benefits both parties. The client's opposition further reduces the incentives to drive automation within the organization, a point further emphasized by Vass and Karrbom Gustavsson (2017). Therefore, the findings of this study underline the risk posed by the variable compensation model to increased digitization and automation in the sector. In contrast, the results also show that projects carried out with a fixed pricing model enhance incentives, where the organization can only benefit from streamlining work in projects through automation as it improves profit margins. However, this finding must be considered within the context of the Swedish market, where the majority of large infrastructure projects are conducted within variable fees contracts. This means that the result may not necessarily apply to other countries where fixed contracts dominate. Thus, this possibly indicates a specific national context where large Swedish consulting firms in the AEC sector face particular challenges related to the fact that a significant portion of Swedish infrastructure projects are carried out under variable fee contracts.

The Role of The Project Manager

Based on the premise that development and innovation within the sector primarily emerge from operational activities, particularly within projects, previous research underscores the project manager's role as pivotal in driving development and innovation (Lindgren, 2016; Eriqat et al., 2023; Vass and Karrbom, 2017; Mäki and Kerosou, 2015). However, the findings of this study do not strongly support this phenomenon. The project managers in this study exhibit minimal involvement in driving automation and efficiency-enhancing solutions in their projects. This can be partially attributed to the scale of the projects led by the project managers in this study, all classified as large or megaprojects with turnovers ranging from hundreds of millions to up to 2 billion. As projects increase in size, the project manager's role tends to become more overarching, distancing itself from operational activities. There is, however, a conflict in the findings regarding the project manager's role in driving innovation and change. Some project managers do not view their role as crucial in this regard, arguing that it should be driven at the operational levels in conjunction with development departments. Conversely, others assert that the project manager, due to the nature of the role, is essential in steering and coordinating development within projects. This is particularly significant given that the role occupies a key position between the organization, client and the project and is seen as vital for driving business development.

The Paradox of Organizational Development in the Project Based Organisation

The results indicate a lack of clear directives and support from management regarding the implementation of automation in projects. Increased efficiency through

automations is expected to be driven by individuals and teams based on emerging needs in the projects. However, organizational development and efficiency improvements are not inherently part of the project framework. This absence is natural considering the customer's perspective, given that such requirements are not typically imposed by clients within the formal contract. However, in an organization that operates primarily through projects, development is yet not explicitly controlled or required within the project scope. This implies that while development is expected to occur within projects, it is not formally prioritized or managed by the organization. Consequently, there is a misalignment between the organization's expectation of development occurring organically within projects and the lack of formal mechanisms to ensure this development actually takes place. The findings reveal that time and cost constraints heavily influence projects and operational activities, with development being secondary to these priorities. This situation creates a paradox: an organization conducts its entire operation through projects and expects development to occur within these projects, yet development itself is not a formal priority within the project scope. This paradox highlights a significant challenge in aligning project execution with the broader goals of organizational development and efficiency. This result aligns with the findings of Lindgren (2016) and Olsson et al. (2021) concluding that little focus on development and improvements both within and between projects impedes the spread of innovation in the sector.

Lack of Experience and Knowledge
Eriqat et al. (2024), Gamil and Rahman (2019), and Ahuja et al. (2020) highlight the issue of insufficient technical expertise related to digitalization as a significant barrier in the construction industry. Given its status as one of the least digitized sectors, the lower level of knowledge is natural but yet presents a substantial challenge. Additionally, the lack of experience and expertise in driving change should be considered. Unlike the IT and industrial sectors, the construction industry has not undergone or experienced radical transformations and rapid development to the same extent. Consequently, there is also a natural absence of broader experience and knowledge in managing change, which itself poses a challenge regarding innovation.

5.2 Recommendations and Implications for Practice

5.2.1 Organizational AI-Readiness

Several conclusions can be drawn on the case organization's level of AI-readiness from the study's empirical results based on Jöhnk et al. 's (2020) organizational AI-readiness framework. This framework comprises five levels: (1) Strategic Alignment, (2) Resources, (3) Knowledge, (4) Culture, and (5) Data.

