An-Najah National University

Faculty of Graduate Studies

THE IMPACT OF TOTAL QUALITY MANAGEMENT ON PROJECT PERFORMANCE: THE MEDIATING ROLE OF ORGANIZATIONAL WILLINGNESS FOR ARTIFICIAL INTELLIGENCE IN THE AEC SECTOR IN PALESTINE

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This Thesis is Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Engineering Management, Faculty of Graduate Studies, An-Najah National University, Nablus - Palestine.

2025

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Dedication

I dedicate this thesis to my beloved country Palestine, and the mighty Palestinian people. To my beloved family. My utmost thanks and gratitude are dedicated to everyone who contributed to helping me complete my thesis.

Acknowledgements

First and foremost, I wish to convey my profound thanks to Allah Almighty for the numerous blessings, wisdom, and strength that have enabled me to successfully complete this thesis. Furthermore, A special acknowledgment goes to my supervisors: Dr. Rabeh Morrar, whose guidance, collaboration, and dedication have been invaluable, and his tireless efforts and invaluable guidance played the pivotal role in assisting me throughout the nights of writing this thesis.

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Declaration

I, the undersigned, declare that I submitted the thesis entitled:

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I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

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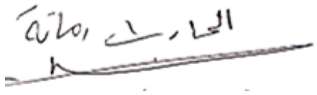
Signature: 

Date: **03/09/2025**

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THE IMPACT OF TOTAL QUALITY MANAGEMENT ON PROJECT PERFORMANCE: THE MEDIATING ROLE OF ORGANIZATIONAL WILLINGNESS FOR ARTIFICIAL INTELLIGENCE IN THE AEC SECTOR IN PALESTINE

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Abstract

This study addresses the Relationship between Total Quality Management (TQM) and project performance within the architectural, engineering and construction (AEC) firms in Palestine with respect to the mediating role of the organizational willingness to adopt Artificial Intelligence (AI). In spite of the long history of association of TQM with efficiency and competitiveness, the area of crossroads between TQM and new technologies is still an unexplored research cycle, especially in the context of weaker economies such as Palestine. The current research issue is based on the consistent problem of the Palestinian AEC companies to offer high quality deliverables in the conditions of limited resources and political uncertainty and pressure in terms of remaining competitive. To address this gap, the research was also launched in a mixed method design. The structured questionnaire was adjudged to 120 respondents in AEC firms and the data were reviewed employing a statistical form of examination known as Structural Equation Modeling (Smart-PLS). Further on, semi-structured interviews with managers and practitioners were performed to complement and place in context the quantitative results. The outcomes indicate that the TQM practices do make a large influence in the performance of the project, both positively and indirectly through the organizational inclinations to embrace AI.

Theoretically speaking, the study brings to the practice of the Resource-Based View (RBV) and Contingency Theory the illustration of a synergistic relation between internal quality capabilities and external pressures to influence AI readiness and, eventually, performance. In practice, it can guide Palestinian AEC companies and policy makers in order to increase resilience and competitiveness. The recommendations indicate the necessity to incorporate quality principles and develop digital transformation readiness,

which is a channel to attain improved project outcomes in a difficult environment.

Keywords: Total Quality Management (TQM), Project Performance, Artificial Intelligence (AI), Organizational Willingness, AEC Sector, Palestine.

Chapter One

Introduction & Literature Review

1.1 Introduction

The global AEC sector faces disruptive trends which are motivated by greater complexity of the project, growing digital advancement, and demand on innovative, sustainable, and cost-effective delivery. The industry companies are demanded to meet increased demands of delivering good work within the restricted scopes of project time and budget plans along with implementing measures to address regulatory pressures and environmental requirements as well as approving progress of digital technologies. This heightened demand is particularly pronounced in the sphere of such industries as construction and design due to which, steadfast challenges relate to the uncertainty of their activities and management of the intricate relationships between stakeholders (Akhmatova et al., 2022).

Such requirements elevate TQM into a slot of being an integrated way of fostering the overall functioning performance and result of the projects. The major concepts of TQM involve the continuous enhancement, focus on the needs of the customers, participative leadership and empowering the employees. The application of structured quality systems and accepted models such as the Malcolm Baldrige National Quality Award (MBNQA) and ISO 9000 are embraced by this model. When applied to AEC companies, the innovation of TQM suggests the simplified workflow, less operational inefficiency, improved interdepartmental collaboration, and improved rates of customer satisfaction overall (Taraza et al., 2023).

Project management is no exception to the disruptive force as was true with Artificial Intelligence (AI) with TQM. Response These tools enable quick decision-making, continuous monitoring of the work, and the possibility to locate and offer a solution to any possible problems fast. The AI tools have demonstrated their ability to enhance the accuracy of the prediction and assist in revealing the problem of the design and making the process of inspection and resource distribution easier in the construction industry. The efficiency increase is great when AI is incorporated into the quality management framework (Dhamija & Bag, 2020; How et al., 2020).

While TQM and AI are known to be effective in isolation, the actual usage of the two together is unclear, especially in resource -constrained backgrounds. AI complements TQM practices with its in-depth data analysis, a simple automated quality control system, and continuous learning operation. On the other hand, TQM prepares organizations to implement digital innovation by developing a quality-oriented environment, streamlining workflow processes, and developing a quality-oriented environment, streamlining workflow processes, and developing managerial commitment. However, AI integration into TQM processes is very much determined by organizational receptivity and the ability to adopt new technology – influenced by the leadership endorsement, staff involvement, availability of existing IT systems, and perception of risks (Vasilieva et al., 2023; Zhao & Gómez Fariñas, 2023).

In light of the distinct nature of Palestine, the demand and struggle for Artificial Intelligence integration are further encouraged. Due to the political and economic daily challenges and huge infrastructure barriers that plague AEC firms operating in Palestine are faced. Even though firms are increasing their ambitions to improve their performance and meet global quality standards, these challenges stifle the adoption of advanced technologies. There are many Palestinian AEC firms that, in one way or another, have successfully implemented quality practices by embracing certifications, understanding clients' needs, and implementing their processes strategically. Nevertheless, most firms cannot introduce AI-based management systems due to limited resources, weak technical skills, and robust barriers to change (Saha et al., 2022; Wall, 2021).

To determine how the two interact to influence the performance of projects in Palestinian AEC firms, this study aims to comprehend how the practices play off with organizational readiness to adopt AI. More precisely, this paper will examine the interaction between TQM practices and the organizational preparedness to embrace AI. Research tries to establish a connection between the formalized quality management system and performance benefit with the help of AI preparedness. This study sheds lighter on the connection between quality and innovation and suggests practical measures that companies that need to innovate with minimal resources should take(Asad et al., 2023; Wassan et al., 2022).

1.2 Background of the Study

The AEC sector is critical to national development, economy, and future urban environments. The AEC industry elsewhere undertakes sophisticated, large-scale, and multi-sector projects necessitating high-level coordination, creativity, and flexibility. The growing size and complexity of projects occasion result in firms failing to deliver at least to quality standards, within budget and time constraints. The complexity modeling of projects and the emphasis of systematic quality management techniques and the state of art technology in terms of performance have demonstrated the significance of both systematic quality management methods and the state of the art technology (Akhmatova et al., 2022).

AEC companies are increasingly relying on TQM in achieving performance and process-based requirements. It was first introduced in the manufacturing sector and TQM has evolved to be an all-inclusive platform that identically embraces the principles of quality in all the organizational functions of the different industries. In the matrix AEC, TQM focuses on standardizing processes, employee involvement, putting clients at the primary position, and constant improvement of practices from the design, the construction, and beyond, up to the post-occupancy analysis. Frameworks such as the Malcolm Baldrige National Quality Award (MBNQA) or the ISO 9000:2015 have acted as important tools for organizations attempting to formalize quality. There have been improvements in project performance because efficient use of TQM has led to increased standards of communication (Taraza et al., 2023).

While the advancement of quality management has been accompanied by the emergence of AI, unprecedented opportunities and new models have been presented to facilitate organizations' effectiveness. AI application now allows for the automation of grunt work, efficient allocation of resources, and efficient application of forward-looking decision strategies in ongoing project management. In construction, the adoption of AI has spread to cover areas such as intelligent workload management, quality assurance by defect detection, risk identification, use of BIM technology, and the use of automated construction machinery. Such tools allow companies to respond swiftly and make informed decisions, avoid mistakes, and quickly respond to unpredictable endeavors. AI especially facilitates a shift from working to solve problems at any given moment to working towards solving them from a distance (How et al., 2020).

In fact, the integration of AI into the TQM systems is far from mere technical problem. It is essentially driven by a firm's culture, the attitude of its leaders, and preparedness of the organization itself. The ability of AI to support TQM system rests on the ability of a well-skilled and flexible team having managerial support on long-term investments in technology. The convergence of quality management and innovation preparedness in translating emerging economies is of greater essence because of scarcity of resources, deficient.(Sinonquel et al., 2021).

Its current problems especially affect the AEC industry in Palestine. Political turbulence and economic restriction add to the drawbacks of the AEC industry, which include multiple instability, the limitation of the flow of personnel and products, and the unavailability of the state-of-the-art infrastructures and technologies. Alongside the formidable obstacles that Palestinian AEC companies pose a formidable ability to withstand and an increased willingness to embrace international quality standards in their efforts to enhance their work and gain a better position in their own land. Businesses have established quality assurance departments and ISO certificates and have made efforts to maximize client satisfaction. However, the introduction of AI in Palestinian AEC firms is limited and uneven, largely due to lack of funds, lack of technical skills, and debate over the financial value (Saha et al., 2022; Wall, 2021).

The particular context of Palestinian AEC companies explains why the necessity to investigate the synergetic value of the TQM practices and organizational preparation is temporary to update AI to project achievements. Knowledge on the extent to which these factors are mixed is of interest to researchers and practitioners interested in formulating corrective measures on adopting innovation and quality improvement in specific contexts. These profits can more particularly be conceptualized in the Palestine companies in enhanced productivity, higher quality production and competitive capabilities lead against the perilous external environment. (Asad et al., 2023; Wassan et al., 2022).

With such theoretical and practical advantages, this study has significant growers by studying the system of quality management as its basis. It discusses the organizational factors that serve to enable or hinder the adoption of new technology and reflects on how combining quality management with AI readiness could help achieve more effective, faster and more cost-effective project results in the Palestinian AEC sector (Hyun Park et al., 2017).

1.3 Problem Statement

Faced with a volatile and competitive AEC industry, superior project efficiency is essential to firms that will have to manage increasing client expectations, budgetary pressure, and change in technology. Although TQM has a proven history to support development with formal systems and continuous improvement, many firms still fail to implement the full benefits, especially in the developing countries. The significant challenge in the present-day stands for the lack of synergy between TQM systems and AI technologies that caused firms' inability to deliver optimal results in real time (Setiawan & Purba, 2021; Taraza et al., 2023) .

The studies claim that AI may be a supplemental tool for TQM, combining such skills as predictive analytics, automation, and real-time data analysis to quality and performance management. However, the journey of implementing AI into project processes - and more specifically to systems that are quality mindful - has turned out not to be that smooth of a task. The integration requires good climatic conditions in the organization which include technological efficiency, committed leadership, productive and innovativeness of employees. Without such enablers firms that have come of age are lacking. (Pallavi Tyagi, 2023).

Although it is clear that TQM enhances the performance of an organization, the connection between TQM and project performance has remained under-researched with organizational readiness to use Artificial Intelligence (AI) as a mediator particularly in the architectural, engineering, and construction (AEC) sector. Although studies carried out in developed economies have highlighted the need to integrate quality practices with the digital transformation, little is known regarding this dynamic in the fragile and resource-based settings. (Munir S et al., 2023; Vasilieva et al., 2023)

Chronic resource constraint, political and economic instability and excessive dependence on external markets and permits are one of the challenges that AEC firms face in Palestine. These factors limit the capacity of firms to invest in advanced technologies and to carry out systematic approaches to quality, but at the same time increase the need for efficiency, resilience and competitiveness. Project delays and cost overruns in addition to consistent quality issues remain prevalent, which again highlights the need for frameworks to improve performance under these constraints.(Saha et al., 2022; Zhao & Gómez Fariñas, 2023).

To close this gap in the literature, this research intends to address the following key question:

Although there are many TQM frameworks in Palestinian construction firms, lack of readiness to integrate AI in the organizations might limit realizing high quality of project performance.

Thus, the necessity to examine the connection between TQM and the project performance and specifically the contribution of the organizational willingness to adopt AI is urgently important. This paper addresses this vacuum by looking at how an organization willingness to embrace AI can mediate the relationship between TQM and project performance among Palestinian AEC companies. In doing so, it also adds value to the global literature as well as providing context-specific insights which can facilitate the Palestinian firms and policymakers in adoption of TQM and AI as a tool for survival and sustainable growth. (Hyun Park et al., 2017).

1.4 Purpose of the Study

To an AEC industry member firms in this technologically enriched world where industry imperative zealously propensities at a tectonic pace, they are inexorably implored to techno logicalize their procedures, and conserve spots simultaneously at the same time, their peerless quality. This is more vivid in destinations like Palestine where resources dearth, compromised infrastructure and political disorder underlie the AEC business. These restrictions make not only the use of advanced technology like Artificial Intelligence very crucial, but also a problematic endeavor. Meanwhile, many Palestinian firms have greatly adjusted their use of total quality management practices to increase efficiency, reduce the errors, and adapt to the global standards. It is possible that implementing TQM or AI separately and not supported by a synergized organization approach cannot guarantee the desired performance developments in the sector (Dhamija & Bag, 2020; Saha et al., 2022).

This study aims at understanding how TQM would integrate with AI readiness, and that organizational readiness for AI should be emphasized in this regard, The purpose of this study is to examine the impact of TQM on project performance in the Architecture, Engineering, and Construction (AEC) sector in Palestine, while assessing the mediating role of organizational willingness to adopt Artificial Intelligence (AI). The advantages of

TQM for creating quality and operational efficiency are well laid out, but its ability to prepare companies for example, there are a number of existing studies on AI in construction that focus more on the technical areas of implementation aspects while there are fewer studies that discuss the organizational and cultural aspects that enable the implementation of the technologies in generating quality assurance processes (Vasilieva et al., 2023; Zhao & Gómez Fariñas, 2023).

This study aims to contribute to the knowledge base of how quality management systems and AI preparedness interrelate with the perception of establishing the strategies that can enable organizations to achieve success in the digital integration in quality endeavors and on the establishment of sustainable enhancement in the project performance. The research is an evaluation of the contributions made by organizational culture, leadership approval, workforce preparedness, and the organizational evaluation of AI advantages in the establishment of effective implementation of technology in the context of quality-based project settings. In the process the research attempts to establish what organizational issues facilitate or discourage this integration, and provide practically suitable inputs through the development of working strategies in driving efficiency and creativity.

- The following four objectives of the research guide the study:
- To examine the impact of TQM practices models on project performance.
- To assess the mediating role of organizational willingness to adopt AI in the relationship between TQM and project performance.
- To explore how AI adoption can improve TQM practices to achieve better project outcomes.
- To identify the challenges and opportunities of implementing internationally recognized quality management standards within AEC firms in Palestine.

By this, the research not only addresses major research gaps in the academic literature, but also provide concrete recommendations to industry practitioners, policy-makers, and organizational leaders. This publication is exposed with a tactical understanding of how institutions in Palestine and the industrialized world can employ their present quality status quo to boost preparedness and conveyance of technology connected reforms. Lastly, the research contributes to the existing debate concerning the role of the quality-dependent coordination of quality and digital transformation management in increasing the performance in high-pressure projects conditions.

1.5 Research Questions

Addressing the concerns expressed earlier in this paper and to meet the stated research objectives, this research is structured around a particular set of research questions that focus on causal and mediating relationships between TQM, organizational tolerance of AI, and project outputs, to highlight impediments and enablers that facilitate synergy between quality management and new digital technologies.

These research questions are developed based on the recent theoretical models of MBNQA standards for the facilitation of TQM, leadership-based theories on technology adoption with a focus on organizational culture and readiness in infrastructure. Moreover, these research questions are based on the unique socio-economic environment of Palestine wherein lack of resources, continued political uncertainties, and slow adoption of digital technologies make all the room to innovate and develop organizations problematic (Saha et al., 2022; Vasilieva et al., 2023).

Accordingly, the study is structured around the following four core research questions:

- How do TQM practices models impact project performance in the AEC sector in Palestine?
- What is the role of organizational willingness to adopt AI in mediating the relationship between TQM practices and project performance?
- How can AI adoption enhance the effectiveness of TQM practices in improving project performance?
- What challenges do AEC firms face in aligning their quality management systems with international standards such as MBNQA?

These are the questions that underlie the way this study conceptualizes its analytical approach and methodology and its data analysis. They lay stress on the equivalent weight, which each of them received, to the development of theory and its transfer to practical issues. The study will answer these questions by supporting the strategic planning, capacity building, and digital preparedness among the industry participants in Palestine and other developing markets with evidence-based recommendation(How et al., 2020; Hyun Park et al., 2017).

1.6 Significance of the Study

Considering the digital revolution in question, the study is up-to-date and topical because it addresses a gap in the discussion of an important nexus between the quality management and the digital transformation in AEC. As the world industries have increasingly become more digitized, business organizations and particularly those in the developing economies have to consider efficiently integrating systems like TQM with digital systems like Artificial Intelligence (AI) to ensure continuity of a competitive, successful and efficient business. (How et al., 2020; Saha et al., 2022).

This paper adds theoretically to the current literature of TQM by emphasizing that it plays not only a crucial role in enhancing internal functioning and quality service provision, but also creating a conducive environment to foster innovation, and technology internalization. Despite the positive influence of TQM on firm performance, as reported in the past, there is no clear insight into the interactive effects of TQM and AI readiness in scenarios where transition to technology is more challenging due to the existence of infrastructure and institutional barriers. The organizational readiness is the novel aspect of the innovation management research because it demonstrates the influence of the internal organizational structure and cultural values on digital transition through project systems(Munir S et al., 2023; Vasilieva et al., 2023).

This study also extends Contingency Theory and RBV and states that the TQM and AI readiness are complementary resources that will result in substantial improvement of firm performance where the resources collide. The study confirms the notion that the technological innovation is anchored on the complete quality systems, and that man is able to think innovatively(Hyun Park et al., 2017).

Practical implication of this study suggests that there is much to be gained by industry specialists, consultants and policy makers in the AEC sector in Palestine, and other developing contexts. The study provides practical recommendations to companies to enhance their digital transformation efforts through the available quality systems, despite the challenges like budget constraints, technological constraints and fragmented organizations. It identifies key organizational conditions that should be put in place in order to adopt AI, such as engaged leadership, empowered employees, and adequate technical provisions that can enhance project success and maintain competitiveness(Pallavi Tyagi, 2023; Zaidi & Ahmad, 2020) .

Moreover, the findings of the study can be helpful to policymakers and developmental agencies in this location because it gives the challenges and enablers of the AI-based application in project-based sectors. The recognition of the effect of the organizational willingness can empower the stakeholders to develop isolated training, resource-planning and combined plans that will facilitate digital change and support quality standards.

The given study offers a detailed model of the theme of dynamics of TQM/AI in terms of performance, and it also gives a realistic understanding of what such an approach is like in an AEC setting in Palestine. To resolve this vast gap in the scholarly discourse, one accessible answer is suggested in the study as a way of getting out of the business by balancing the advantages of its operations that it has had with the digital novelty.

1.7 Scope and Delimitations

In this study, participants will determine the correlation between the TQM practices and the project outcomes, and the potential mediating variable (AI adoption). The research is limited to businesses that are in the AEC industry, such as architecture and engineering consultancy firms, project management firms, and firms that engage in construction. This choice was mainly based on the natural complexity of projects by the AEC, which will require strict quality management and the implementation of new technologies, which are essential for project excellence (Setiawan & Purba, 2021).

The scope of study encompasses organizations that have either adopted or are actively introducing TQM practices, i.e., organizations that are certified to either the MBNQA or ISO 9000 standards. It encompasses firms potentially beginning to come to terms with or even begin to engage with AI, irrespective of whether they are already using particular tools. This means that the study's door is open to companies, regardless of direct AI integration, since organizational readiness to explore AI is the primary measure of interest.

This study focuses on three key constructs:

- Total Quality Management (TQM) practices,
- Organizational willingness to adopt AI, and
- Project performance (measured through indicators such as cost control, time efficiency, and quality of deliverables).

The data are produced at firm level through the use of structured questionnaires filled by the middle and senior level professionals and decision-makers in project planning, quality assurance, and executive management. This kind of assessment is done to ensure that the respondents are conscious of the practice and strategic activities of quality and innovation in the organizations, which are portrayed in the state of the respondents.

Delimitations

- The research contains much information about the Palestinian AEC sector, but few limitations are also to be noted:
- This study did not cover organizations in the public sector, firms of other industries or firms outside Palestine. In turn, this selection criterion ensured logical consistency of the research, but it can also cause restriction in the scope of the findings generalization in other regions.
- The analysis is based on the time at which organizations are likely to implement AI, rather than the technological and managerial strategies. In the research, the attitudes, intentions, and preparedness of organizations regarding the AI front are the only measured variables, and no empirical test is provided regarding the performance of the AI systems.
- The conceptual model does not expressly include regulatory frameworks, client behavior, and geopolitical instability, but it is known that these are variables that affect the quality and adoption of technology. In this method, the study is only restricted to internal analysis of the organizational structure.
- The survey data obtained across sections of time, obtained in this research, cannot be considered sufficient to confirm causal relationships in the long term. The longitudinal approach to future research would then, in turn, provide a more profound insight into the dynamic nature of changes that quality and innovation practices experience over time.

With these limits, the study aims to be stringent even to the point of giving practical and situation-specific recommendations. This reduction in the scope will enable the researchers to develop a narrow, conceptual framework that will then be applied to scholarly analysis, as well as a component of the strategic decision-making of the Palestinian construction sector.

1.8 Definition of Key Terms

- Total Quality Management (TQM): A holistic and strategic management plan for infusing the quality practice amongst every part of an organization. TQM emphasizes the constant improvement, the need to address the customer needs, the inclusion of the leadership, employee participation and the improvement on the organization processes. >>Operation of TQM in this study is enacted by referring to dimensions which portray the developed guidelines such as the one provided by the Malcolm Baldrige National Quality Award (MBNQA) criteria and ISO 9000:2015 standards (Setiawan & Purba, 2021; Zaidi & Ahmad, 2020).

- Artificial Intelligence (AI): This includes use of computers systems and algorithms that were created to attend to activities such as data analysis and mining, forecasting, pattern identification and decision-making, which was previously carried out by human beings. As shown by the research, AI of AEC companies involve such technologies as machine learning and automation that are implemented for project efficiency, improving forecasting, and risk management purposes (Dhamija & Bag, 2020; How et al., 2020).

- Organizational Willingness to Adopt AI: The organization's adaptability towards a constructive mindset, openness to innovation, readiness to integrate AI technologies, and receptivity to leaders promoting such. This construct reflects the organizational climate for AI adoption, the attitudes towards benefit, risk, and change irrespective of whether the AI has been implemented in its entirety (Pallavi Tyagi, 2023; Vasilieva et al., 2023).

- Project Performance: The project effectiveness based on the cost variance, time and quality of the identified project. The outcome of the project success in this research is gauged against the following parameters of financial control, project schedules, stakeholder satisfaction, and quality. (Taraza et al., 2023).

- Architecture, Engineering, and Construction (AEC) Sector: Industry of firms providing services in project management, design, engineering and construction. For the purposes of this work, the AEC sector refers to Palestinian companies that provide private or externally funded construction services & infrastructural work.

- Quality Standards (MBNQA and ISO 9000): Compulsory systems used across the globe when it comes to assessing and putting into practice the practice of quality management. Whereas ISO is interested in seven dimensions of organizational performance excellence, the Malcolm Baldrige National Quality Award focuses on these seven dimensions.

- When these terms are defined operationally, the study helps clarify the boundaries and variables at the center of the investigation for all the stakeholders.

1.9 Literature Review Introduction

Literature related to the underlying constructs discussed in this research is reviewed in this chapter. TQM, integration of AI, the attitude of organizations towards AI solutions, and the implications for project performance; AEC sector. The review of the literature is intended to serve several critical roles. First, it presents the main theoretical and conceptual frameworks on which the study is based. Second, it aggregates previous studies to reveal known links, departure points, and controversies that remain in present research. Third, it points to gaps in the existing research that drove the current investigation, especially with regard to developing nations such as Palestine.

Due to the dynamic changes in digital transformation among construction and the increasing call for quality assurance in project management, the integration of TQM and AI in organizations remains to be a newly emerging academic subject. The current literature has performed in-depth research on the individual impact of TQM and AI, but there has been a lack of empirical evidence on how the two areas interact with each other – particularly in terms of organizational readiness for technological growth.

There are several critical subparts of the content. The second subsection section 2.2 presents a background on TQM and its actual implementation in construction and project. Section 2.3 discusses the increasing use of Artificial Quality in Architecture Engineering and Construction and includes its benefits, strengths with the rest of the challenges that organizations face during implementation. Part 2.4 is devoted to the concept of organizational willingness to implement AI compared to actual implementation and the influential determinants that are assessed. Section 2.5 pays attention to project performance indicators analysis and explores the possibility of improving them with the assistance of quality and technological enhancements. Section 2.6 synthesizes prior

research concerned with exploring how the constructs inter-relate, particularly concentrating on research that develops and validates mediating frameworks. In Section 2.7, attention is shifted to outline key gaps in the existing studies and the purpose of the current research to cover the issues.

An extensive review of previous research on the part of the chapter defines the theoretical background to the conceptual model and hypothesized relationships of the study. The current chapter also illustrates why the proposed investigation is already an innovative and necessary contribution to the field with the help of anchoring the study into the existing theory.

1.10 Total Quality Management (TQM)

TQM is a comprehensive and integrated approach to management that focuses relatedly on ongoing improvement of the organization's processes, outputs and services to provide long-term customer satisfaction and business success. Grown out of solid operational groundings and institutionalized organizational culture TQM promotes employee engagement and embeds quality objectives with continuous processes improvement (Setiawan & Purba, 2021; Zaidi & Ahmad, 2020).

1.10.1 Core Principles of TQM

The fundamental principles of TQM are well defined and also out lined continually in studies in the academia and industry standards. These include:

- Leadership – Members of the organization help to create values, vision and ethical standards for the organization, and develop a culture focusing on quality.
- Strategic Planning – Links quality aims to organizational strategies and monitors development of these goals.
- Customer Focus – Focuses on learning about customer needs to raise satisfaction and loyalty.
- Measurement, Analysis and Knowledge Management – Makes data insights available for the strategic decision making and enables the institutional learning.
- Workforce Focus – Encourages engagement, training and consolidation of staff efforts with quality objectives.
- Operations Focus – Focuses on management and improvement of important work process in order to ensure quality results are delivered.

- Results – Judged the performance of organization in terms of customer satisfaction, operational efficiency, workforce effectiveness and financial goals.

These guiding principles outline the framework for organizations on how to bring quality constantly, in everyday work and big business strategies.

1.10.2 Historical Development of TQM

Post war-industrial revival in particular Japan has been instrumental in the evolution of TQM. The founders of modern quality practice were eminent quality scholars such as W. Edwards Deming, Joseph M. Juran, and Kaoru Ishikawa. Deming's management focused heavily on statistical quality and the role of the management whereas Juran dedicated work to quality planning and estimation of cost involved in poor quality. He created instruments in the forms of fishbone diagrams and focused a lot on involving every employee (Dhamija & Bag, 2020).

By the 1980s and 1990s, TQM developed into structured frameworks and was large scale adopted by Western companies in order to improve their competitiveness in the world. At this period, governmental agencies and industry associations started quality awards and certification schemes to regulate and strengthen TQM standards throughout the industry.

1.10.3 Leading TQM Frameworks

TQM is achieved and measured by relying on recognized global frameworks that define criteria for measuring and improving the performance of the organization(estimations):

- Malcolm Baldrige National Quality Award (MBNQA): the MBNQA was developed in 1987 in the U.S. as a holistic framework, which encompasses seven dimensions, used to measure an organization performance: leadership, strategy direction, client focus, measurement and analysis, development of employees, operational excellence, and performance outcomes. With two purposes, the MBNQA is accepted and used across the country as a self-assessment tool aimed at steering performance excellence (Hyun Park et al., 2017; Taraza et al., 2023).
- ISO 9000 Family: The ISO 9000 family, most notably 9001:2015 gives a universal standard of a quality management system. ISO 9001 highlights the risk-based thinking, dynamic leadership, integrated processes and data driven approach in strategy making. ISO 9001 certification is a common choice of firms to demonstrate

compliance with quality criteria and increase the businesses' competitiveness in international markets (Setiawan & Purba, 2021).

- Deming Prize: The Deming prize was established in Japan in 1951 and was given to organizations that have outstanding outcomes of applying TQM principles. Its sphere of interest comprises of intensive efforts on management representation, strategic planning, DB decision making, and interdepartmental collaboration.

The similarity of these frameworks is that they aim at achieving a state of excellence within an organization through quality practices, however, they differ individually in terms of coverage, being inculcated and focusing.

1.10.4 TQM in Contemporary Research

TQM has ceased to be restricted to the sphere of manufacturing and has spread to any sphere that fosters performance excellence of services provision, healthcare and education towards perfection of results and projects. Researchers are discovering more and more that TQM will indeed facilitate organizational learning, innovate and provide long-term performance outcomes. TQM of the company becomes successful and, in addition, increases the productivity of the internal processes of the enterprise and promoting the creation of the future-oriented one, such as the digital transformation and the technological adoption of a company (Vasilieva et al., 2023).

Finally, total quality management proves to be a demanding and dynamic management tool whose unavoidable importance is felt in modern and fast exceeding and technological firms. Other than as a tool of continuous improvement, TQM serves as an overall principle to guide an organization that desires to incorporate new technologies like A.I into the quality processes of the organization.

1.11 TQM in the AEC Sector

Fluctuating need for interdisciplinary teamwork, desire for frequent adjustments in the scope of a project, high deadline pressure, limited budget, and a high degree of uncertainty are just some of the AEC sector complexity determinants. TQM has become an essential strategic structure within the AEC industry, due to the dynamic nature of project needs, for realizing optimal project results, improving work processes and enhancing client satisfaction (Hyun Park et al., 2017).

1.11.1 Importance of TQM in Project-Based Environments

While other sectors offer a standard product, AEC projects look at one-off mega-trucks with bespoke solutions. AEC projects incorporate a complicated set of stakeholders including architectural firms, engineers, contractors, consultants, and clients with unique interests and the expectations. Such division increases the chances of communication problems, error, and financial overrun and schedule delay. reply

TQM supports project management since it packages quality processes throughout all construction stages like design, procurement, construction and hand-over. It favors avoiding faults during the construction process to the post-construction process of remedying them, a fact particularly noteworthy in the sense that the cost of rework, and the negative effects associated with it, can be considerable (Zaidi & Ahmad, 2020).

1.11.2 Challenges of TQM Adoption in the AEC Sector

Despite all the benefits TQM will bring, the reluctance to embed it into the AEC industry is predetermined by a complex of issues:

- Cultural resistance: On the one hand, cultural resistance is the price required to provide the project on time and meeting the budget and equally good systems are considered a relative minority priority and, hence, is always slightly more or slightly less consistently assimilating practices of TQM.
- Fragmented project delivery: When expectations of quality differ among many subcontractors and vendors, it is standard to encounter barriers which prevent homogeneous integration of TQM.
- Limited awareness and training: The majority of the firms in this category are widely unfamiliar with, or uneducated on, quality management systems, like ISO 9001, or MBNQA.
- Short-term project mindset: Teams that have project-based model may slow down ability by organizations to maintain quality improvement programs involving long run strategies (Wall, 2021).

These are magnified within countries like Palestine, which being infrastructural lacking, with no resources, no proper regulatory framework to influence quality management into the system.

1.11.3 Benefits of TQM in the AEC Sector

Nevertheless, performance improvement across several dimensions is invariably reported by TQM implementers in construction setting when they are successful.

- Time and cost efficiency: The delay is avoided and rework is eradicated through routine working procedures and proactive quality auditing.
- Client satisfaction: Stakeholder's confidence is improved by quality assurance and communication protocols.
- Reputation and competitiveness: The nature of certification/adherence to ISO/MBNQA criteria and the equivalent is itself a guarantee of professionalism and increases eligibility to work on high value projects.
- Employee engagement: Accountability measures and procedures will boost their morale and perform well as a team.

Empirically, Hyun Park affirmed that the TQM dimensions viz. the support of top management, training and process control, establish significant positive influence on the performance of AEC firms. Akhmatova adhered to their conclusions since she highlighted those relentless efforts to boost productivity not only in operations but also responsiveness to change under the circumstances of a project(Akhmatova et al., 2022; Hyun Park et al., 2017).

1.11.4 TQM as a Foundation for Innovation

The new literature is a reconstruction of TQM as something that enhances performance but also a prerequisite of digital innovation. The institutionalization of systematic process provides TQM data collection and accountability practices with the fertile soil to adopt technologies related to building information models (BIM), internet of things (IoT), or Artificial Intelligence (AI). Also, organizations that have already embarked on a journey on quality standards will find it less tedious to integrate these technologies more regularly as they are already occupying a culture of process discipline and evidence based-decisions (Vasilieva et al., 2023).

Finally, AEC business as a company has some obstacles to the QM but there are infertile advantages in the TQM. Even better, the digital world of TQM might be a form of strategic enabling factor that will turn organizations to the ultimate revolution of

performance excellence - i.e. creating the use of AI tools and systems into a project setting.

1.12 Artificial Intelligence in Project Management

Artificial Intelligence (AI) is increasingly becoming the space of managing and optimizing projects in various field. In the architecture, engineering, and construction (AEC) world, AI is being deployed to solve the most stubborn of problems, including cost over-runs, schedule delay, fragmented information, and safety hazards. As a field of computer science, AI allows the machines to perform human cognitive functions such as learning, reasoning, problem-solving, and decision making – and these capabilities are now being built into project management tools and platforms (Dhamija & Bag, 2020).

1.12.1 Defining AI in the Context of Construction

In the framework of project management, specifically, in construction and design spheres, AI means algorithms, data model and self-learning system for automating processes, deriving insights and informing decisions. Applications can be machine learning, natural language processing, computer vision, robotic process automation (RPA), predictive analytics. These technologies enable a project team to interpret bigger data-sets and anticipate results and act in real time to changes in the variables of their project (Zhao & Gómez Fariñas, 2023).

1.12.2 Applications of AI in AEC Project Management

The application of AI in the building and design process is rapidly expanding and an increased number of applications are emerging throughout the project lifecycle.

Planning and Scheduling: AI can be used to optimize the allocation of resources and to generate predictive schedules based on past data. These sorts of tools automatically tweak to those disturbances by producing an individual who's more efficient with time.

Cost Estimation and Budgeting: Machine learning models are more precise in cost estimates than standard methods because it uses the market trends, nature of the project and vendor history.

Risk Analysis: The patterns that signify threats of safety, schedule delay or scope creep can be identified using AI algorithms, which can foresee risk mitigation.

Design Optimization: The AI-based generative design offers architects and engineers a large number of options of designs that are structurally and aesthetically feasible because they are easily tested.

Quality and Safety Monitoring

Document Management and Communication: Natural language processing can also be used to automate classification and summaries of documentation of a project in a manner that makes the communication process between the stakeholders easier.

This is not only to enhance project execution but the basis of real time responsiveness, which is likely to play a crucial role in dynamic project settings (Saha et al., 2022).

1.12.3 AI's Strategic Role in Project Management

Beyond operational efficiency, AI is also becoming regarded as strategic capability to an organization that boosts its decision making in the face of uncertainty. AI systems offer valuable insights in the deluge of unstructured information - BIM files and supplier databases, field reports and weather forecasts, and much more. It is a benefit of predictive project control as managers can foresee problems, instead of responding to them after the event (Pallavi Tyagi, 2023).

Besides, AI aids knowledge management by collecting insights learnt, obtaining conclusions from completed projects and suggests action due to past success or failure patterns. This is especially suitable in the AEC industry where knowledge is routinely tacit and forgotten between projects.

1.12.4 Barriers to AI Adoption in AEC Firms

Regardless of its increasing applicability, implementation of AI in the construction sector specifically, in such developing economies as Palestine is variable. There are a number of barriers which prevent its full-scale implementation:

- High investment costs and uncertain return on investment (ROI).
- Lack of skilled personnel capable of managing AI tools.
- Resistance to change from traditional project teams.
- Data privacy and integration concerns, particularly in firms with legacy systems.
- Limited awareness of available AI tools and their practical benefits.

These barriers emphasize the value of organizational preparedness and cultural congruency as the precondition of the successful AI adoption(Vasilieva et al., 2023; Wall, 2021).

1.12.5 AI and the Future of Project Delivery

As the construction projects continue to move quickly, data-rich and complex, AI will continue to become all the more strategy-critical. AI does not merely robots, it actually changes the decision-making procedure, not the intuition, but the project intelligence. When PMS systems are introduced, AI increases the responsiveness of the effort to offer greater agility and resilience to firms, such that they can respond to any change in the scope of work addressed, or consumer needs, or external threats, in a quick manner.

In a conclusion, AI can be an effective instrument, as far as re-definition of project management in the context of AEC companies is concerned. But success does not necessarily lie in the relative availability of technology, but in the organization and its willingness to accept it to a certain significant extent, a fact, which will be discussed later in this chapter.

1.13 Integration of AI and TQM

Although TQM is not novel to organization as a strategic tool of organizational exquisiteness, the complexities and volumes of data of our business surroundings demand innovative methods of sustaining and cultivating upon quality. Artificial Intelligence (AI) may allow creating a unique chance to reformulate and update the TQM practices to have the chance to cover: automation; predictive analytics; and data-based decision-making in those systems. The introduction of AI in TQM may as well result in a new generation of intelligent quality management, the ancient concepts of continuous improvement being streamed with new AI-oriented approaches: live quality feedback and predictive learning algorithms (Dhamija & Bag, 2020).

1.13.1 Enhancing TQM Capabilities Through AI

Some of the simplest TQM actions can be supported or influenced with the help of AI.
Process Optimization: AI software will be able to examine the data of the workflow and determine the ineffectiveness, bottlenecking, or variation in the amount of performance. This also helps to maintain the process improvement which forms the foundation of TQM.

Quality Control and Defect Prevention: Computer vision and machine learning devices have the opportunity to determine defects of design documents, site photos, or final products automatically, increasing the accuracy of the inspection process, as well as the scope of its implementation by human hands.

Customer Focus: AI-based sentiment analysis and data mining obtained in accordance with the feedback of clients enable organizations to learn what people need, and expecting more and design products and services accordingly.

Employee Empowerment: Chatbots and AI-driven interfaces can assist the employees access the real-time operation data, training programs and standard operation procedures-reusing their functions in the quality assurance.

Leadership and Decision Support: AI dashboards and predictive analytics enable leaders to have a view of quality metrics and performance trends with the clear knowledge of how to proactively manage.

These enhancements strengthen TQM assembled structure, which is more responsive, foreseeing and information reactive(How et al., 2020; Pallavi Tyagi, 2023).

1.13.2 Empirical Evidence from Other Industries

Although little is known as to its scope of construction, several industries provide empirical findings on the positive relationship between AI and TQM:

- In manufacturing AI has been implemented for the prediction of machine failure and improve preventive maintenance systems so that the downtime has decreased dramatically and the product quality is increased.
- AI-assisted diagnostic systems have increased accuracy rates hence strengthening quality procedures at patient care in healthcare.
- In logistics firms use AI to optimize supply chains; predict delivery delays; reduce errors-direct aid to continuous improvement initiatives.