Strategic Alignment
For the first level, Strategic Alignment, which includes AI-business potentials, the results indicate that there are multiple application areas with potential business opportunities to justify AI implementation, as shown in Table 2. However, when it comes to Customer AI-readiness, the perceived fear and uncertainty customers have towards AI/automation solutions presents a barrier. Their lack of understanding of how both parties can benefit from, for example, task automation, poses challenges. Questions arise, such as how a task previously performed manually, which produced the desired results, but now done by a robot, can not only ensure good final quality but

also be properly valued for billing purposes. This involves the uncertainty of transitioning from a cost model based on paying for time and material to one that assesses the value of the service provided. i.e a service based compensation model. This level also includes the factor of Top Management Support, where Jöhnk et al. (2020) emphasize the importance of leadership demonstrating commitment and vision for AI adoption. The results show that although management encourages AI adoption and automation, they do not provide a clear direction on how it should be implemented within the organization, leading to a lack of confidence in this area. Lastly, the factor of AI-process fit emphasizes the need for standardized processes for AI adoption. The project managers point out that there are difficulties in implementing new technology, such as AI, if all work processes and methods are unique from project to project. They describe this as a consequence of being a decentralized, project-based organizational structure, where each project can be compared to a small, individual company. This raises the question of the benefit of implementing a tool that can only be applied to a specific problem in a specific project.

Resources

For the second level, Resources, the discussion focuses on the importance of having adequate resources to cross the threshold where AI implementation demonstrates real value for the organization. In the case of the AEC organization, resources are available, but two main factors complicate their utilization. First, as a publicly traded organization, there is pressure to present strong financial results to shareholders, leading to a short-term focus that sometimes doesn't extend beyond the next quarter. Second, as a consultancy-based organization, it must justify the time billed to clients. Clients rarely have an incentive to allow a consultancy to develop and refine its processes at their expense, even though this study shows that it benefits both parties. This indicates that, to successfully implement AI, the organization should inform shareholders about the long-term value of investing in AI while also utilizing resources that could have been billed to clients but are instead funded internally for R&D.

Knowledge

The third level concerns Knowledge as a crucial factor for organizational AI-readiness. Under this level, AI-awareness is included, emphasizing the importance of employees understanding the various application areas for AI and the expectations they should have. The results indicate an expressed concern among employees about how their tasks may be affected by AI implementation, which can indirectly hinder a technological transition based solely on fear of the future. This concern could be alleviated at the organization if overall AI awareness were increased among employees. Additionally, an important component for spreading AI awareness is having an effective knowledge transfer system. However, the current organizational structure, decentralized and project-based, complicates this process. Knowledge tends to remain within closed projects, creating so-called silos (Jöhnk et al., 2020).

Upskilling

Upskilling is also a crucial factor connected to the Knowledge level (Jöhnk et al., 2020). The importance of upskilling can be illustrated by drawing parallels to the challenges faced during the implementation of BIM (Xu and Lu, 2022). Xu and Lu (2022) describe previous technological adoption issues with BIM within the AEC sector, noting that insufficient competence among employees led to a mismatch between the organization and the technology. This resulted in slow technology adoption that did not reflect its potential benefits. Currently, the project managers describe their organization as a

knowledge-based organization, but to maintain this status, the organization must ensure it has strong competence in AI to avoid falling behind. Therefore, important lessons from the BIM implementation should be applied to AI implementation. To achieve real value from leveraging AI technology, adequately skilled personnel are essential.

Culture
The fourth level is Culture, which includes the factor of Innovativeness, concerning the attitude of the organization's employees towards innovation. The results show that project managers strive to promote a supportive culture within the project teams, encouraging employees to raise questions and concerns. However, there is insufficient emphasis on fostering a culture of innovative thinking, as innovation is not commonly discussed, or a major focus, in the projects.

Data
The final level, Data, focuses on ensuring that the input data is structured in a specific way and maintains high quality to avoid generating incorrect outputs. However, this study has not focused on how project managers perceive the current structure of the organization's data or how to feed AI with high-quality data, making it difficult to connect this point to Jöhnk et al.'s organizational AI-readiness framework.

5.2.2 Enablers for Innovation and Change

Technology Pull Strategy Combining Top-Down Support with Bottom-Up Initiatives
The findings clearly indicate that a technology pull strategy, where solutions emerge and adapt based on operational needs, is the most effective approach within the organization and the sector overall as supported by Hartmann et al. (2012). Given the unique conditions of each project, a technology pull strategy is considered the optimal method. With a focus on technology to support and improve efficiency in alignment with already existing work practices through this strategy, this has the potential to prevent the technology paradox of new technology resulting in decreased productivity due to too vast effects on changes in work practices (Hartmann et al., 2012; Brynjofsson, 1993). However, this strategy should not be isolated from managerial initiatives. Management must exercise greater control and responsibility to ensure that improvement and development occur, even when driven by specific needs. The absence of managerial support is a significant barrier, as support and involvement from management are essential for the comprehensive development and implementation of new technologies like AI. Management should provide clearer directives and conduct follow-ups to guarantee development. This requires increased involvement from leadership, and as previous research highlights the necessity of support and involvement from management to achieve change through advancements and efficiency improvements through automation and AI (Jöhnk et al., 2020; Bag et al., 2020; Wu et al., 2021; Lines and Vardireddy, 2017), this can not be ignored. Therefore, a comprehensive approach combining bottom-up initiatives with top-down support is viewed as essential for realizing the full potential of digitalization and new technologies such as AI.