1.13.3 Synergistic Benefits of TQM-AI Alignment

The integration of AI and TQM can be used in an organization in a manner that is synergistic. These are not merely the results that the two effects may sum up to. TQM is the cultural and procedural bed - structured working processes, accountability

mechanisms, performance measure - against which to build AI into. In its turn, TQM becomes stiffer, scalable and more far-sighted with the assistance of AI. This synergy enhances:

- Real time continuous improvement not post project reviews.
- Defects preventive methodology based on predictive alerts and automation.
- Interdisciplinary teamwork, facilitated by common information systems and intelligent communication tools.

Such integration builds a digital empowered quality management ecosystem that is appropriate to the project-based and innovativeness-oriented character of such an industry as construction (Alanazi, 2020; Saha et al., 2022).

1.13.4 Challenges and Conditions for Integration

Despite the promise, integrating AI in TQM has a number of challenges. The implementation will be successful depending on:

- The quality and availability of data The AI systems need to have access to quality and reliable history to train and predict.
- Leadership support, to align AI initiatives with strategic quality goals.
- Workforce readiness, ensuring employees are not only trained but also motivated to use AI-enhanced tools.
- The adoption of change management strategies, to overcome resistance and establish credibility in the quality processes strengthened with AI.

Organizations practicing TQM face these challenges easily because of well-structured planning, process review and tracking performance that TQM presents to organizations.

1.13.5 Relevance to the AEC Sector

The use of AI in the AEC sector, where the fragmentation of project and risk are normative, may be conducive to TQM, such that automated design validation, schedule prediction, and safety inspection (all in keeping with the goal of TQM to get it right) could be realized. Nevertheless, companies that combine the two schemes in parallel will have their projects delivered, customer satisfaction, and organizational learning improved in a colossal manner (Wall, 2021; Wassan et al., 2022).

1.14 Organizational Willingness to Adopt AI

Since Artificial Intelligence (AI) plays a bigger role in contemporary project management, the success of the technologies used in modern organizations does not only depend on technical ability but willingness of the organizations to embrace and accept AI strategies. In the context of AEC sector – specifically in developing economies such as Palestine this intention takes place from complex interplay of leadership vision, organizational culture, perceived value and readiness of change (Pallavi Tyagi, 2023; Vasilieva et al., 2023).

1.14.1 Defining Organizational Willingness

Organizational willingness to adopt AI will be the internal state and directional orientation of a firm to adopt AI technologies. It includes such things as attitudinal readiness, perceived usefulness, leadership advocacy, digital openness and innovation culture. Willingness as opposed to technical readiness Zeal or the lack of it is what drives or slows up AI adoption; the intangibles but critical psychological and cultural determinants (Munir S et al., 2023).

1.14.2 Leadership as a Driver of Willingness

Such attitudes of organizations towards innovation are largely influenced by leadership. It is not only funding and resource allocation, that leaders impact, but how change is communicated and managed as well. Organizations that are highly supportive concerning AI topical issues tend to succeed in overcoming resistance and also creating a space for experimentation and technological integration into their ideologies (Alanazi, 2020).

Willingness supported leadership behaviors are:

- Airs about AI in the strategic planning.
- Establishing innovation-friendly policies.
- Modeling openness to technological change.
- ·Spent on AI oriented training and capability building.

Unless there is apparent leadership commitment the effort on AI adoption is usually disperse or abandoned in the early stages.

1.14.3 Culture and Change Readiness

AI adoption is largely influenced by organizational culture. A culture embedded in the old way of conducting projects may reject automation, fear to lose jobs or deride algorithmic decision making. On the other hand, cultures that value collaboration, transparency, learning, and flexibility are likely to adopt AI as an optimizer, rather than something threatening their existing roles (Zhao & Gómez Fariñas, 2023).

AI change management is a preparation of the workforce emotionally and intellectually for digital disruption. This includes:

- Communicating strategic value of AI.
- Addressing fears of job redundancy.
- Early initiation of employees in stages of implementation.
- Encouraging feedback and continuous learning.

Firms that do not consider these cultural dimensions remain to have poor adoption outcomes despite good technical tools.

1.14.4 Perceived Usefulness and Strategic Fit

The perceived usefulness of new technology as a factor of technology adoption is one of the most important determinants of new technology adoption. In the case of AI, this presupposes those employees and manager have to believe that AI tools will enable them to conduct their tasks, more effectively. Additionally, AI has to adapt accordingly toward organizational goal, working processes, and customer expectation in order to receive internal support (Saha et al., 2022).

Perceived risks (as data security, implementation complexity, and ROI uncertainty, can reduce the willingness when usefulness is recognized. Therefore, organizational communication and training initiatives should not only be concerned with the operation of AI, but why its operation is of importance, given that it contributes to enhancing existing quality and performance interventions.

1.14.5 Digital Maturity and Capability Support

The overall state of digital maturity of the firm is also more likely to increase willingness. This integrates explicit digital vision, which allows IT systems and cohort of sharing information such as experience in working with digital features as Building Information

Modeling (BIM) or cloud project management and at the same time through other digital features. When organizations view AI as part of an overall transfiguration strategy, they can more effectively dedicate the resource and time to do so (Dhamija & Bag, 2020).

It is even more essential to construction settings where the lack of digitization in physical environments and the dominance of conservative workflows remained a traditional issue. Firms must not only be technically prepared, but they need to be mentally and culturally positioned, to exercise appropriate utility of AI tools.

1.14.6 Relevance to the Palestinian AEC Context

The further structural barriers to organizational preparedness to AI in Palestine are political instability, lack of funding and the lack of access to advanced technologies. Despite those issues, companies that have already instituted TQM frame work could possess healthy internal systems, leadership cohesiveness and employee engagement - all of which are central to building AI readiness(Wall, 2021; Wassan et al., 2022).

In the present study, the willingness of the organization to implement AI is the conceptualized mediating variable linking structured quality systems (TQM) to enhanced project performance. Its existence or lack thereof may determine whether the digital transformation of the AI tools into the operational benefits is a key construct in the analysis of the digital transformation in the AEC field.

1.15 Summary of Empirical Studies

The personal and collective implications of TQM, and Artificial Intelligence (AI) on various facets of organizational performance have been supported by masses of empirical studies. Nevertheless, relatively few studies have been performed that would merge both constructs - particularly in regards to the project-based industries like the Architecture, Engineering, and Construction (AEC) industry. Moreover, the role of the willingness of an organization to embrace AI in this relationship, specifically, resource-scrapped contexts, has been researched very sparingly.

TQM's relation to improved project results in cost control, timely completion of projects, stakeholder satisfaction, and quality compliance is always the focus of various studies. On parallel tracks, AI has empirically associated with better decision-making, de facto elimination of defects, predictive scheduling, and operational efficiency. Some

researchers propose that TQM can become the enabler for AI integration enabling creation of structured environment for innovation and change. The following table shows a synthesis of some empirical studies which investigate the relationships between these constructs, indicating its research focus, the environment under which the study was carried out and the major findings of the study. All Data in table 1 in appendix 1

Table 1

Summary of Empirical Studies on TQM, AI, and Project Performance

Article #	Reference	Article Full Name	Findings	Variables
Article 1	(Akhmatova et al., 2022)	Integrating Quality Management Systems (TQM) in the Digital Age of Intelligent Transportation Systems Industry 4.0	Industry 4. 0 has a positive impact with TQM implementation while some of the challenges are the security of information and skilled workforce.	TQM, Industry 4.0, Digitalization
ETC	ETC	ETC	ETC	ETC

The form for summery of Empirical Studies on TQM, AI, and Project Performance with an example for the first article

These studies as a whole corroborate the main thesis assertion of this work. TQM and AI are collaborative drivers of project performance and their relationship is moderated by an organization's readiness and willingness toward digital transformation. The review goes ahead to support the relevance of the proposed conceptual model, where TQM is the independent variable, organizational willingness to adopt AI as the mediator and project performance is the outcome variable.

1.16 Gaps in the Literature

While a significant literature exists around TQM, Artificial Intelligence (AI) and project performance, numerous critical gaps exist – especially between these constructs and in the context of developing, and conflict-affected such as Palestine. Such gaps legitimize the necessity of this study as well as evidence the novelty and practice of its contribution to the theory and practice.

1.16.1 Limited Integration of TQM and AI in Construction Research

Although TQM and AI both hold independent impacts in improving organizational performance, little empirical analysis has investigated the strategic synergies that may be generated by the strategic integration of these two frameworks. The bulk of TQM research is aimed at internal process and cultural improvement, the increasing matters of emphasis in AI research is technical efficiency and automation. The absence of models which integrates these perspectives restricts the understanding of how quality management systems can enhance or magnify AI technologies in project settings in the real world (Alanazi, 2020; Vasilieva et al., 2023).

1.16.2 Overlooked Role of Organizational Willingness as a Mediator

A second significant gap is the lack of representatives for the organizational willingness to adopt AI as a mediating variable. Although technological readiness and leadership support are discussed quite frequently, there are not many studies which specifically distinguish willingness as a psychological and cultural trait which predicts the likely failure or success of AI adoptions. Especially in project-oriented settings, willingness is a decisive, yet understudied cross-over point between established management systems and ultimately applied digital innovations (Munir S et al., 2023; Pallavi Tyagi, 2023).

1.16.3 Lack of Context-Specific Frameworks for Developing Economies

Majority of the existing models are based on data obtained in developed or economically stable countries. In this way, they neglect the specificity of developing economies, their financial restraints, their poor digital infrastructure, their political instability, and a low level of digital literacy. The little research that has been carried out in developing countries tends to include such limitations as background variables, rather than fundamental parts of the study framework. There is a feasible need for a context sensitive model that would capture the operational and institutional realities and the cultures of regions like Palestine's AEC sector (Saha et al., 2022; Wall, 2021).

1.16.4 Scarcity of Empirical Validation Using Structural Models

Though an increasing number of conceptual arguments on the potential synergy between TQM and AI are published, little empirical evidence is provided by structural equation modelling (SEM). The use of techniques such as Partial Least Square Structural Equation Modeling (PLSSEM) can help generate robust results of causation and the presence of

intervening effects that contribute to fitness of model - however, they have not been extensively used in this intersectional area of research, particularly within construction and engineering.

The current study addresses these gaps with the development and validation of a conceptual framework with a contextualized rationale of how TQM relates to project performance with the mediating role of organizational intention to embrace AI, which is driven by the empirical evidence of Palestinian AEC companies. In addition to the new theoretical applications, the work also provides concrete advice to companies operating in the same limited environment interested in implementing quality management and digital transformation.

1.17 Conceptual Framework

Based on the literature review and gaps in the research, this study proposes a conceptual framework that incorporates TQM, organizational responsiveness to Artificial Intelligence (AI), and project performance on the background of the AEC sector in Palestine. The framework is based on the quality management, innovation adoption and organizational performance theories, but with empirical research that suggests consequential interdependencies among the constructs.

1.17.1 Theoretical Foundation

This model is based on:
TQM theory that assumes systematic quality systems boost process effectiveness, eliminates wastes and contentment of the stakeholders. Technology Acceptance and Organizational Readiness models that lead to the importance of the psychological, cultural and strategic aspects of digital adoption. And the contingency theory supporting the argument that the effectiveness of the organization is contingent on the internal capabilities, in response to external demands.

A combination of these positions, the framework provides the general image of quality improvement whereby quality practices are the structural base or foundation, AI is the technology catalyst, and willingness is the condition of success in this shift.

1.17.2 Framework Constructs

Independent Variable: Total Quality Management (TQM) - Leadership commitment, Process management, Employee involvement, Continuous improvement and Customer focus are also the dimensions. TQM is the platform of systemic alignment of the organizations, consistency of operational conditions of the factors and the data-based decision-making process.

Mediating Variable: Organizational Willingness to Adopt AI – Theorized as a firm orientation and culture towards AI technologies. These areas of leadership are leadership advocacy, openness to innovation spirit, perceived usefulness, and alignment with strategic goals.

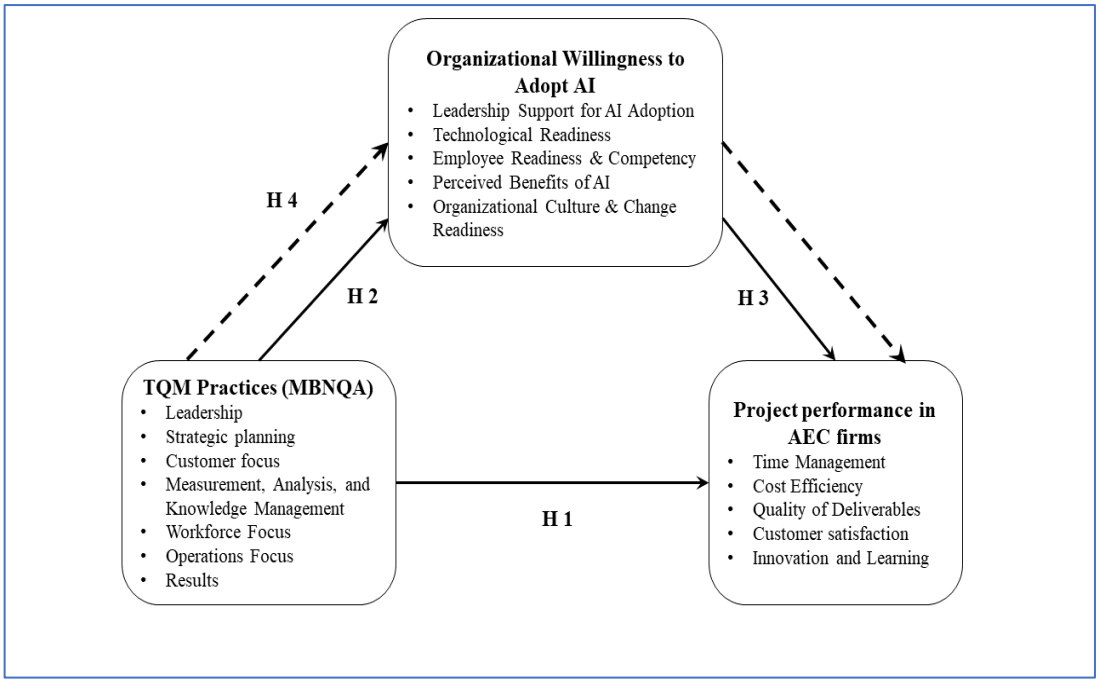
Dependent Variable: Project Performance – Offered to explain the tracking of a project by some performance indicators; such as adherence to budget and schedule, quality of deliverables and stake holder satisfaction, responsiveness to risks.

1.17.3 Visual Representation

A diagram representing the conceptual framework showing:

Figure 1

Theoretical framework



This model is used to create hypotheses and carry out structural testing, which is conducted later. It captures a strategic perspective of the interaction between quality practices and readiness to innovate to bring about quantifiable results in performance-driven sectors.

Independent Variable and Constructs

Total Quality Management (TQM)

The independent variable (IV) is TQM, The TQM system is an entire management vision in which quality improvement has been anchored on the sustained customer satisfaction and the incessant process optimization and articulated quality systems. The validated approach creates measurable operational performance more favorable because it quells operational inefficiencies and minimized expenses and improved quality of products and services. Real life project management issues in modern environments are more than constraints of that practice of TQM implementation. The Palestinian AEC industry is currently confronted with limited resource base and more primitive infrastructure constraints as it is subjected to a perpetual political unrest. In order to counter these concerns, there exists an urgent need that the TQM frameworks adopted be at least modeled after internationally-recognized model such as the Malcolm Baldrige National Quality Award (MBNQA). These standardized models bring a universal model of quality management that can be localized to the requirements of the localities that results in the stability of structures and improved quality of operations. (Alanazi, 2020; Setiawan & Purba, 2021)

TQM Metrics MBNQA Principles to Be Integrated

Based on a thorough review of the literature, the paper applies the concepts of Malcolm Baldrige National Quality Award (MBNQA) to the TQM practices within the AEC industry. The chosen measures Leadership, Strategic Planning, Customer Focus, Measurement and Knowledge Management, Workforce Focus, Operations Focus, and Results provide a full-fledged framework of the excellence accomplishment. Basing the argument on the conclusions made by Setiawan and Purba, and Taraza et al and other results indicated in table 1. these measures highlight alignment of leadership, strategic planning, workforce development and customer centric approaches to enhance the performance of projects and maintain competitiveness in the AEC industry.

Leadership: Through Leadership MBNQA demonstrates how top management guides organizations toward achieving quality excellence. Organizations achieve success through leadership that creates well-defined aims and objectives and stands for aligned values at the same time it develops accountability standards together with ethical conduct standards and continuous enhancement initiatives. Senior leadership members have the core responsibility to energize workforce members as they maintain strategic focus goals while creating organizational innovative capabilities. The AEC sector depends heavily on effective leadership which combines the task alignment with quality requirements alongside stakeholder team coordination and quality standard enforcement among different organizational tiers.(Setiawan & Purba, 2021; Taraza et al., 2023)

Strategic Planning: Organizations using the Strategic Planning component develop long-term objectives while strategically aligning their resources to fulfil those goals. Organizations deploy this method to establish crucial objectives and unite quality enhancement efforts while having risk factors incorporate into their decision-making structure. An organization needs regular strategy updates because market dynamics evolve alongside customer demands and new industry difficulties emerge. AEC companies maintain competitive positioning through strategic planning when they adopt optimal project management protocols and efficient resource distribution methods alongside optimized operational structures which results in superior project performance.(Setiawan & Purba, 2021; Taraza et al., 2023)

Customer Focus: Customer Focus stands as a central component in MBNQA programs which requires businesses to both grasp customer requirements and deliver experiences that surpass those expectations. Organizations need to stay intimately connected to their customers through dynamic service improvement programs which build customer satisfaction and increase loyalty among clients. Service excellence initiatives combined with effective customer relationship management strategies create the tools organizations need to maintain their competitive standing. To establish enduring partnerships in the AEC sector firms must focus their efforts on meeting client needs through following project timelines, delivering high-quality work within budgets and adjusting to market variation and specific requirements. (Setiawan & Purba, 2021; Taraza et al., 2023)

The Measurement, Analysis, and Knowledge Management: To achieve organizational excellence decision-making relies on effective data-driven analysis according to the

Measurement, Analysis and Knowledge Management criterion. The collection of data followed by analytical processing and effective utilization allows organizations to follow performance standards and discover optimal practices for strategic actions and decisions. Organizations practicing efficient knowledge management create data-sharing systems between different teams while employing technology tools including AI and analytics for data analysis and by setting industry benchmarks. AEC firms benefit from real-time project monitoring tools along with predictive analytics to create proactive strategies and decrease operational risks delivering better project results. (Setiawan & Purba, 2021; Taraza et al., 2023)

The Workforce Focus Organizations in the Workforce Focus criterion show how they tap human capital to stimulate participation of employee in its mission of establishing a successful high-performance environment. Both training programs and competency development and a systematic inclusion system along with a total employee participation paradigm are part of this model. Organisations, to help in their quality improvement efforts must inspire the staff with their required skills and tools. In the AEC industry, investing in workforce education is necessary, as it helps to adapt to changes in sector standards and new technology and complex engineering projects (Setiawan & Purba, 2021; Taraza et al., 2023).

The Operations Focus: Operations Focus measures organizational efficiency when it comes to optimizing fundamental operational processes while increasing both performance and quality. Process standardization combined with supply chain management alongside continuous improvement and risk mitigation strategies makes up this metric. The streamlined management of daily operations leads to project perfection and reduces resource waste while raising overall productivity levels. The AEC industry benefits from standardized operational workflows combined with advanced project management tools to maximize resource utility while speeding up project completion time and meeting both regulatory criteria and quality requirements. (Setiawan & Purba, 2021; Taraza et al., 2023)

The Result: The Results category monitors economic performance results along with operational achievements and customer satisfaction statistics for organizations. The assessment of strategic goal achievement requires organizations to keep track of key performance indicators including profitability targets and project timeline productivity

and client satisfaction feedback. Firms operating in the AEC sector achieve operational excellence with cost reduction and maintain both business sustainability and competitive advantage through effective quality management implementation. (Setiawan & Purba, 2021; Taraza et al., 2023).