To achieve structured and controlled development, projects should not only aim for economic gains but also contribute to organizational development and improved

processes. While development obviously is present in current projects, it lacks clear direction and involvement from management, resulting in sporadic and uncontrolled progress driven by immediate needs. This approach might overlook potential in other areas that are not as pressing. The traditional time, cost, and quality are the primary factors guiding project delivery, underscoring the sector's adherence to traditional methods as an impeding factor for development (Lindgren, 2016). However, projects should also aim to deliver organizational benefits in these areas. By integrating development goals into project frameworks, organizations could to a greater extent ensure that each project contributes to long-term growth and efficiency improvements. A more holistic approach in project execution could hence enable projects to at a wider extent support both immediate operational needs and broader strategic objectives. As Lindgren (2016) and Olsson et al. (2021) attribute innovation challenges in the sector to the limited focus on development in projects, this supports the above suggestions for greater control of, and a greater focus on, development in projects.

However, the lack of standards and effective knowledge transfer within the organization, which is a widespread problem throughout the entire sector (Davies and Harty, 2013; Eriqat et al., 2023; Lindgren, 2016; Olsson et al., 2021), poses a challenge for the effective diffusion and establishment of innovations. Clearly including, requiring, and measuring development in projects could however potentially increase initiatives to share knowledge and innovations between projects, thereby leading to improved inter-organizational collaboration. Yet, the extent to which time and cost constraints hinder this remains a concern, further underscoring the importance of management support to prioritize these efforts. It is unlikely that focusing on development and innovation will leave time and cost unaffected in the short term, indicating an impact on short-term results but with probable gains and enhanced competitiveness in the long term. However, without support and clear directions on how to continue developing automated workflows, including the use of AI, implementation is likely to follow the slow trend observed with BIM which development and implementation have been slow due to being primarily driven and decided upon at operational levels and has yet not reached its full potential within the AEC sector (Vass and Karrbom Gustavsson, 2017). If time, cost, and tradition continue to dominate priorities over development, the sector's move towards increasingly automated workflows, particularly with AI as the most promising technology, will likely remain slow. This will hinder the sector's ability to swiftly realize and harness AI's potential to facilitate the radical shift considered necessary to increase productivity and more cost-effective projects.

Project Managers as Change Agents

The role of the project manager in driving change and development must also be addressed with regard to the above proposal. If greater demands for development are placed on projects, the project manager, who is ultimately responsible for project delivery both internally and externally, cannot be detached from this responsibility. Given the project manager's key position between the organization, project, and client, this role can potentially be crucial in driving change and act as a change agent, as described by Lines and Vardireddy (2017), who emphasize the importance of influential figures in organizational change. The findings of this study highlight the project manager's significant role and responsibility, suggesting their suitability as change agents. The close connection to the client further justifies this, as the client often serves as a barrier to innovation and change within contracts. Therefore, the

project manager holds a potentially important position in aligning organizational goals with client interactions and driving these objectives forward.

Utilizing the Full Potential in Fixed Price Contracts

The barriers associated with variable fee contracts are not found to be present in fixed fee contracts. Therefore, projects with fixed fees have significant potential to drive the development of automated solutions and AI. These projects could serve as incubators for innovation within the organization. However, proposals to emphasize development must be considered with respect for the substantial challenges faced by the decentralized, project-based organization. Increased involvement and direction from the top are challenging and in many cases as shown in this study, perceived as undesired which suggest risks with resistance. Nonetheless, previous research underscores that top-down support is crucial for achieving significant changes, which further stresses the importance (Jöhnk et al., 2020; Bag et al., 2020; Wu et al., 2021; Lines and Vardireddy, 2017). Initially focusing on development within fixed-price projects could be an optimal starting point, as the opposition is less pronounced here, before transitioning to a greater focus on projects with variable fees. It is however of great importance to plan for how developments made in fixed-price projects will be transferable to other projects.