Mediating Variable and Constructs

Organizational Willingness to Adopt AI

The willingness of an organization to embrace Artificial Intelligence (AI) in this study is conceptualized as a mediating variable between the TQM and performance of the project. The role of a mediator variable is that it explains the mechanism by which an independent variable comes to bear on a dependent variable whereas a moderator merely modifies the strength or direction of such a relationship. Leadership commitment, continuous improvement, and customer focus are some of the TQM practices that create an open, learning, and innovating culture. Such cultural basis leads to a greater willingness of organizations to use new technologies, such as AI. This willingness, in turn, increases the results of a project in terms of better decision-making, efficiency, and flexibility. (Saha et al., 2022)

Therefore, being willing to adopt AI is a part of causation pathway between TQM and project performance. This conforms to the Resource-Based View (RBV) that concentrated on the reality that capabilities that are produced in an organization as a result of quality management serve as an impetus to additional strategic resources such as digital adoption. It is also aligned with Contingency Theory that proposes that TQM effectiveness is influenced by how internal processes of the organizations are adapted to face external environmental and technological needs. In this regard, willingness is not a boundary condition, which moderates TQM time effectiveness, but is a process, which defines how TQM is transformed into improved project performance regarding digital readiness. (Pallavi Tyagi, 2023)

the adoption of AI is a key technology that underpins the functionality of Total Quality Management systems to a large extent. With AI, predictive analytics enable organizations to perform ongoing quality control as they deploy data-driven resource molds with the latest machine learning and big data analytics and automatic solution tools. The innovative technology plays an essential role for Palestinian AEC firms dealing with

complicated projects by limited resources and competing in a challenging market. When Organizations are willing to implement AI, they record improved outcomes to TQM strategies as well as increased innovation and operational effectiveness and sustainable competitive advantage. Organizations must encourage their employees to adopt AI technology by matching international standards thus overcoming regional obstacles.(Saha et al., 2022).

Organizational Willingness to Adopt AI Metrics based on previous studies Previous academic research has served as the source of insights to develop the metrics which measure Organizational Willingness to Adopt AI. A company's ability to adopt AI depends on Leadership Support and Technological Readiness along with Employee Readiness, Perceived Benefits and Organizational Culture. Through research analysis it becomes clear that AI adoption succeeds when organizational leaders demonstrate strong support along with prepared infrastructure and change-ready trained employees. Zhao & Gómez Fariñas and Dhamija & Bag and others from table 1, show successful AI integration depends on both an organizational innovation culture and widespread confidence in AI benefits. The metrics remain useful tools for assessing an AEC company's AI adoption preparedness.

Leadership Support for AI Adoption: Organizations will embrace Artificial Intelligence only when their top leaders show approval. Senior leaders need to lead AI projects by giving money and setting strategic directions to help business systems use artificial intelligence better. When top leaders don't back AI adoption plans those plans often get actively opposed by employees and other parts of the organization. When leaders step forward, they create AI technology trust while bringing AI projects closer to business goals.(Zhao & Gómez Fariñas, 2023)

Technological Readiness: The infrastructure and software availability along with the organization's technical staff knowledge prepare its AI system deployment. Companies with established information technology infrastructure and digital platforms earn better chances of achieving AI implementation success. AEC companies must check their IT system readiness to decide what changes are needed before bringing AI technology on board. Updating our systems with new technology assists us in getting better ready for using artificial intelligence while making the shift to AI operations run smoothly.(Dhamija & Bag, 2020)

Employee Readiness and Competency: Organizations succeed with AI when their workers are prepared to use these technologies. Employees require proper knowledge training and interest to accept AI technology. Organizations need to train their teams and lead change projects to help staff get ready for AI use. Company success with AI increases when they train their employees in AI skills (Pallavi Tyagi, 2023).

Perceived Benefits of AI: Organizations choose to use AI based on what they believe the technology can bring to them. Organizations adopt AI systems because they believe AI will create better ways to get work done while lowering expenses and sharpening decision-making processes. Companies that see how AI helps them run projects more effectively and use their assets better will quickly adopt these tools.(Sinonquel et al., 2021)

Organizational Culture and Change Readiness: When companies embrace innovation and digital development properly their AI transition becomes successful. and When organizations let employees explore new ideas and learn from experience, they achieve better results when adding AI technology. Change readiness requires organizations to test their readiness toward AI use and create solutions to fight negative reactions.(Dhamija & Bag, 2020)

Dependent Variable and Constructs

Project Performance

The dependent variable (DV), Also the key evaluation metric of Project consists of four interconnected dimensions which include project time management and project Finances and both Final product quality and receiver satisfaction ratings. A project requires these dimensions for successful evaluation. The research-defined hypothesis demonstrates that fully implementing TQM while intentionally integrating strategic Artificial Intelligence elements produces noticeable positive impacts on complete project performance benchmarks. The Palestinian territories face regular project hurdles because of their political instability and economic disruptions but TQM's focus with AI integration creates an effective solution for resource management while enabling robust real-time data-driven project management systems. This strategic combination aims to surpass industry requirements by tailoring to fast-paced sector demands to enhance operational

achievement while strengthening strategic company positioning in the sector (Wall, 2021).

Project Performance Metrics based on previous studies The study introduces Project Performance metrics that are based on findings that come from research established in previous academic research. Performance in the AEC sector is highly dependent on Time Management and the Cost Efficiency of deliverables which combines with Quality Standards and Modern Learning Techniques to drive project success. With effective time management companies reach milestones while minimizing delays and proper cost efficiency enables firms to keep expenditures in-line while managing resources efficiently. According to Yas & and Zaidi & Ahmad and others from table 1 research solid foundational methods such as Total Quality Management with modern technologies including Artificial Intelligence enable process streamlining while enhancing quality standards and promoting ongoing improvement efforts. Evaluation metrics provide an important foundation to effectively measure construction performance in the context of the complex environment of the AEC sector in Palestine.

Time Management: Good time management aids in determining the success of the projects for firms in the AEC sector who need their deadlines to be met. Good time management helps the project team meet planned milestones which reduces project delays. Programming and time forecasting tools combined with automated workflows help businesses better use their resources which reduces project delays and boosts output. Adding AI to Time-Based Quality Management lets organizations speed up projects by setting uniform processes and fixing wasteful steps.(Yas et al., 2021; Zaidi & Ahmad, 2020)

Cost Efficiency: Running effective project cost operations becomes necessary for successful business results. Organizations achieve better expense management by scheduling funds and materials properly to prevent price increases. AI technology helps AEC firms do expense predictions accurately to make better financial strategies. Implementing TQM components especially process enhancement and waste elimination techniques improve cost effectiveness and raises project finance results.(Zaidi & Ahmad, 2020)

Quality of Deliverables: The AEC sector relies on project management to achieve top-quality project results. When TQM frameworks guide project quality management it aims to maintain project specifications, decrease errors and build better customer relations. AI tools that automate inspections, analyze project data in real-time and find defects help deliver better and more consistent results. By uniting Total Quality Management and Artificial Intelligence companies achieve better project quality results and produce less defective work. (Wassan et al., 2022; Zaidi & Ahmad, 2020)

Innovation and Learning: In the dynamic AEC sector there are many ways of learning continually and innovating. The adoption of AI technologies in organizations' TQM frameworks helps organizations to develop a continuous improvement culture through the usage of data driven insights, automation, and advanced analytics to support project successes. A learning-oriented culture when encouraged helps teams to adapt to new challenges, implement best practices and use technological understanding to push long term project success. (Zaidi & Ahmad, 2020)

This framework as depicted in Figure 1 is a direct and a mediated relationships of TQM, AI and project performance. In Palestine where political and economic instability bombards towards the delivery of a project, the integration of TQM and AI fills resource scarcity and allows real time data driven project management. The dual approach fits to the fast pace of and competition in the industry and will give firms the means to increase their strategic position.

1.18 Hypothesis Development

Hypothesis 1: Total Quality Management (TQM) impact on project performance in the AEC sector.

There is a strategic management approach for TQM to improve project performance by way from MBQNA metrics. Within the AEC sector, where projects are complex and resource intensive, the implementation of TQM Practices, i.e., leadership, strategic planning, work force focus… etc, has been proven to improve operation efficiency, lessen costs, and improve quality results. Implementation of effective TQM enables firms to accomplish project objectives through minimization of waste, delays and achievability of industry standards and client expectations. Quality improvement culture can be created by leadership while the participation of employees helps to ensure the quality principles

will be embedded in the day-to-day operation.(Asad et al., 2023; Setiawan & Purba, 2021; Taraza et al., 2023)

The literature has shown that organizations that use TQM have improved project results (e.g. improved cost management, on time delivery). The integration of TQM principles from MBQNA allows AEC firms to anticipate and prevent risks at the onset of the project, therefore allowing for more predictable, sustainable and risk-free project execution. In addition, when a firm commits to TQM, its processes are continuously fine-tuned and adapted to both industry changes and the company itself, enabling the firms to continue growing and succeeding in the long run. Although TQM is a benefit, the AEC industry's TQM adoption will prove successful when it is orchestrated by strategic planning, continuous training (education), and strong leadership support to achieve its best project performance benefits.(Alanazi, 2020; García-Alcaraz et al., 2021; Mushtaq & Peng, 2020; Setiawan & Purba, 2021; Taraza et al., 2023)

Hypothesis 2: Total Quality Management (TQM) impact on Willingness to Adopt AI
With integration of Artificial Intelligence (AI) into operations, the principles of TQM: continuous improvement, process optimization, employee involvement come naturally. TQM is mostly useful in AEC sector where efficiency and precision are essential to succeed, it's a forward-looking environment which is hospitable to innovations such as AI. The reason is that TQM not only boosts process efficiencies but also prepares and motivates employees to accommodate new technologies, thereby increasing the organizational readiness to accept AI.(Alanazi, 2020)

TQM goals to improve quality, efficiency of operations, and AI technologies can automate, enhance predictive analytics, and promote decision making are highly aligned. This hypothesis could be validated by examination of the relationship between the presence of TQM practices and the attitude of organizational towards AI adoption using survey or interview.(Akhmatova et al., 2022)

Hypothesis 3: The impact of organizational willingness to adopt AI and project performance.
This hypothesis suggests that the higher the organizational willingness to implement Artificial Intelligence (AI), the more efficient and the higher quality the project will be in terms of efficiency, quality and client satisfaction in AEC sector. Organizational will

includes leadership’s endorsement, an organization’s adaptation to new technology, employee training in AI tools and organization’s infrastructure preparedness for the effective use of AI in project management.(Liu & Lin, 2021; Zhao & Gómez Fariñas, 2023)

The readiness to adopt the AI can largely determine how well these technologies will be applied in project planning, execution, monitoring, and control. AI can, for example, improve resource allocation, risk management and real time data analytics, all crucial to better project results.(Pallavi Tyagi, 2023)

If this hypothesis is to be validated, data collected on the level of organizational willingness to give in to AI and corresponding project performance indicators would have been collected during the process. Then, the strength of the relationship between these variables can be found through any kind of statistical analysis.(Hyun Park et al., 2017)

Hypothesis 4: Organizational willingness to adopt AI mediates the relationship between TQM practices and project performance in the AEC sector.

We hypothesize that organizational willingness to become involved in TQM practices serves as crucial mediating variable in the relationship between TQM practices and the adoption of AI technologies. Not only does this relationship reflects how cultural receptiveness to innovation, leadership support for new technology, and operational preparedness can either promote or forestall the presence of AI within a TQM frame reference, but it also suggests that the advantages of TQM as a management tool are more effectively established by the same tools which foster AI implementation. Organizational willingness plays a mediating role: even in the presence of powerful TQM systems, highly leveraged AI technologies are likely to impact project performance only when the environment supported by such TQM systems is changed to an aligned organizational mindset and infrastructure. (Munir S et al., 2023)

A number of theoretical models may assist in the integration of TQM and AI, to illustrate how the practices can improve an organization’s readiness, to accept AI. Consequently, these models indicate that TQM's dedication to improving upon and maximizing the system is naturally united to the capabilities of AI to better operations and decision making. TQM plays an important role in nurturing the foundation for innovation and

therefore prepares the organization for the adoption of AI by systematic process enhancement as well as the quality improvement.(How et al., 2020)

The present hypothesis suggests that the readiness of the organizations within the AEC sector to adapt Artificial Intelligence (AI) operates as a vital intermediary variable that drives the effects of the TQM process on the projects' performance. Organizational willingness is identified as a mediating variable, in that although TQM prepares the groundwork for process improvements as well as readiness for innovation, the magnitude of the benefits of the practices of TQM on project outcomes are greatly increased or limited by the organization’s willingness to deploy AI.

The adoption taking place of AI is not embraced by every organization that will take it in; these organizations are characterized by a willingness to integrate AI into their organizations by being culturally open to innovation, sponsoring leadership support for new technology, and being tech and operational ready to realize AI integration. This is important because even the most established of TQM frameworks will only help improve project performance if they are aligned with actioning an organizational mindset and infrastructure to welcome AI's potential.

The hypothesis is empirically verified by gathering information about TQM practices, organization willingness to embrace AI, and project performance indicators, i.e., time, cost, and quality compliance. We will analyze the data to determine if the willingness of the technology to adopt AI is truly a mediator to further enhance the impact of TQM on project performance. (Hyun Park et al., 2017)

1.19 Summary of the Chapter

This chapter discussed the theoretical foundations and literature supporting such a relationship between TQM, Artificial Intelligence (AI) and organizational willingness to adopt AI and project performance in the Architecture, Engineering and Construction (AEC) industry.

This review commenced by giving the definition of TQM and establishing the principles of TQM and the historical development of TQM, the basis was laid with the help of well-known models such as MBNQA, Deming, and ISO 9000. It then explored some of the unique challenges and opportunities of using TQM particularly in project-based settings

- and specifically for the construction industry. This was followed by an analysis of the transformative role of AI in project management (from predictive analytics to design automation) and the potential for the AI, once merged with structured management systems, to improve quality outcomes.

The chapter also added organizational willingness to adopt AI as essential intervening construct that reflects the significance of leadership support and innovation culture, as well as of perceived usefulness as the enablers of digitalization. An empirical studies resume was generated to synergize the evidence base of the constructs of the study and to rationalize the suggested relationships. Although there is abundant literature regarding TQM and AI separately, the chapter found critical research gaps including the low integration of TQM and AI in AEC, and scholars who have not been exploring the mediating role of organizational willingness in developing economies such as Palestine.

To fill these gaps, the chapter suggested a conceptual framework constructing the relationship between TQM, AI willingness and project performance, and developed four testable hypotheses. The subsequent chapters will use this framework to design and analyze the research.

The methodology to be used in carrying out the test of the proposed model will be outlined in the next chapter as well as the research design, the population, sampling and the sampling instruments, data collection tools and the statistical analysis techniques.

Chapter Two

Methodology

2.1 Introduction

This chapter describes the methodological framework used to study the association between TQM and Project performance, concentrating on the mediating effect of organizational willingness to adopt Artificial Intelligence (AI) in AEC firms in Palestine. The chapter comprehensively describes the research design, population under study, sampling procedure, measures of variables, data collection procedures and methods of analysis.

Given the empirical nature of the study, the quantitative approach was used because statistical analysis of causal relationships between the constructs was feasible. The rationale for this methodology is an outgrowth of the study's purpose to test the hypotheses drawn from the existing theories and evaluate the structural relationship postulated within the conceptual framework through Partial Least Squares Structural Equation Modeling (PLS-SEM).

This chapter is designed as follows: Section 3.2 introduces the research design, and the choice of cause-comparative and descriptive quantitative approach is justified. Section 3.3 defines the study population – Palestinian AEC firms and explains the sampling and inclusion criteria for participants. It is in Section 3.4 that the research's main study variables and their operational definitions are described. Section 3.5 gives an overview of questionnaire instrumentation as to sources of items and scale structure. Section 3.6 describes the procedures of data collection and ethical aspects. The data analysis methods used with SPSS for simple statistics and SmartPLS for structural modeling are described in section 3.7. Section 3.8 at the end of the chapter is a summary of important methodological decisions.

2.2 Research Design and Approach

This research is quantitative in nature and descriptive-causal comparative in design. The central focus of this research is to empirically test the relationship between Total Quality Management (TQM) practices and project performance by reviewing the mediating effects of organizational willingness to adopt Artificial Intelligence (AI) in Palestinian AEC firms. Such an approach is adequate for testing predefined hypotheses and determining the causal strength and direction of well-structured variables.

2.2.1 Quantitative Approach

A quantitative approach is chosen because quantitative research allows the researcher to quantitatively measure opinions, perceptions, and behavior of organizations within a set population by means of structured instruments. The current approach is particularly appropriate for hypothesis testing, which is the core of the study's objectives. Quantitatively, the study can determine how much TQM practices affect project performance directly, and to some extent, through internal readiness and the willingness of the firm to adopt AI technologies (Munir S et al., 2023).

Quantitative studies guarantee objectivity and repetition, eliminate the researcher’s influence, and are particularly effective in such research as that in which variables can be operationalized and put into statistics. Besides, it allows the application of sophisticated multivariate methods, i.e., Structural Equation Modeling (SEM), which are needed to assess the proposed conceptual model(Pallavi Tyagi, 2023).

2.2.2 Descriptive and Causal-Comparative Design

This study is both descriptive and causal-comparative in nature. The descriptive dimension is concerned with describing the state of TQM implementation, the state of AI readiness, and the performance of the projects in Palestinian AEC firms. Descriptive stats aid in condensing the level of adoption, perception of readiness, and differences in performance indications amongst organizations (Setiawan & Purba, 2021).

The causal comparison dimension attempts to establish the cause-and-effect relationship among the major variables. The research is intended to examine if there is any significant relationship between TQM practices and the performance of the project, and if there is, whether it is mediated by the willingness of the organization to adopt AI. Causal-

comparative studies are non-experimental in characteristics, dependent on observation and comparison, as well as comparison of pre-existing groups without the researcher's intervention in changing variables. This design aim for contexts involving situations such as organizational research where random experiments are unworkable or ethically impossible (Munir S et al., 2023).

2.2.3 Justification for Using SEM (SmartPLS)

Due to the complexity of proposed model and presence of latent constructs (i.e., variable, which is not directly observable but measured through multiple indicators) the current study uses Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS software (Munir S et al., 2023; Pallavi Tyagi, 2023).

PLS-SEM is particularly well-suited for:

- Multiple dependent, and mediating variable models.
- Constructs measured by survey using a Likert scales.
- Typical sample sizes in sector-specific research i.e. small to medium sizes.
- Exploratory research, in which theory testing and model development are conceived as a single process.
- conceived as a single process.

Compared to covariance-based SEM (e.g., AMOS), PLS-SEM does not require data normality and is more robust than other models that include multiple reflective constructs. Simultaneous measurement and structural model testing, resulting in outputs such as path coefficients, factor loadings, reliability scores (Cronbach's Alpha and Composite Reliability), Average Variance Extracted (AVE), R^2 values and effect size (f^2) is also made possible by it In addition, bootstrapping procedures are used to test the significance of mediation effects and hypothesis validation(Alanazi, 2020; García-Alcaraz et al., 2021; Zaidi & Ahmad, 2020).

2.2.4 Alignment with Study Objectives

The selected design and methodology correspond with the central goal of the study. To empirically determine if TQM practices predict improved project performance and if they can be enhanced by the willingness to use AI by an organization. Before an empirical test of theoretical relationships at the element level can be done, this framework can facilitate the construction of a practically relevant model for quality and innovation integration in

the Palestinian AEC sector(García-Alcaraz et al., 2021; Munir S et al., 2023; Pallavi Tyagi, 2023).

Finally, the combination of the quantitative, descriptive, and causal-comparative design coupled with PLS-SEM analysis guarantees that the research questions and hypotheses will be answered validly and reliably (García-Alcaraz et al., 2021; Munir S et al., 2023; Pallavi Tyagi, 2023).

2.2.5 Rationale for Mixed-Methods Approach

Although quantitative is the first design for this research, the study applies a component of mixed methods to deepen the findings and increase their applicability. Mixed-methods research is a process that incorporates the collection and analysis of quantitative and qualitative data, enabling a more complete examination of the research issue. In this study, to collect quantitative (numerical) data from wide range of AEC professionals through a survey; semi-structured interviews from selected practitioners delivered qualitative (thematic) insights into the lived experiences, challenges, and contextual nuances of AI adoption and TQM implementation.

The approach to this study was mixed method as the quantitative stage was applied initially with the qualitative stage coming afterwards. The initial quantitative survey was possible to make the generalization on a broad level, involving a sample of workers in the sphere of AEC, and provided statistical help to the correlation between Total Quality Management, desire to introduce AI into the organization, and the project performance. On the basis of these findings, the related qualitative interviews were very informative in interpretation and situationalization of the statistical patterns, as well as in explaining the lived experiences and used challenges of managers and practitioners. This was done to ensure that the quantitative findings were not only acceptable in terms of statistics but also enriched with the qualitative data which might explain the causes and mechanisms that give rise to the observed relationship. (Hyun Park et al., 2017)

The motivation that led to the incorporation of the two approaches is due to the necessity to merge the generalizability and contextual awareness. The questionnaire provides industry-wide signals of performance, which points to how many companies have been successful in adopting TQM and AI practices. This is what allows the research to test hypotheses and measure incidences of TQM and AI application in firms statistically. In

comparison, the interviews will be rich qualitative descriptions that will show how these practices are or are not comprehended, practiced, and modified in reality on the organizational level (Hyun Park et al., 2017)

The triangulation of these two sources of data would give this study greater validity, depth, and practical usefulness. The statistical evidence is strong evidence of patterns and relationships and the qualitative data shows the why and how of patterns. It is particularly useful in the Palestinian AEC environment where the lack of resources, regulatory challenges, and cultural biases would negatively influence a quality management and a digital transformation strategy.

2.3 Study Population and Sampling Strategy

The target group in this study will be the professionals in the Architecture, Engineering and Construction (AEC) in Palestine. The reason why the AEC sector was selected is that it is a project-based activity where the stakeholders interact in a multidimensional manner, and the willingness to quality and technological transformation is on the increase. Companies in this industry are progressively adopting formalized quality management, and considering the new technology such as Artificial Intelligence (AI) due to the pressure on performance and competitiveness in the market, as well as donor-sponsored development projects.

2.3.1 Target Population

The sample of the study includes architectural and engineering consultancy firms, construction companies and project management organizations in West Bank and Gaza Strip. Some of which are either:

- Delivered or certified on TQM models (e.g. ISO 9001, MBNQA), or
- Investigating and or questioning how AI technologies can be incorporated into their project processes.

The players in these companies include middle and senior level employees, including project managers, quality assurance/engineers, heads of departments and leaders of IT/innovation: individuals with a working knowledge of organizational strategy, technology adoption, and quality practices.

2.3.2 Sampling Strategy

In order to make it representativeness and relevant, stratified random sampling technique was employed. Initial division of the AEC industry was along type of firm (consultants, contractors and project managers) and geographical segments (North, Center, South of the West Bank and Gaza).In each stratum firms were randomly selected from professional directories and engineering union lists. This method improves population coverage and minimizes sampling bias to make the responses indicators of variation with respect to the types of organizations and regional circumstances.

2.3.3 Sample Size Determination

The sample size required was informed by the recommendations for PLS-SEM analysis that recommended at least 10 times the maximum number of structural paths pointing at any of the constructs in the model Due to the complexity of the model, and the use of latent variables, a minimum sample size of 100 was aimed at achieving statistical power for hypothesis testing. Further, the purpose of the research work was to achieve a minimum response rate that would allow strong bootstrapping procedures and reliability tests (García-Alcaraz et al., 2021; Pallavi Tyagi, 2023).

2.3.4 Ethical Access to Participants

Respondents were communicated with directly through the use of professional engineering associations, LinkedIn networks, university alumni websites, and emails and phone calls to firms. Participation was optional, and all the participants were provided with information concerning the purpose of the study, confidentiality of the data, and their right to withdraw.

Overall, the population and sampling strategy were informed so as to guarantee that data capture would not only reflect the diversity, but also the practical realities of the Palestinian AEC sector, thereby increasing the validity, relevance and applicability of the results of the study.

2.4 Variables and Operational Definitions

In turn, this study is based on three primary constructs. Total Quality Management (TQM), willingness to adopt Artificial Intelligence (AI) by the organization, and project performance. These constructs create the foundations of the conceptual model and are

operationalized through extant measurement items from validated literature. All variables are considered reflective latent constructs, whereas they are measured by the items shaped on a 5-point Likert scale (from 1 = Strongly Disagree to 5 = Strongly Agree).

2.4.1 Total Quality Management (TQM)

TQM forms the independent variable of the study. It is said to be a total management philosophy aiming at delivering long-term success by means of customer satisfaction, permanent improvement, and high involvement of all employees. There are seven dimensions to the TQM and they are based on the Malcolm Baldrige National Quality Award (MBNQA) criteria.

1. Leadership
2. Strategic Planning
3. Customer Focus
4. Measurement, Analysis, and Knowledge Management
5. Workforce Focus
6. Operations Focus
7. Results Orientation

Although project performance is modelled as the dependent variable, in this study "Results Orientation" is kept within the TQM construct for theoretical and empirical reasons. Excellence frameworks such as and MBNQA do consider results (e.g. customer, people and business results) as an integral part of quality systems, making sure that quality is demonstrated in tangible organizational outcomes. Crucially, the TQM results dimension represents organizational-level quality achievements (e. g. reduced rework, higher customer loyalty, process efficiency) while the project performance DV represents project-level success (cost, time, quality, scope, client satisfaction). The two are thus complementary not redundant. Including results harmonises the TQM construct with recognized models as well as acknowledging evidence from AEC contexts that the stronger the internal quality results, the better the project performance.

All dimensions are measured using several indicators which have been adapted from previous studies). The items measure organizational practices, strategic alignment, process control, quality driven decision-making. Such items were reviewed and affirmed accordingly in relevance to the AEC sector. (Setiawan & Purba, 2021; Taraza et al., 2023)

2.4.2 Organizational Willingness to Adopt AI

The mediating variable is the organizational willingness to adopt AI. It refers to the level of readiness and the willingness of the organization to adopt AI technologies in the operation and quality management system. This construct is operationalized by using five dimensions based on models of innovation readiness and technology adoption (Munir, 2023; Pallavi Tyagi, 2023):

1. Perceived Usefulness of AI
2. Leadership Support for AI Adoption
3. Employee Attitude Toward AI
4. Strategic Fit of AI with Organizational Goals
5. Openness to Innovation and Change

These aspects demonstrate the organizational culture as well as attitudes towards AI integration in project environments.

2.4.3 Project Performance

The dependent variable is the project performance and is the degree to which a project has achieved its desired outcomes in terms of cost, time, quality and satisfaction of stakeholders. This construct is operationalized based on the standard performance dimensions in the AEC industry such as:

- Cost Performance
- Time Performance
- Quality of Deliverables
- Client Satisfaction
- Innovation and learning

The items used to measure this construct are adapted from validated project performance instruments in construction and project management literature (Hyun Park et al., 2017; Zaidi & Ahmad, 2020).

2.4.4 Summary

Multi-scales, which were reviewed by applying content validity and translated to Arabic to fit into the local context, were also used in rating the constructs. All the items of the survey were conducted on a 5-point Likert scale with the aim of achieving consistency

and comparability in data analysis. The validation of measurement model used in structural analysis will be based on factor loadings, composite reliability, Cronbach alpha, and Average Variance Extracted (AVE).

2.5 Instrumentation

data of the study were informed by a structured, bilingual questionnaire which was specially compiled to measure the three primary constructs: Total Quality Management (TQM), organizational readiness to adopt Artificial Intelligence (AI), and project performance. The questionnaire has been prepared according to the already developed models and adjusted to the scale of Palestinian AEC firms. All items were measured using a 5-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree.

2.5.1 Structure of the Questionnaire

The instrument consists of the following sections:

- Section A: Demographic and Organizational Information This section captures key background data, including gender, age, educational level, years of experience in the AEC sector, current job title, firm size (by number of employees), and the firm's specialization.
- Section B: TQM Practices TQM is measured using seven dimensions aligned with the Malcolm Baldrige National Quality Award (MBNQA) framework:

1. Leadership (4 items)
2. Strategic Planning (3 items)
3. Customer Focus (3 items)
4. Measurement, Analysis, and Knowledge Management (3 items)
5. Workforce Focus (3 items)
6. Operations Focus (3 items)
7. Results (4 items)

These items assess how firms embed quality principles across strategic, operational, and performance areas.

- Section C: Organizational Willingness to Adopt AI This construct is measured using five dimensions:

8. Leadership Support for AI Adoption (5 items)
9. Technological Readiness (3 items)

10. Employee Readiness and Competency (3 items)
11. Perceived Benefits of AI (4 items)
12. Organizational Culture and Change Readiness (3 items) These items assess organizational attitudes, cultural adaptability, infrastructure, and strategic alignment toward AI.

– Section D: Project Performance Project performance is measured across six performance areas commonly used in construction and project management:

1. Time Management (4 items)
2. Cost Efficiency (3 items)
3. Quality of Deliverables (3 items)
4. Innovation and Learning (4 items)
5. Customer Satisfaction (3 items)

Although the original questionnaire contained 58 items, the final PLS-SEM model used 17 indicators. To address this contradiction between the starting point of 58 number of survey items and the ending point of only 17 number of indicators in the model, this research considered an item parceling approach. Specifically, related items which measure the same sub-dimension of a construct were averaged into one composite indicator. This procedure is consistent with recommendations in the SEM literature, wherein parceling is used to reduce model complexity, enhance indicator reliability, and obtain more stable parameter estimates to deal with large numbers of items (Little et al., 2002) .

2.5.2 Scale Design and Language

Survey items were scored on a 5-point Likert scale to from least agreement to most agreement. The survey was created in English, translated into Arabic, and then checked by experts in the subject to check its meaning and accuracy. The Arabic version was checked by back translation to ensure that the questions were understandable for people working in the Palestinian AEC sector.

2.5.3 Pilot Testing and Validation

A group of 15 AEC professionals evaluated the questionnaire to check its clarity and make sure each question is relevant. We went over all unclear items in the questionnaire based on the feedback we received. The first analysis of the pilot data looked at internal

consistency, using Cronbach's alpha to confirm that the survey items went along consistently across all areas. All in all, the tool was purposefully created to collect information on both basic organization routines and specific point of view of employees, making it good for in-depth data analysis and model construction.

All in all, the questionnaire was designed to properly measure many aspects of quality management, digital preparedness, and project results, using a practical and statistically strong approach.

2.6 Data Collection Procedures

Here, you can find out the steps used to collect primary data from experts in Architecture, Engineering, and Construction in Palestine. The processes were put in place to uphold ethical values, get accurate results, and cover many areas in the industry.

2.6.1 Data Collection Method

The participants completed a questionnaire that was distributed online to hikers through professional and online platforms. Because of the situation and distance of the population from each other, an online survey was considered the best way to collect information.

The survey was distributed using:

- Organizations made up of professionals within engineering fields (e.g., engineering syndicates)
- LinkedIn and WhatsApp professional groups
- Direct email invitations to firm contacts
- University alumni and academic partner networks

Thanks to this strategy, we were able to survey respondents from companies of different sizes, based in different regions, and handling different functions.

2.6.2 Informed Consent and Confidentiality

Before they took part in the questionnaire, participants were informed about the purpose of the research, given a choice to refuse, and guaranteed their anonymity and confidentiality. Specifically:
Nothing that could personally identify someone was included in the study.
Those taking part had the choice to withdraw anytime they wanted to.

Participants' data was held privately and used by the research for its purpose only.

The study followed the rules for research with people and got permission from the right academic institution before starting to collect the data.

2.6.3 Targeting and Follow-Up

The researcher used stratified targeting to ensure balanced participation across:

- Consultant vs. contractor firms
- Northern, central, and southern regions
- Firms with and without ISO certifications

People were reminded after two weeks of the initial contact, in a bid to receive a more resounding response in order to prevent bias. They also encouraged people to forward the survey to individuals in comparable positions in their organizations.

2.6.4 Response Monitoring

Answers were checked constantly to guarantee:

- Completeness (no missing mandatory sections)
- Candidates had the required amount of experience and worked in the appropriate roles
- Elimination of duplicate entries

The survey platform firstly exported data to Microsoft Excel to be cleaned, and subsequently, was imported into both SPSS and SmartPLS to analyze it.

In brief, the data collection methodology was well-considered to have a large number of sectors and safeguard the rights of everyone, as well as ensuring that the information was reliable to achieve the objectives of the study.

2.6.5 Qualitative Interviews

Besides the questionnaire survey, this paper employed semi-structured interviews to learn more about the research problem. The interviews were selected because they offer the possibility to investigate the managerial views and contextual issues that are hard to measure using structured survey questions. The interviewees included a project manager, senior engineer, quality assurance officer, and an innovation/BIM leader of Palestinian AEC companies, who were chosen based on the direct involvement in the process of TQM

practices implementation and evaluation of preparedness to AI adoption. These interviews had threefold purposes: (1) to confirm and complement the statistical findings of the quantitative analysis; (2) to describe the reality behind the fact that certain relationships in the statistical model proved to be stronger or weaker; and (3) to clarify the rationale. This study enhanced the validity and interpretively of the study outcomes, as is typical of a mixed-methods research.

2.7 Data Analysis Techniques

Here the methods used in analyzing the data and tests of the framework hypotheses are mentioned. The analysis will be conducted at two main levels: I shall begin with a descriptive statistic that will provide an overview of the sample and responses, and thereafter will model with Smart-PLS structural equation modeling (SEM).

2.7.1 Descriptive Analysis

To profile the respondents and describe the sample, descriptive statistics were carried out using the SPSS program. Key outputs include:

- Firm size, the geographic location of firms, and their years of experience
- The way each survey item is measured and the standard deviation it has
- Proper use of skewness and kurtosis to check if the data are normally distributed

It helps explain the results and indicates the extent to which the findings can be applied in different cases.

2.7.2 Thematic Analysis Procedure

To interpret the data of the interviews, qualitative as a method of data collection, this research employed thematic analysis that followed the six steps (Braun and Clarke 2006). The researcher got acquainted with the transcripts through repeated reading in the first place. Second, initial codes were created to extract meaningful units that concern TQM, organizational readiness to implement AI and project performance. Third, the codes were categorized with a view of arriving at general themes that illustrated patterns that were common in interviews. Fourth, these themes were processed and developed to ensure that, they are coherent and different on the inside. Fifth, the themes were well stated and marked. Lastly, the report synthesized the results by comparing findings done on the qualitative to the results of the quantitative. The coding was done manually using the

Microsoft excel software, which enabled systematic organization, filtering and accruing frequency-coding count data (Braun & Clarke, 2006).

2.7.3 Measurement Model Evaluation (Outer Model)

The Smart-PLS program is used to validate the measurement model. In order to do this, we need to determine the degree to which each latent construct corresponds to reality by using the following measurements:

- Indicator Reliability: Individual factor loadings should exceed 0.70.
- Internal Consistency Reliability: Cronbach's Alpha and Composite Reliability (CR) should both be more than 0.70 when evaluated.
- Convergent Validity: Assessed using Average Variance Extracted (AVE), which should exceed 0.50.
- Discriminant Validity: The Fornell-Larcker criterion and the HTMT ratio were used to confirm that all dimensions were clearly separate from each other.

When all these conditions are met, we are able to interpret the structural model confidently.

2.7.4 Structural Model Evaluation (Inner Model)

When the measurement model is confirmed, the structural model is inspected to check the proposed hypotheses. The following outputs were used:

- Path Coefficients (β values): Present the nature and influence of the connections between different variables.
- T-statistics and P-values (via bootstrapping with 5,000 resamples): Used to test the statistical significance of each path.
- Coefficient of Determination (R^2): Represents the amount of variation decrease seen in the dependent variables.
- Effect Size (f^2): Tests the effect each exogenous construct has on the endogenous construct.
- Predictive Relevance (Q^2): Samuel checked predictive power by trying the model using data that was not included in building the model.
- Model Fit: Several methods including Standardized Root Mean Square Residual (SRMR) and others commonly used for Partial Least Squares analyses are used.

2.7.5 Mediation Analysis

To study how much organizational AI willingness affects the relationship between other factors, the bootstrapping method is employed.

- Partial mediation occurs when there is an important indirect effect and the main direct effect does not go to zero.
- Sometimes, if only the indirect effect is strong and the direct effect is not significant, we can say that mediation is full.

The analysis lets the study understand if willingness, as a mechanism, is important in the link between TQM and project results.

2.8 Validity and Reliability

The researchers used several statistical tests to make sure the measurement model was accurate and trustworthy. Prior to examining the structural model, the assessments were done with SmartPLS 4.0 and follow the standards recommended for reflective constructs in Partial Least Squares Structural Equation Modeling (PLS-SEM).

2.8.1 Construct Reliability

Construct reliability checks the uniformity of results across the different items used to measure one latent variable. The evaluation took place by focusing on the criteria mentioned below.

- Cronbach's Alpha (α): Checks the items of each construct to make sure they are stable. A reliability measure of 0.70 or greater is considered acceptable.
- Composite Reliability (CR): Allows for a complete and thorough test of reliability when compared to Cronbach's alpha. All constructs needed to score 0.70 or more to meet the minimum standards.

Each construct in this study (TQM, organizational acceptance of AI, and project performance) showed reliable results, so the items in each scale all consistently mean the same thing.

2.8.2 Convergent Validity

Convergent validity looks at how different items that are meant to measure the same concept are in agreement. It was examined using:

- Average Variance Extracted (AVE): If the threshold reaches 0.5, more than half of what varies in the observed variables is explained by the construct.

The fact that all AVEs were above 0.50 proves that each scale showed good convergent validity.

2.8.3 Indicator Reliability

Factor loadings were examined for each item and the construct they are related to assess their reliability. Those items with loadings above 0.70 were chosen, as they clearly contribute a lot to the latent variable. In situations where loadings fell within 0.60 to 0.70, they were kept in the study if the construct's main reliability and AVE were without issue. The construct's overall reliability and AVE remained acceptable.

2.8.4 Discriminant Validity

Discriminant validity is a test that confirms that constructs that are supposed to be separate will remain separate. It was assessed by:

- Fornell-Larcker Criterion: Every construct's AVE square root has to outweigh its highest correlation with any other construct.
- Heterotrait-Monotrait Ratio (HTMT): An HTMT below 0.90 means that discriminant validity exists.

Both conditions were fulfilled and thus it could be determined that the constructs of the study varied in a real-world context.

2.9 Summary of the Chapter

In this chapter, the method of researching the relationship between TQM and project completion was discussed, and the impact of using Artificial Intelligence (AI) in the Palestinian AEC industry was mentioned. In this study, research questions were answered through a quantitative, descriptive, and causal-comparative design, while also using certain elements of mixed methods to help explain the results.

Both SPSS and SmartPLS were used in the research for descriptive statistics and SEM. They looked at the strength of links between the variables, checked the measurement and structural models, and looked for mediation effects using various methods.

Chapter Three

Research Results

3.1 Overview

The primary aim of this chapter is to share the results derived from analysis using SmartPLS 4.0. This chapter investigates whether TQM influences the effectiveness of projects in the architectural and engineering sector and explores the role of how an organization perceives AI adoption as a possible intermediate factor.

Internal consistency, convergent and discriminant validity are evaluated in the model at this point. This allows assessing how strongly the proposed associations among the constructed variables hold.