Diverse Expertise and Experience in Change

Finally, the effects caused by the lack of experience and knowledge in change management, as a result of the sector not having undergone significant transformations or experienced rapid change, should be discussed as this can hinder such efforts. Addressing this issue could involve recruiting from other industries with more extensive experience in transformation, such as IT and manufacturing. This strategy could potentially introduce new perspectives to projects and operations, challenge traditional culture and mindsets, and thereby promote innovation and change.

6. Conclusion

The purpose of this study was to provide insights into the barriers to digital innovation and change in the AEC sector and contribute to enhanced understanding of how AI could impact project management practices and provide outlines for the preferred developments by answering the following research questions

1. *How do project managers in the AEC sector perceive and what are their expectations on the introduction of AI in project management?*

2. *How do project managers in the AEC sector perceive the challenges associated with implementing new technologies and work methods?*

Regarding the first research question, the results reveal an overall positive attitude towards AI as an supportive and efficiency and quality enhancing tool among project managers. Several potential application areas for AI not only in mere project management but also in the wider project related work appear from the result. The impact of an implementation of AI in AEC projects is expected to result in higher efficiency, quality and reduced costs mainly through the potential to eliminate labor intensive and time consuming tasks by automation and by leveraging its predictive capabilities in several areas. The impact would further enable and create more time for project managers to focus on more value-adding activities, mainly the interaction with and management of people. However, even if project managers do not fear AI to replace their role in a foreseeable time, some concerns are raised for the potential replacement of other roles within projects. Yet, another perception is that a successful integration of AI will result in greater competitiveness and the possibility to take on a larger amount of projects and further expand the business, hence leaving human capital unthreatened.

For the second research question, the project managers identified several challenges in implementing new technologies and work methods. These challenges partly stem from the project's decentralized organization, where the absence of adequate support and directions from top management regarding AI adoption is clear and appears disconnected from the operational levels where development and implementation of new technologies is expected to occur relying on individual initiatives. This is currently causing development and innovation to occur in a sporadically, random and uncontrolled manner, and not extending beyond immediate short-term needs. Furthermore, the lack of standardized work methods and inadequate knowledge transfer, the disconnection of development and innovation demands in projects - where this simultaneously is expected to occur, and the lack of border experience and knowledge in change management is further found to impede innovation. Lastly, one of the main challenges regarding automated workflows and widespread AI adoption stems from the variable compensation model, under which most projects are executed, as this model creates conflicting priorities at the organizational, individual, and external levels. However, this challenge must be considered as potentially specific to a Swedish context as the distribution of fixed vs variable contracts may look different in different countries.

6.1 Recommendations for Future Studies

Given the insights from this study on the barriers to digital innovation in the AEC sector and the impact of AI on project management practices, several areas for future research emerge.

- A continued exploration of how top management can establish clear directions and support structures for AI initiatives to facilitate widespread organizational adoption.

- Investigate the expectations and requirements of AEC clients and stakeholders regarding AI and automation in project management and assess how these expectations influence the adoption and implementation of new technologies within the sector.

- Examining contexts beyond Sweden to compare and draw conclusions about what works well in the AEC sector for implementing new technology and organizational change in different countries to enable change recommendations based on comparative insights.

- Explore how interorganizational collaboration can be structured to facilitate AI implementation and widespread organizational adoption in the AEC sector.

- Replicating this study from the perspective of other roles within the AEC sector regarding the introduction of AI and challenges related to technology implementation and change of work methods.

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Appendix I

INTERVIEW GUIDE

PROJECT MANAGEMENT

- Could you describe your work role and tasks as a project manager?
- What would you say are the biggest challenges with project management within your industry?

AI IN PROJECT MANAGEMENT

- How familiar are you with the concept of artificial intelligence?
- How do you feel about the introduction of digital technologies in general, and AI, in your profession?
- What impact do you think implementing AI in project management would have on your job role and tasks?
- How do you think the work roles in the project team will be affected?
- Can you give examples of specific tasks or processes where you believe AI has the greatest potential?
- What do you think are the biggest opportunities with the application of AI in project management in your industry?
- Are you concerned about any potential risks with increased use of AI?
- How do you experience the attitude towards AI in your organization?

ORGANIZATIONAL CHANGE AND IMPLEMENTATION OF NEW TECHNOLOGIES

- How do you experience the initiatives to change work methods driven in your organization?
    - Are they initiated at the management level or do they occur in the projects?

- What role do you have as a project manager within your organization when it comes to introducing new technologies or work methods?
- What do you perceive as the biggest challenges with changing work methods and implementing new technologies in your organization?
- What do you think will be the biggest challenges in terms of implementing AI?
- Do you feel that there is sufficient support from the organization when it comes to change?