The next part is devoted to an evaluation of the impact and significance of the associations between the underlying constructs. It examines the effects of TQM on AI readiness and the correlation between AI readiness and performance improvement and evaluates the extent to which AI readiness improves the relationship between TQM and the improvement of performance. Also, some statistical parameters are considered to determine the fit of the structural model to the data gathered.

- To measure the impact and relevance of relationships included in the model, a number of different methods were used.
- Path coefficients (β) to establish the strength and direction of relationships.
- T-values and P-values to test the statistical significance of individual path.
- Coefficient of determination (R^2) to determine the explanatory power of the model.
- Effect sizes (f^2) to interpret the effect of particular predictors.
- Model fit indices such as SRMR and NFI to evaluate the overall fit of the model to the observed data

3.2 Descriptive Statistics

The following are the most important descriptive numbers obtained on the basis of the research data. The characteristics and beliefs of the participating individuals were summarized using a variety of measures that were derived using SPLS.

3.2.1 Demographic Characteristics of Respondents

The respondents gave demographic information which included information such as gender, age group, educational background, years of experience, job position, employer size, and type of organization. There were both male and female participants with the majority within the 26-45 age group which represents a professionally working workforce. The majority of respondents were undergraduate level holders with Master level qualification coming after. Experience wise, over 50 percent had experience of 6 to 20 years in construction or engineering. Their work was a combination of management and engineering work. The companies that they were employed in varied in terms of size and size of offices; some had less than 10 staffs and others above 100 staffs. Lastly, the participants belonged to the architectural firms, engineering consultant firms, and contracting firms in the construction industry.

Table 2

Demographic Characteristics of Respondents

Category	Gender		Age Group		Education Level		Work Experience	
data	male	82	18-25	14	High school	2	less than 5	24
			26-35	57	Diploma	4	6-10	40
			36-45	39	Bachelor	84	11-15	39
	Female	38	46-55	8	Master	28	16-20	9
			55+	2	PHD	2	20 +	8
Total		120		120		120		120

Category	*Job Title*		*Firm Size*		*Organization Type*	
	Engineer	66	less than 10	34	engineering office	25
data	Project manger	23	11-50	40	Consultant offices	22
	consultant	12	51-100	17	Contracting	40
	contractor	19	100 +	29	Real Estate Development	28
					Public service and municipalities	5
Total		120		120		120

These results were discussed in the context of the demographic findings that provide a background of the differences in perceptions between quality management and technological preparedness.

3.2.2 Descriptive Statistics for Key Constructs

Table 3 demonstrates the mean and standard deviation (SD) of each of the main constructs in the study, which shows the summary of perceptions of the participants in the dataset.

Table 3

Descriptive Statistics for Key Constructs

Construct	Mean	Standard Deviation	Interpretation
Total Quality Management (TQM)	4.12	0.52	High
Organizational Willingness to Adopt AI	3.87	0.66	High
Project Performance	4.03	0.58	High

This demonstrates that the respondents considered their organizations to have properly adopted quality management and adopted the application of AI technologies. An increase of the project performance variable means that the level of confidence in the level of performance and the results of the projects being taken is assured. With a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) the following meaning was assigned to the range of scores.

- 1.00–1.80 = Very Low
- 1.81–2.60 = Low
- 2.61–3.40 = Moderate
- 3.41–4.20 = High
- 4.21–5.00 = Very High

The descriptive statistics indicate that the sampled firms record exhibit elevated levels of TQM practices (M = 4.12), high organizational willingness to adopt AI (M = 3.87), and high-level project performance (M = 4.03). These findings show that Palestinian AEC firms perceive themselves to be relatively mature in the use of quality management techniques and the achievement of acceptable project outcomes, and they are marked by a strong desire to adopt AI technologies. It should be observed that the mean of willingness to adopt AI is greater than TQM but lower than TQM, indicating that the adoption of AI is in its formation stage and it has not yet been integrated with quality practices as its counterpart. The trend supports the reason for including organizational intention to adopt AI as a mediator since this will provide a mechanism for TQM practices to be translated into positive project performance. This leads to the following analysis with the models to evaluate the quality of measurement for each construct as well as its position within the proposed structure.

The results support the hypothesis of high perceived level of employees as far as quality management capabilities, as well as the level of organization's implementation capability

for AI and its performance on projects. The highest rating of TQM indicates that the importance of quality control is increasing in the local industry. Furthermore, the participants exhibited positive attitudes on how prepared their organization was to implement AI-based solutions and how successful their projects were.

3.3 Measurement Model (Outer Model Evaluation)

The measurement model was tested for the reliability and validity of the constructs before moving on to the structural model. The results of testing the measurement model included factor loading, internal consistency reliability (Cronbach's Alpha and Composite Reliability), convergent validity (Average Variance Extracted-AVE), and discriminant validity including the Fornell-Larcker criterion and HTMT ratio.

Table 4
Convergent Validity and Reliability

Construct	Cronbach's Alpha	Composite Reliability (CR)	AVE	Interpretation
Total Quality Management (TQM)	0.935	0.937	0.720	Valid and Reliable
Organizational Willingness to Adopt AI	0.929	0.930	0.780	Valid and Reliable
Project Performance	0.921	0.922	0.762	Valid and Reliable

Table 4 shows the data for Measurement Model of the Outer Model Evaluation and the next section will do the Interpretation for the data.

3.3.1 Indicator Reliability (Outer Loadings)

All indicator loadings exceeded the minimum threshold of 0.70, confirming that each item sufficiently represented its underlying construct.

3.3.2 Internal Consistency Reliability

Reliability was confirmed using Cronbach's Alpha and Composite Reliability (CR). Both exceeded the threshold of 0.70 for all constructs:

- TQM: $\alpha = 0.935$, CR = 0.937
- Organizational Willingness to Adopt AI: $\alpha = 0.929$, CR = 0.930

– Project Performance: α = 0.921, CR = 0.922

This indicates strong internal consistency across all latent variables.

3.3.3 Convergent Validity (AVE)

The Average Variance Extracted (AVE) for each construct was above 0.50, confirming convergent validity:

– TQM = 0.720

– Organizational Willingness to Adopt AI = 0.780

– Project Performance = 0.762

3.3.4 Discriminant Validity

Validity was supported by assessing three different forms.

– Fornell-Larcker Criterion: The measure of a construct's AVE was greater than the correlations it had with all other constructs.
– Cross Loadings: Each item for a construct displayed stronger ties to it than to other constructs.
– HTMT Ratio: The HTMT ratio fell within the acceptable range for all measures. All HTMT values were below the conservative threshold of 0.90
– TQM ↔ AI = 0.661
– TQM ↔ Project Performance = 0.806
– AI ↔ Project Performance = 0.716

The discriminant validity of the constructs was evaluated on the basis of Heterotrait-Monotrait (HTMT) ratio of correlations. According to Table 6, the HTMT values are not above the conservative value of 0.90, which proves the empirical separation of the constructs (Hair et al., 2017). Particularly, the HTMT value of TQM Practice and AI Willingness was 0.661, between TQM Practice and Project performance was 0.806, and between AI Willingness and Project performance was 0.716. These findings also show that despite the conceptual relationship among the constructs, they are statistically different and therefore discernment validity can be established in the measurement model. These findings further support that the constructs were conceptually distinct.

3.3.5 Measurement Model Summary

In general, the measurement model showed high reliability, convergent and discriminant validity. The findings validated that TQM constructs (Organizational Willingness to Adopt AI), and Project Performance constructs were well measured and could be analyzed later in the structural model.

3.4 Structural Model Assessment (Inner Model Evaluation)

After the measurement model was successfully tested for reliability and validity, the structural model was tested to assess the hypothesized relationships between constructs. The evaluation included considering coefficient of determination (R^2), path coefficients, mediation analysis, effect sizes (f^2) and model fitting indices. Bootstrapping with 5000 subsamples was performed to estimate the significance of the path coefficients.

3.4.1 Coefficient of Determination (R^2)

– Organizational Willingness to Adopt AI:

R^2 = 0.380 (Moderate): TQM practices show 38% of the variation in organizational willingness to adopt AI.

– Project Performance in AEC Firms:

R^2 = 0.627 (Substantial): TQM practices and organizational willingness to adopt AI together shows 62.7% of the variation in project performance.

This shows that TQM accounts for 38% of the variation in AI readiness and it also explains 62.7% of the variation in project performance, along with the influence of AI readiness. The model provides strong R^2 values by PLS-SEM standards which is a reliable explanation for a significant portion of the variance in both constructs.

3.4.2 Path Coefficients and Hypothesis Testing

– Hypothesis 1 (TQM → Project Performance):
– Path Coefficient (β) = 0.551, T = 5.876, P < 0.001 → Supported
– Result: Accepted, significant positive effect of TQM on Project Performance
– Hypothesis 2 (TQM → Organizational Willingness to Adopt AI):
– Path Coefficient (β) = 0.616, T = 10.997, P < 0.001 → Supported

- Result: Accepted, Demonstrating a significant positive influence of TQM on AI readiness
- Hypothesis 3 (Organizational Willingness to Adopt AI → Project Performance):
- Path Coefficient (β) = 0.323, T = 3.966, P < 0.001 → Supported
- Result: Accepted, Showing a significant positive relationship between AI readiness and improved project performance

All hypothesized direct relationships are positive and statistically significant. As a result, increasing the level of TQM is associated with higher AI readiness and better project performance. Being AI-ready significantly enhances the organizational performance.

3.4.3 Mediation Testing

- Indirect Relationship (TQM → Organizational Willingness to Adopt AI → Project Performance):
- Indirect Effect (β) = 0.199, T = 3.941, P < 0.001.
- Result: Since both the direct (β = 0.551) and indirect effects were significant, this indicates partial mediation. TQM not only enhances project performance directly but also indirectly by strengthening organizational readiness to adopt AI.

Mediation analysis was conducted to test whether organizational willingness to adopt AI mediates the relationship between TQM and project performance. The indirect effect (TQM → AI Willingness → Project Performance) was 0.199, with T = 3.941 and P < 0.001. Since P < α (0.05), the mediation effect is statistically significant. Given that both the direct effect of TQM on project performance (β = 0.551, P < 0.001) and the indirect effect through AI willingness are significant, this indicates partial mediation. Thus, organizational willingness to adopt AI partially mediates the relationship, suggesting that TQM improves project performance both directly and indirectly by enhancing readiness for AI adoption. There is a significant indirect path in which TQM influences project performance by increasing an organization's willingness to adopt AI. As a result, companies that successfully apply TQM are shown to benefit in two ways: improved performance from higher AI readiness levels.

3.4.4 Effect Size (f^2)

- TQM → Organizational Willingness to Adopt AI:
- Effect Size (f^2) = 0.613 (Large), TQM has a strong influence on AI readiness.
- TQM → Project Performance:
- Effect Size (f^2) = 0.505 (Large), TQM directly affect significantly to project performance.
- Organizational Willingness to Adopt AI → Project Performance:
- Effect Size (f^2) = 0.173 (Medium), AI readiness has a medium effect on project performance.

3.4.5 Model Fit Indices

- Standardized Root Mean Square Residual (SRMR): Value = 0.050
- Conclusion: Good fit (below the threshold of 0.08).
- Normed Fit Index (NFI): Value = 0.875
- Conclusion: close fit (threshold of 0.9).

The results indicate a satisfactory model fit, confirming that the hypothesized model provides a robust explanation of the observed data.

3.5 Final Model Visualization

This section of the analysis evaluates the reliability and accuracy with which the study's variables are measured. The findings, together with the SmartPLS model diagram, show that the questionnaire questions can accurately measure the key concepts of the study. Confirming the properties of this measurement model is essential to establish its reliability and high-quality outcomes.

3.5.1 Final SmartPLS Model: Visualization and Interpretation

The final SmartPLS model is represented in the diagram below to illustrate how the study's variables correlate and relate to each other. This diagram presents:

- Path coefficients (β values): The scale and direction of the relationship predicted between the hidden factors.
- R^2 values: The number printed inside the blue circles for each endogenous construct indicates the extent to which it accounts for the overall variation within the data.
- Outer loadings: All the indicator loadings exceed 0.70, indicating that each indicator

is correctly capturing and reflecting the attributes of its respective construct.

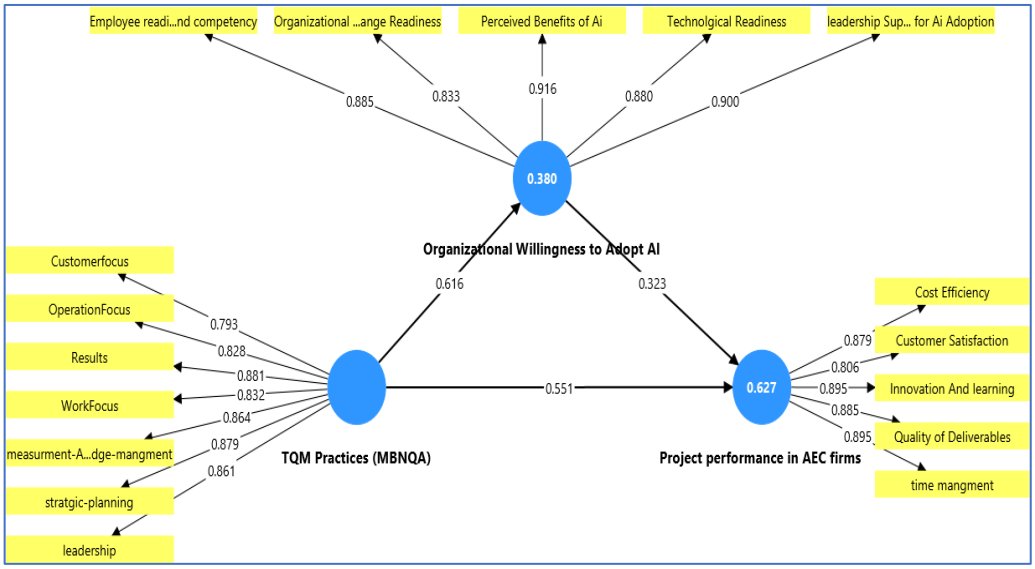
Key Insights from the Diagram:

- TQM Practices help increase both the organization's Willingness to Adopt AI (β = 0.616) and improve project Performance (β = 0.551).
- Adoption of AI by organizations contributes to improved project performance in their endeavors (β = 0.323).
- Organizational Willingness to Adopt AI is explained by the model to the extent of R^2 value 0.380.
- The R^2 value for Project Performance is 0.627, suggesting substantial predictive accuracy in the model.
- All three constructs (TQM, AI readiness and performance) are assessed using numerous items that have high degree of associations with their respective latent variables (outer loadings over 0.80).

The model clearly supports the proposed theoretical framework presented in Chapter 2. It reveals that Total Quality Management influences both the ability of an organization to implement AI and the success of its projects. Further, this model shows that adopting AI increases the effectiveness of quality management methods.

Figure 2

Structural Model Assessment in SmartPLS



3.6 Qualitative Summary: Interview Coding Matrix

The coding matrix was created using the reflections shared by five key informants in the AEC sector of Palestine. Those interviewed were a project manager, a quality assurance expert, the firm's senior partner and the director in charge of BIM and innovation strategies. The participants were asked about TQM activities, how ready their organizations were to integrate AI and the effects these strategies had on the success of projects. The coding matrix organizes the information obtained from the interviews and positions the relevant themes in line with the focus of this study.

TQM Practices: Overall, all interviewees acknowledged that their organizations bold proxy customer focus, top management support, structured project procedures, and data-driven performance evaluation are essential pillars of their operations. Companies showed different approaches but all emphasized their own standards such as regular design reviews, safety audits, and performance assessments. These methods had become second nature to employees, indicating that the firms continuously emphasized quality even without standardized certification processes.

AI Readiness: There was substantial disparity in the degree to which firms were prepared to implement AI. Some companies had integrated AI into their BIM processes and were employing AI-powered risk analysis and quantity estimation tools. Other firms have shown lower levels of readiness for adopting AI due to either a lack of understanding or the necessary resources. This diversity in AI uptake reveals that firms need to be ready and strategically positioned to take full advantage of benefits the technology offers.

Impact on Project Performance: All the interviewees underlined the correlation between structured quality practices and improved project performance. Consequences were lower chances of mistakes, improved collaboration between disciplines, less rework, faster project delivery, and preference in repeat business from clients. This qualitative analysis can be taken as evidence of the positive influence of TQM on the success of construction projects.

Barriers to AI Adoption: Many key obstacles to integrating AI emerge from the data visualization. Major obstacles were inadequate training, reluctance to adopt new approaches, limited financial resources, doubts held by customers about the credibility of AI-generated results, and a scarcity of Arabic-language tools. These barriers explain the

extent to which the structural model provides insight into potential solutions.

Synergy Between TQM and AI:While nearly all interviewees saw promise in the connection between AI and quality systems, the incorporation was still rare among the participants. Participants emphasized that AI can strengthen TQM by automating tasks, ensuring consistency, and improving information usage in decision processes. This finding supports the model's assertion that well-developed quality systems allow organizations to prepare for undertaking innovative projects.

The analytical matrix derived from interviews bolsters the findings of the quantitative model. It shows that organizations committed to TQM are both more likely to achieve project excellence and are ideally prepared for adoption of AI. The data indicates that quality management and digital transformation are complementary approaches that can improve organizational performance immediately and promote innovation readiness over time

Table 5, presents a consolidated view of the coded themes across all interviews, serving as a bridge between the statistical outcomes and real-world practices in the Palestinian AEC sector.

Table 5

View of the coded themes across all interviews

Participant Role	*Prominent TQM Principles*	*Level of AI Readiness*	*Impact on Project Performance*	*Key Barriers to AI Adoption*	*Perceived Synergy Between TQM and AI*
Interview p1 - Project Manager	Customer focus, leadership, continuous improvement	Low to moderate – interest but limited adoption	Improved coordination, reduced rework, stronger client trust	Cost, mindset, lack of training	Recognized, not yet realized
Interview p2 - QA Engineer	Factual decision-making, process control	Low – limited awareness and infrastructure	Better inspection outcomes, reduced rework, enhanced compliance	Lack of awareness, digital systems, resistance to change	Potential exists, currently disconnected
Interview p3 - Senior Partner	Customer focus, strategic planning, leadership	Moderate – design-phase experimentation	Faster design cycle, reduced errors, improved stakeholder alignment	Client skepticism, cost, lack of localization	Strong synergy in design processes
Interview p4 - BIM & Innovation Officer	Process approach, continuous improvement, evidence-based decisions	High – integrated into workflows and pilot tools used	Shortened delivery time, predictive risk identification	Data fragmentation, external partners' digital immaturity	Clearly defined and aligned
Interview p5 - Project Manager	Client orientation, process control	Moderate – exploratory tools used, lacks full integration	Clearer documentation, fewer conflicts, better execution	Budget, leadership direction, lack of structure	Recognized but not implemented

Note: In the thematic analysis results, there is designating of interview participants as P1-P5, for anonymity reasons. Each code corresponds to one person interviewed and his or her quotations are rendered in full to illustrate the identified themes.

Table 6

Thematic Analysis Results of Interview Data

Theme	Codes (Examples)	Illustrative Quotes	Participants Mentioned
Tqm practices enhance quality	Teamwork, Documentation, Continuous improvement	"Our firm relies heavily on teamwork to improve quality." (P2)	P1, P2, P4
Barriers to ai adoption	Lack of training, Cost, Resistance	"We lack training in new technologies." (P1)	P1, P3
Organizational readiness	Leadership support, Willingness to invest	"Our management is open to adopting new tools if they improve performance." (P5)	P3, P5
Impact of ai on projects	Efficiency, Error reduction	"AI can help reduce rework and delays." (P4)	P2, P4
Hr & learning challenges	Skills gap, Need for training	"Most of our engineers don't have AI skills." (P1)	P1, P5
Tqm practices enhance quality	Teamwork, Documentation, Continuous improvement	"Our firm relies heavily on teamwork to improve quality." (P2)	P1, P2, P4

The five main themes were revealed through the thematic analysis of the five interviews. For example, the role of TQM practices such as teamwork, documentation and continuous improvement in improving the quality of the works have been emphasized by P1, P2 and P4, respectively. At the same time, P1 and P3 pointed to obstacles to adopting AI, especially lack of training, cost and resistance. P3 and P5 identified leadership support and willingness to invest as indicators of organization readiness. In terms of project outcomes, P2 and P4 reckoned that AI aids in reducing rework, delays and erroneous work. Finally, P1 and P5 raised their concerns on the availability of skills gaps and expenditure on continual training.

3.7 Linking Interview Insights with Quantitative Results

To further reinforce the interpretation of quantitative results of Structural Equation Modeling, qualitative insights gained from semi-structured interviews of managers and engineers within Palestinian AEC firms were included in this study. The purpose of this section is to connect the evidence from the interview with the statistical findings to give richer explanations and more context-specific interpretations that. By triangulation both sets of data were used, the analysis not only serves to validate the hypothesized relationships, it can also clarify the practical realities that affect the strength of these relationships in the Palestinian environment.

H1: TQM - Project Performance

The quantitative results showed that TQM had an important positive impact in achieving the performance of the projects ($\beta = 0.551$, $t = 5.876$, $p < 0.001$). This result shows that quality management practices have a positive impact on the realization of project outcomes. Interviewee was very supportive of this link and expressed it as follows: TQM results in better planning, less mistakes and more client's satisfaction. One senior engineer commented: "The application of quality standards in a consistent manner between projects is one reason why there is less rework or inter-project dispute time and cost performance is directly improved.

H2: TQM - Organizational Willingness to Use AI

Analysis showed that a significant positive path was found between TQM with the organizational willingness to adopt AI ($\beta = 0.616$, $t = 10.99$, $p < 0.001$). It also means that firms with an embedded quality system tend to be more open to digital transformation, a finding again supported by interviews - a disciplined and data-driven culture born from TQM is a key factor in being comfortable with AI tools. As one manager stated: "When we already have standardized processes through quality management, deploying AI is not viewed as a risk but as an opportunity for improvement in increasing efficiency."

H3: Organizational Willingness to adopt AI - Project Performance

The relationship between the willingness of organizations to adopt AI and the performance of the project was significant but relatively weak compared to the strength of the relationship that was expected ($\beta = 0.323$, $t = 3.966$ $p < 0.001$ The implication of this is that willingness alone, without an appropriate supply of resources and stable

conditions, is not enough to ensure good results. Interviewees provided context for this finding and suggested the existence of financial and political impediments present among many firms who are interested in AI solutions. One project director said: "We are ready to adopt AI, but unstable environment and lack of investment make it difficult to realize the full benefits in project delivery."

H4: Mediation effect of AI willingness (TQM - AI Willingness - Project Performance)

Results using mediation analysis supported the study's findings, revealing that organizational willingness to adopt AI partially mediated the effects between TQM and project performance (indirect effect $\beta = 0.199$, $t = 3.941$, $p < 0.001$) which means that direct effects of TQM are mediated by organizational willingness to adopt AI. Supporting this mechanism were the interviews where respondents highlighted that these firms are in a stronger position to integrate AI into projects if they have adopted a culture of continuous improvement and learning. One quality assurance officer commented as follows: "Our quality practices bring awareness and openness. With no such mindset, AI tools would not be used."

3.8 Comprehensive Summary of Structural Model Results

The structural model obtained with SmartPLS demonstrates a good fit and offers empirical evidence in support of the proposed hypotheses. TQM, Organizational Willingness to Adopt AI and Project Performance were considered to have a number of direct and indirect links that relate to each other using the same dataset.

3.8.1. Path Coefficients (Direct Effects)

Table 7
Path Coefficients (Direct Effects)

Path	Coefficient (β)	T-Value	P-Value	Significance
TQM → Org. Willingness to Adopt AI	0.616	10.997	0.000	Significant
TQM → Project Performance	0.551	5.876	0.000	Significant
Org. Willingness to Adopt AI → Project Performance	0.323	3.966	0.000	Significant

Interpretation: All direct effects are statistically significant ($p < 0.001$), which proves support of H1, H2, and H3:

- TQM significantly enhances both AI readiness and project performance.
- AI readiness significantly enhances project performance.

3.8.2 Indirect and Mediating Effects

- Mediation Path (TQM → Organizational Willingness to Adopt AI → Project Performance):
- Indirect Effect = 0.199
- T-Value: Significant
- Result: Confirmed

This confirms H4, which shows that organizational willingness to adopt AI partially mediates the relationship between TQM and project performance. The indirect effect (0.199) is statistically significant.

3.8.3 Total Effects

- TQM → Project Performance:
- Total Effect = 0.750
- TQM → Organizational Willingness to Adopt AI:
- Total Effect = 0.616
- Organizational Willingness to Adopt AI → Project Performance:
- Total Effect = 0.323

The strongest total effect is between TQM and Project Performance, confirming the centrality of TQM in driving outcomes, both directly and via AI readiness.

3.8.4 Reliability & Validity (Constructs)

All constructs have:

- Cronbach's alpha ≥ 0.92
- Composite reliability ≥ 0.93
- AVE ≥ 0.72

This confirms internal consistency reliability and convergent validity.

3.9.5 Discriminant Validity (HTMT)

Table 8

Discriminant Validity (HTMT)

Constructs Compared	HTMT Value	Threshold	Status
TQM vs AI Readiness	0.661	< 0.90	Valid
TQM vs Project Perf.	0.806	< 0.90	Valid
AI Readiness vs Project Perf.	0.716	< 0.90	Valid

All constructs pass the HTMT criterion, confirming discriminant validity.

Chapter Four

Discussion, Conclusion, and Recommendations

4.1 Overview

The chapter gains a thorough interpretation of the findings in Chapter 4 and puts the findings into the greater context of the already available (local and international) literature as well as the realities of the functioning of the architectural and engineering (AEC) firms in Palestine in particular. The object is to expound on the interplay of Total Quality Management (TQM), AI readiness and project performance translate to theoretical knowledge and practice.

The discussion starts with the analysis of the key relationships that are determined in the structural model and the assessment of their implications based on the outcomes of the previous empirical studies and other theoretical perspectives. A specific focus is put on how the said results compare or contrast the findings of the global research and local studies that are carried out in the Palestinian context. Where it is fit, quotes and information obtained during semi-structured interviews with industry professionals are incorporated to provide an additional dimension of discussion, as well as a spot of context, but never used beyond the academic sources.

The chapter goes on to explain the influence of the TQM and AI readiness on the outcomes of the projects and finds practical and policy-related implications of the findings to inform firms that want to improve their performance by using quality strategies and technological preparedness. The analysis is concluded with the identification of the research limitations and suggestions of the future research directions, especially in the context of emerging economies that share the same institutional and technological constraints.

4.2 Discussion of Major Findings

In this section, the results offered in Chapter 4 can be deeply interpreted in the light of preliminary theoretical and empirical evidence offered in previous chapters by connecting the aspects of the empirical findings with the theoretical background and prior empirical information. The major relationships explored were direct effect of TQM to Project Performance; intermediary influence of Organizational Willingness to Adopt Artificial

Intelligence (AI), and the consequent implications of the relationships to architectural, engineering, and construction (AEC) firms, especially in connection to Palestine.

4.2.1 Direct Relationship: TQM → Project Performance

Data from the study supports the presence of a substantial and consistent effect of TQM on Project Performance ($\beta = 0.551$, $t = 5.876$, $p < 0.001$), as predicted by Hypothesis 1 (H1). This result supports claims within the field of quality management that adopting and utilizing TQM principles provides significant improvements in key metrics of project performance, especially with respect to time, cost and quality (Yas et al., 2021; Zaidi & Ahmad, 2020).

TQM's effect arises from the role of its key component to promote efficiency within the organization, reduce waste, and place a strong emphasis on achieving quality outcomes (Zaidi & Ahmad, 2020). Adoption of TQM is particularly vital for architectural and engineering firms in order to successfully deliver projects marked by intricate specifications, interactions between several parties, and rigid time constraints (Alanazi, 2020; Asad et al., 2023).

This observation conforms to the existing literature reviewed by Zaidi and Ahmad (2020) and Yas et al. (2021), who stated that companies incorporating the practices of TQM are at a greater advantage to manage project schedules, unnecessary spending, and enhance customer satisfaction. The outcomes are especially applicable in project-based industries such as architecture and engineering where integrated processes and integration of stakeholders are highly needed to realize intricate projects.(Yas et al., 2021; Zaidi & Ahmad, 2020)

In more theoretical perspective, such a relation also agrees with the resource-based view (RBV) of TQM as a strategic resource specific to a firm, improving its operation competence and giving a competitive edge. also support the given opinion by stating the importance of quality-oriented leadership and data-driven decisions in balancing operational process and strategic objective alignment. (Yas et al., 2021; Zaidi & Ahmad, 2020)

Practitioners in Palestinian architectural and engineering companies can take useful lessons from this analysis, namely the use of TQM strategies in the entire structure of an

organization could allow projects to excel in the most resource constrained and competitive circumstances.

This practical implication was also verified with qualitative knowledge obtained by means of interviews. One senior project manager (Interviewee 1) clearly pointed out, "At our firm, structured quality checks and checklists majorly played a big role in trimming down the conflicts and reducing the project delivery schedules. Likewise, as one Quality Assurance engineer (Interviewee 2) noted, it significantly reduced reworks on site and increased the steps to satisfy the customer demands through repeated inspections and formal approvals. These qualitative validations are used to complement the quantitative results, which they triangulate.

In addition to justifying the quantitative findings, these cases also serve as the sources of the evidence of the localization and operationalization of TQM principles among Palestinian companies. These companies are turning TQM into a continuous operating philosophy rather than a lip-service certification which are making control and dynamic project environment more flexible and adaptive to the environment.

4.2.2 Direct Relationship: TQM → Organizational Willingness to Adopt AI

TQM has a significant positive effect on Organizational Willingness to Adopt AI, displayed in a significant path coefficient of 0.616 ($t = 10.997$, $p < 0.001$). This observation proves the Hypothesis 2 (H2) at a high probability level and confirms the strategic importance of TQM to increase the openness of an organization and its readiness to implement innovative technologies such as AI.

In theory, such a connection complies with the Technology-Organization-Environment (TOE) theory, which prioritizes the importance of organizational readiness to make technological innovation possible (Alanazi, 2020) The TQM establishes a corporate culture that enhances continuous improvement, systematic decision-making, and horizontal problem-solving, which are crucial preconditions to be adopted in the implementation of disruptive technologies (Akhmatova et al., 2022).

Vasilieva have already empirically justified the connection between TQM and innovation readiness by emphasizing that structured quality management practices offer the needed discipline and logical course of action that would perfectly introduce and interpolate the

practice of new technologies into the process of any corporation (Vasilieva et al., 2023). Likewise, Alanazi claimed that the companies that have a well-established TQM framework will show a more significant extent of digital maturation in the form of a strategic alignment, discipline of the processes, and a high culture of constant learning and changing (Alanazi, 2020).

This relationship assumes a greater meaning in the AEC sector and especially in Palestine. With the limited technical infrastructure and the lack of resources, the TQM practices can play a crucial role of a backbone to stability and coherence of operations. In fact, according to one BIM and Innovation Officer (Interview 4), our internal quality systems are properly documented and followed, which did not necessitate much inconvenience to conduct any tests with AI-based scheduling tools. This confirms the argument that developed sets of quality will help enhance the courage and potential of a company to experiment and adopt AI technologies.

Conversely, the overall readiness of all the firms was not high. One of the QA engineers of a middle-sized company (Interview 2) shared with us that we have our own quality standards to be met, but AI is yet to be concrete to us (where to begin with, which tools to employ). This reflects the fact that although TQM can offer the platform of AI receptivity, it will also require the other enablers which include awareness, technical literacy and strategic alignment.

All in all, it can be seen that TQM is not only an internal issue of consistency and enhanced performance, but also a culture and operation facilitator of technology revolution. According to this, companies that thoroughly invest in quality activities have a higher chance of being prepared - both organizationally and culturally - to embrace AI.

4.2.3 Direct Relationship: AI Readiness → Project Performance

Empirical analysis in chapter 4 exhibited that organizational willingness to adopt AI positively correlates with project performance ($\beta = 0.323$, $t = 3.966$, $p < 0.001$), reinforcing hypothesis 3. This result shows that achieving a ready state for AI adoption translates directly into improved performance on key measures for the project.

Organizations that are ready for AI adoption are more likely to implement tools such as data analytics, automation, and machine learning in their day-to-day work, and help firms

to improve the accuracy of designs, make faster choices, minimize mistakes made by staff, and use their budgets more effectively.

The given discovery is consistent with previous research by Alanazi and Akhmatova who assert that companies that have an established TQM system in place, especially those that conform to the frameworks such as MBNQA, are more likely to facilitate the innovative course, including digitalization and the implementation of AI. The defined procedures, executive sponsorship, and strategy advocated by TQM can seem to establish the facilitating environment in which the AI technologies could be embraced and incorporated successfully, thereby leading to better project implementation, tracking, and stakeholder satisfaction.(Akhmatova et al., 2022; Alanazi, 2020)

This finding is particularly applicable in the AEC sector in Palestine. A lot of companies work in environment with limited resources and uncertainty and quality management is a well-organized approach which can be a basis of further technologic development. According to the BIM and Innovation Officer (Interviewee 4), his organization may consider AI-based risk analysis tools when it finally got their core quality processes consistent and auditable. It is consistent with the finding of the model that AI readiness (0.323) has a complementary effect in improving project performance.

On the other hand, the QA engineer (Interviewee 2) highlighted the opposite situation, that is, our team has been importing internal quality processes, but the use cases of AI are not well understood or trained. The interest is there, we just aren't structurally prepared yet. Such inconsistency across companies illuminates the incomplete mediation - TQM is a contributor to AI readiness and the completion of the integration and subsequent performance benefits require the presence of other company features, including digital infrastructure, leadership vision, and change management strategies.

The partial mediation indicates that TQM is still a significant performance predictor; however, its potential can be better achieved in combination with the organizational willingness to adopt the emerging technologies. Hence, companies willing to get the most out of their projects must consider quality and innovation not as independent programs, but as strategically connected.

4.2.4 Mediation Effect: TQM → AI → Project Performance

The fourth hypothesis (H4) tested if Organizational Willingness to Adopt Artificial Intelligence (OWAI) acted as a mediator between Total Quality Management (TQM) and Project Performance. The results supported a partial mediation effect because the indirect effect was significant ($\beta = 0.199$, $t = 3.941$, $p < 0.001$). and the direct effect ($\beta = 0.551$, $p < 0.001$). It implies that TQM can shape the project results directly and indirectly through improvement of readiness to adopt AI. This result implies that TQM underpins a company's ability to get ready for AI while total quality management and artificial intelligence work together to achieve greater results.

This was confirmed by bootstrapping with 5,000 resamples. Approximately, 26.5 percent of the total impact of TQM on project performance ($\beta = 0.750$) was conveyed via AI readiness, which significantly contributed to improvement in performance.

The results also correspond to the Resource-Based View (RBV) and the works of Alanazi and Vasilieva that point to the fact that effective quality systems establish the structural and cultural prerequisite to implementing digital innovations such as AI. This conclusion is backed up by interview insights. One of the BIM Officers remarked that the integration of AI in the project planning went smoothly because of well-established quality processes. Conversely, a QA engineer reported little AI preparation, although the company runs quality internally, citing the absence of training and strategic direction. Overall, besides enhancing project performance per se, TQM also promotes AI readiness, which in turn leads to better results. Organizations combining quality practices and innovation readiness stand a better ground to achieve successful efficient projects particularly in a resource limited setting such as Palestine.(Alanazi, 2020; Vasilieva et al., 2023)

4.3 Theoretical Implications and Contribution

The present research has numerous theoretical implications that may add value to the current stock of knowledge about TQM, innovation adoption, digital readiness and project performance. First of all, it will expand the theoretical concepts of the Resource-Based View (RBV) and Technology-Organization-Environment (TOE) in the empirical evidence that supports the mediating role of the organizational preparedness to accept AI in the context of TQM.

On the one hand, this research extends the RBV theory in the first place by confirming

empirically the direct and indirect utility of TQM, that is, the utility of TQM as an operational and as a strategic resource enabling technological innovation. It is not only presented as an instrument of instant improvements in operations but rather as an underlying ability that increases the responsiveness of an organization to technological shocks (Alanazi, 2020; Asad et al., 2023)

Second, the present research is also important in terms of the TOE framework because it also contains empirical data, gathered in the particular setting of the Palestinian AEC companies, that shows that organizational characteristics and variables can play a great role in technological adoptions decisions. The results highlight the necessity to combine quality management and technological innovation as a strategic approach, especially in harsh and deprived settings (Akhmatova et al., 2022; Vasilieva et al., 2023).

Lastly, the given study also highlights the importance of such interdependence between TQM and organizational innovation readiness and indicates that the best performance results are achieved when quality management activities are strategically paired with the digital transformation programs.

The new addition is the introduction of the concept of AI readiness as a mediator. It demonstrates that the capacity to innovate is not an external aspect but rather lying in the quality practices, supporting both the RBV and the Contingency Theory perspectives by stressing on the fit between internal management systems and the emergent technologies.(Alanazi, 2020; Vasilieva et al., 2023)

The results prove that TQM directly influences the project performance to a large extent and also contributes to building the organizational willingness to embrace Artificial Intelligence (AI). The mediation analysis indicates further that part of the influence of TQM on the performance is conveyed via the AI readiness. It helps to justify the argument that TQM could not be considered as a mere operational tool, but also as a capability that could add to the capacity of a firm to interact with new technologies.(Asad et al., 2023)

That is in accordance with the RBV, because TQM seems to be an internal capability, which enhances efficiency as well as adaptability. The presence of the AI readiness mediating variable also includes a minor extension to the theory, as the connection between quality systems and innovation adoption is less established in the existing literature. Furthermore, the findings correspond to the Contingency Theory in underlining

the fact that the success of TQM and innovation approaches is a factor of organizational context. When applied to the Palestinian AEC firms, where the constraints of resources and uncertainty are widespread phenomena, quality practices can provide a sense of stability and help with the steady technological advancement.(García-Alcaraz et al., 2021)

Besides, the location of this model in the Palestinian AEC sector would bring theory into under researched, resource-limited settings and would show that TQM and innovation can be successfully interconnected even in the developing economy. Mixed methods help to validate the integrity and local applicability of theoretical framework, Data from mixed methods enabled a richer explanation of the ways in which these constructs are connected, drawing insights from perspectives of quality management.

Overall, while the research is not aimed at re-defining the current theories the research does support and enhance them slightly by positioning the TQM and AI preparedness in the same model and determine the effect of their combination on the performance of the project. The findings create a part of a extra coherent view of the way in which conventional administration practices are in a position to have an effect on innovation preparedness, notably within the developing context.

4.4 Practical Implications

The results of the research have a number of practical implications, especially to the AEC firms working in Palestinian context. Some of the common challenges coming to these organizations are resource constrains, unstable regulations, and technology disparities. The research proposes the idea that employing the systematic TQM practices would help enhance the performance of the project hence directly, also boost the organization preparedness to embrace the emerging technologies like Artificial Intelligence. The findings, therefore, provide practical implications to companies willing to improve their operational performance and level of innovation under the limitations of the local environmental (Ali & Johl, 2022)

It is most relevant that at the operational level, AEC companies need to become more concerned with the integration of an extensive model of TQM, i.e. TQM model of the Malcolm Baldrige National Quality Award (MBNQA) in their common patterns. The empirical findings make it clear that strong TQM are one of the surest ways of improving

the tangible outcome of the project due to better time utilization, costs, quality, and above all higher client satisfaction (Yas et al., 2021; Zaidi & Ahmad, 2020). This is why when the goal of the company is to have a consistent success of the projects, it is advisable to set an orderly approach to the organized quality actions, i.e., frequent audits, formalized inspection process, and proper accountability.

Also, this paper explains the strategic expression of TQM, not only on conventional goals of quality, but also expressing its importance in helping an organization become ready to experience digitalization. Practitioners are, thus, to appreciate TQM as more than merely an operational requirement but rather to be viewed as a strategy or a rationale where the technology can be adopted. To show the argument, Palestinian AEC companies, despite the limitations of infrastructural and financial resources, can capitalize on well-developed TQM systems, gradually build their ability to deploy AI functions, such as predictive analytics, automated inspections, and generative design tools. Such integration will enable the organizations to integrate the efficiency and sustainability to their projects despite the lack of resources (Alanazi, 2020; Vasilieva et al., 2023).

The implications of the practical research made in the current study on the AEC firms to the extent they are operating in the resource constraint and technologically evolving environment like Palestine are enormous. Having articulated that TQM does not only improve the performance of projects but also makes project teams ready to implement Artificial Intelligence, the study shows two roles of TQM, as a process discipline tool and as a culture enabler of innovation.

TQM structures guide AEC companies to deal with complicated processes, enhance the organization of many stakeholders and produce reproducible outcomes. TQM is a tool that helps Palestinian companies, operating under political and financial pressures on a daily basis, to have a structure that allows standardization, timely identification of problems, and effective prior planning (Setiawan & Purba, 2021; Zaidi & Ahmad, 2020). As an illustration, the quality review panels composed of the engineering, construction, safety personnel will provide real-time supervision, and Plan-Do-Check-Act (PDCA) cycles will be used at the site level in order to avoid recurrent mistakes and delays (Hyun Park et al., 2017)

Besides, the TQM promotes such type of standard checklists, adapted to each stage, such

as design to handover and helps to increase the number of accountabilities and the less possible last-minute changes (Mushtaq & Peng, 2020). These arguments are substantiated by the interviews conducted in the framework of the given study: project managers and QA engineers discussed how well-structured planning tools and technical reviews at the initial stages of project processes contributed to the decrease in rework and better cooperation between project teams (Wall, 2021).

In addition to operations, TQM serves as a source of innovation culture as well. It is the consistent quality of an organization that increases the likelihood of seeing AI as one of the extensions of its improvement plans, rather than a disruptive threat. The principles of TQM, in particular, continuous improvement, leadership involvement, and empowerment of the staff, align with the needs of successful AI adaption, Companies that have adopted TQM are more willing to implement the pilot of digital technologies by using AI-enabled clash detection, estimating costs, and determining schedules (Alanazi, 2020; Pallavi Tyagi, 2023; Vasilieva et al., 2023).

Organizations ought to ensure that the objectives of quality are aligned with technological spending to prepare to undergo digital transformation. These involve not only the training of staff in quality systems but also in the AI-enabled tools, incorporation of digital KPIs in project monitoring systems, and collaboration between the quality and the innovation department. Low-cost, high-impact AI tools could also be utilized by firms to supplement their current quality practices to increase returns on finite resources, these include generative design, automated inspections, or predictive analytics.(Dhamija & Bag, 2020)

Such the combination of digital readiness and TQM is particularly important to the Palestinian AEC context. The companies in this area are under different types of limitations-they are infrastructurally disjointed, have problematic financing and besides have inadequate access to premium technological innovations. Nonetheless, this research shows that even when considering such an environment, organizations that build a high TQM culture are in a better advantage in terms of trying and implementing AI by taking small steps. Companies with limited capacities can start with formalization current quality processes, implementation internal quality auditing, and the development elementary digital literacy and scale greater solutions afterwards.(Saha et al., 2022; Wall, 2021)

The conclusions of the study have important practical consequences for specialists

working in the architectural, engineering and construction industries. Evolving demands of fast project cycles, sophisticated designs, environmental awareness, and accelerating technological advancements have made the intersection of TQM and Artificial Intelligence (AI) readiness an essential priority instead of merely an optional approach. (Dhamija & Bag, 2020)

4.5 Conclusion: Restatement of Research Objectives

This study aimed to examine the effect of (TQM) in the performance of projects in architectural and engineering (AEC) firms especially in the Palestine resource-limited environment. Understanding that technological innovation is increasingly important in the construction business, the study examined the intermediary status of Artificial Intelligence (AI) preparedness in such association. The main research question filled was the fact that the area of influence of internal quality practices upon both operational performance and the possibilities of digital transformation is poorly understood, especially in the case of developing economies.

To solve this issue, the tested research model employed four hypotheses: (1) the direct relationship between TQM and project performance, (2) the mediation of TQM and the organizational willingness to adopt AI, (3) the direct relationship between AI readiness and project performance, and (4) the mediating relationship between the TQM and project performance through AI readiness. This paper sought to legitimize a model, which combines the element of quality management and the concept of digital readiness as partakers of project success using structural equation modeling (SEM) with SmartPLS. The implications of the findings are both theoretical and practical because as the authors show, TQM is not only a performance mechanism, but also a strategy level innovation facilitator.

4.6 Summary of Findings

The results of this study provide a rationale why TQM is critical in the performance of any project within the AEC organization. More to the point, but more importantly, the findings indicate that the very notion of TQM can be extended to define an organization as willing to adopt Artificial Intelligence, which, in the present case, acts as a proxy measure of its overall potential in digital innovation. This indicates two roles of TQM -

besides the performance improvement system; it is also an inherent facilitator of technology change.

The outcome of the study was the determination that TQM directly affected the positive shift of project outcomes by creating an organized process, collaboration and quality control. At the same time, the willingness of more TQM-mature companies to incorporate AI applications into their business processes increased. That means there is an existing quality culture in place that will provide the internal discipline and openness necessary to adopting digital innovations. Rather than the independent variable AI readiness, the study considers it as the outcome of the digital maturity of an enterprise, its ability to innovate and transform the operating process.

The result of this research was concluded that TQM had a direct impact on the positive change of project results through the development of systematic procedure, cooperation and quality management. At the same time, the willingness of more TQM-mature companies to incorporate AI applications into their business processes increased. That means there is an existing quality culture in place that will provide the internal discipline and openness necessary to adopting digital innovations. Rather than the independent variable AI readiness, the study considers it as the outcome of the digital maturity of an enterprise, its ability to innovate and transform the operating process.

It was revealed that AI preparedness contributed positively to the performance of the projects. The organizations, which are willing to adopt AI, have tremendous opportunities to adopt intelligent solutions that will enhance precision and speed in planning, risk management, and decision making. The identified mediation supports the evidence that the TQM does not only affect the performance directly but it also affects it indirectly by enhancing the AI preparedness. In a conclusive way, the findings go beyond statistical validation to show how TQM works in respect not only of improving operational greatness, but of strategic versatility. The integration of quality systems and readiness to AI enables the transition to a continuous cycle of innovation within the project environment, and especially in the context of resource shortage like Palestine. That is why, companies should react to this by making quality and innovations two faces of the same coin that forms a weapon of competitiveness.

These findings are also supported by model diagnostics:

- The model was capable of explaining 62.7 percent of the factors in influence of project performance and 38 percent in influence of AI readiness indicating that it is highly predictable.
- SRMR = 0.050 and NFI = 0.875 prove that the model fits well.
- The evaluations of reliability and validity pointed to strong construct reliability (CR over 0.93) and convergent validity (AVE more than 0.72).

AEC industry experts concurred, suggesting that teams with good quality programs in place will be better able to implement new technologies, like AI. As a result of both quality processes and digital use, these organizations found that rework was reduced, teamwork improved, and projects were delivered more quickly.

4.7 Contributions of the study

4.7.1 Strengthening TQM Practices to Improve Project Performance (H1)

The results of this study showed TQM has a significant and direct impact on the performance of the projects in the Palestinian AEC firms ($\beta = 0.551$, $t = 5.876$, $p < 0.001$ This point out that where organization have constantly practiced TQM practices their outcomes are having better score of cost efficiency, timelines adherence and client satisfaction. To attempt to get the most out of this finding, firms should institutionalize a complete quality culture at all levels of the firm.

This can be achieved by showing more leadership commitment, involving the employees in the decision-making process and by a continuous improvement program where errors and rework are eliminated. Special emphasis here should be placed on training of the staff in the areas of systematic problem-solving risk management and quality control tools. Moreover, quality policies must not be reduced to theoretical documents, but, on the contrary, properly translated in operative guidelines and actively monitored through the periodic audits. Incorporation of TQM principles into day-to-day practice is helping Palestinian AEC companies better cope with the stresses posed by insufficient resources, volatile market and political instability and, importantly, helps them to more predictably and successfully complete their projects.

4.7.2 Using Quality Systems to Build AI Readiness (H2)

The results have ensured that the TQM is a significant determinant of organizational willingness to adopt AI ($b = 0.616$, $t=10.997$, $p < 0.001$). It would imply that good quality culture does not only translate into higher performance, but it also equips the firms to adopt digital transformation. In practice it implies that Palestinian AEC companies should consider management of their quality system as the strategic foundation of adoption of AI.

To realize this, the operationalization of AI-oriented performance indicators should become a part of the system of monitoring on the quality of a company, including data accuracy and use of technological tools and automation of work processes. The employees should be not only taught about the principles of quality, but also how AI applications, such as predictive scheduling, automated design tools and software to aid quality inspections, comply with it. To encourage internal innovation, firms should also think of organizing cross-functional teams to have high quality specialists and IT engineers collaborate and strategize on which locations can apply AI to enhance existing processes. By doing so, the TQM will lose its classical nature as a system of rules, and in such a manner, it is bound to evolve into a living culture that will accept and stir the creation of technology.

4.7.3 Addressing Barriers Between AI Willingness and Project Performance (H3)

Despite the result showed significant positive relationship between organizational willingness to adopt AI and performance of the project ($\beta = 0.323$, $t = 3.966$ $p < 0.001$). interviews with managers and engineers indicated existence of persistent barriers. These include the costs associated with acquiring AI technologies, technical expertise within firms, and the political and economic restrictions in Palestine in general. This finding suggests that merely being willing is not enough to ensure performance improves when firms ignore addressing these barriers.

Palestinian AEC companies should therefore have a phased approach to the implementation of AI. Instead of investing in expense issue, large-scale systems, firms can look starting with cheap AI applications to scheduling, budgeting, and quality monitoring. Partnerships with local universities and incubators and technology providers can also lead to access to expertise and lower costs. Equally as important is the need to

produce internal champions - that is, employees trained as the "AI ambassador" guiding their teams to incorporate digital solutions into work on a day-to-day basis with their projects. Such initiatives will help bridge the gap between willingness and results from theory, which will allow for firms to put their willingness into measurable results of projects.

4.7.4 Integrating AI Readiness into TQM Frameworks (H4)

The results of mediation analysis have confirmed that organizational willingness to adopt AI mediates the relationship between TQM and project performance partially (indirect effect $\beta = 0.199$, $t = 3.941$, $p < 0.001$)). This extends the net to quality systems not as directly affecting performance but indirectly, too, by helping create a space where AI can flourish and do its job.

Palestinian AECs firms should ensure that the AI preparedness is integrated into their TQM frameworks in order to tap into this mediating mechanism. This may be accomplished by making digital readiness indicators an element of quality audits, which guarantee that quality measures of technology adoption are routinely perceived in company of quality measures of behavior. As an example, when conducting internal quality reviews, companies are not only to confirm that processes are in line with either ISO or EFQM standards but also that they are flexible enough to be used by AI and to support digital processes. Moreover, IT and innovation experts should be a part of TQM committees, as they could help to guarantee the orientation of AI implementation to the organizational strategy. By officially introducing AI readiness into the quality system, companies are not enforcing technology as a single project, but they are integrating it into their DNA as part of the organization.

4.8 Policy-Level Recommendations

This study identifies the aggression of policy level intervention to incentivize the use of TQM and AI by Palestinian AEC firms; however, firm-level strategies cannot be ignored.

4.8.1 Enhancing Institutional Support for TQM

The accreditation agencies, the professional associations, and the Palestinian government should become more active regarding the quality management standards. This is offered through subsidized training programs on TQM, certification programs and incentives on

successful quality practice execution by companies. An institutional support may also assist in the aspects of introducing industry-wide benchmarking and culture of excellence in the industry.

4.8.2 Facilitating Affordable Access to AI Technologies

Under the conditions of financial limitation Palestinian firms are exposed to, policy makers must contemplate how to make the adoption of AI less expensive. This might take the form of negotiating volume software licenses of AI with local businesses, tax credits to invest in digital equipment, inclusive of privatized participation arrangements with technology vendors. Donor agencies can also contribute significantly to funding construction and architecture pilot AI projects, which can be used to demonstrate the usefulness of such projects.

4.8.3 Building National Digital Infrastructure and Skills

Implementation of assignment AI thus will be determined by the presence of strong digital infrastructure in the AEC industry. In policy terms, there should be the focus on the enhancement of connectivity to the internet and cloud services as well as data security policies. Meanwhile, AI and digital construction modules should become part of the university and vocational education system as well, as the future generation of engineers and architects must be ready to work in this digital age.

4.8.4 Creating a Stable Regulatory Environment

Last but not least, a stability that all firms must risk upon a digital transformation is demanded in the context of politically and economically volatile Palestine. The policymakers must be operating with the understanding that they are to reduce bureaucracy, make the permit issues easier and have a structure in place, legally, to promote innovation instead of deterring it. Still, even minor changes in predictability of regulations can boost investment levels on TQM and AI endeavors by companies.

4.9 Future work and limitations

Limitations

To begin with, it was cross-sectional in nature and it constrained the ability to establish the change over time and appropriate causal conclusions. Second, the data were not collected in all sectors and regions of Palestine as well, which limits the possibility of

generalized findings. Third, the key mediating variable was TQM had adoption of AI; other emerging technologies which would have likely mediate TQM had not been considered.

Future Work

To overcome such shortcomings the following are the bright directions:

- Longitudinal Studies: A successful research to determine more about the long-term impacts of TQM practices and AI readiness ought to adopt longitudinal designs, which can be employed to determine the flows of these practices and facilitation over time, on the performance of projects.
- Expansion of Geographic Scopes: It is suitable to generalize the research to other developing and developed countries because it can not only compare the outcomes in cross-cultural and institutional contexts but it can also offer the results of the research the geographical validity.
- Discovery of Other Technologies: The future research will need to consider other digital technologies such as Building Information Modeling (BIM), the Internet of Things (IoT), and blockchain to establish the usefulness of the tools in supplementing TQM to enhance project performance.
- Sectoral Comparisons: It is advisable to compare the results with organizations outside the AEC industry (healthcare, manufacturing and banking) to establish whether the mediating effect of the willingness to adopt AI in organizations is industry-specific or broad.

Altogether, even though the current study represents a welcome addition to the theory and practice, its limitations do suggest that the direction of future research should consist of a few areas. The additional research can provide the more detailed image of how these three phenomena depend on each other with tendencies to become bigger in time, geography and interests which appear in technologies and geographical sphere of the organization.

4.10 Final Reflections

This paper investigated the association between the Total Quality Management (TQM), the preparedness of Artificial Intelligence and performances in projects in the AEC and companies that operate in Palestine to be exact. The purpose of the study was to

investigate the factor of the contribution of the institutionalized quality systems in the enhancement of not only the operational excellence, but the digital readiness too, which are beginning to be inevitable in the present living universe of projects - dynamic, high-complex and fast-paced.

These successes are a good indication of the fact that TQM is not merely a compliance tool. TQM instills the discipline, responsibility, and innovativeness spirit as far as it is carried out effectively. These attributes not only enhance performance of a project over time, in terms of cost performance and quality performance, but also associated with the creation of an organizational environment where AI tools and digital solutions can be applied. The mediation paradigm in place supports the fact that TQM and AI preparation are significantly interlinked and can cooperate to guarantee high project delivery results.

The paper being discussed is a source of strategic optimism in the circumstances under which Palestinian firms are compelled to strike a balance between the variability of the regulatory environment and under-investment and access to state-of-the-art technology. It demonstrates that in case of the inside organizational rearrangement and capacity-building as well as in the instance of quality enhancement provided by the leadership, a meaningful innovation and enhancement of performance is still feasible. It should be mentioned, that in this paper, AI readiness was not considered as a rigid technical ability but a degree of intention and possibility of a company to innovate according to its constrained ability of functioning.

The confirmed partial mediation effect of AI preparedness highlights one of the necessary lessons: the best results of the project are achieved when organizations develop quality systems at the same time as they develop digital capabilities. The implications of this finding on the way in which firms should design and execute their organizational transformation strategies- not as a separate quality or digital program but rather as a comprehensive initiative- are direct.

In order to successfully integrate this two-pronged focus, companies will need to take a holistic approach that connects quality management with digital transformation. This entails the integration of digital KPIs into quality management systems by measuring AI utilization, progress made in achieving digital transformation, number of projects enhanced with digital solutions, etc. Digital maturity should be measured alongside other

traditional performance measures. At the same time, organizations should priorities areas like ambiance of AI in education and training so that the workforce is able to clearly see the link between technology and quality-driven activities to create a culture where innovation is the natural extension from there quality tasks. Moreover, the establishment hybrid management roles like Quality and Innovation Officers, the latter keeping in mind the practices of TQM while monitoring the preparedness of AI is imperative as these persons would both manage practices of TQM and monitor the preparedness of AI; thanks to these projects, they would be vital connectors between operation and technological domains while providing the needed connecting in leadership between departments. Finally, an executive approach needs to match operational capacity to ensure that investments in AI are complemented with strong regulations, good training frameworks, and a culture of openness to change to prevent gaps between strategic intent and implementation in practice.

Combined, these strategies result in the formation of the organizational ecosystem where continuous and digital innovation co-exist. The companies that have merged these dimensions will not only report better outcomes of the already in action projects, but they will be more maneuverable and be able to stand on its own when technological turmoil comes along.

In addition to the contributions, the study will also ultimately provide a bigger picture of what is likely to transpire during the project-based industries even in the emerging economies. Will the questions of quality management and online preparedness be not a pleasant but a necessary task as the requirements of the world in the spheres of expediency, smartness, and post-sustainability of the project delivery will change, Possibly the easiest and most topical way that needs to be pursued by the companies concerned with the long-term sustainability and competitiveness via internal capabilities such as TQM and the idea of digital openness.

In general, this paper contributes to proving the idea that both quality and innovativeness are two interconnected approaches in the industry. As a part of corporate culture, one can make TQM an instrument of successful functioning and technology development. The combination is a viable and realistic roadmap that AEC firms in Palestine and other analogous settings can achieve on a journey toward sustainable, high-performance projects delivery in the digital age.

Table of Abbreviations

Abbreviation	Meaning
TQM	Total Quality Management
AI	Artificial Intelligence
AEC	Architecture, Engineering, and Construction
MBNQA	Malcolm Baldrige National Quality Award
ISO	International Organization for Standardization
PLS-SEM	Partial Least -Squares Structural Equation Modeling
RBV	Resource-Based View
TOE	Technology-Organization-Environment
PDCA	Plan-Do-Check-Act
BIM	Building Information Modeling

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Appendices

Appendix A

Summary of Empirical Studies

Article #	Reference	Article Full Name	Findings	Variables
Article 1	(Akhmatova et al., 2022)	Integrating Quality Management Systems (TQM) in the Digital Age of Intelligent Transportation Systems Industry 4.0	Industry 4. 0 has a positive impact with TQM implementation while some of the challenges are the security of information and skilled workforce.	TQM, Industry 4.0, Digitalization
Article 2	(Pallavi Tyagi, 2023)	Smart Analytics, Artificial Intelligence, and Sustainable Performance Management in a Global Digitalized Economy	Implementation of AI and Smart analytics enhances organizational sustainable performance management because it addresses issues of efficiency and effectiveness in the decision-making process.	AI, Smart Analytics, Sustainable Performance
Article 3	(Hu et al., 2023)	Exploring the Relationships Between Attitudes Toward Emission Reduction Policies and the Use of AI in Sustainable Performance	Positive attitudes towards emission reduction policies are linked to higher adoption of AI in organizations, which in turn enhances sustainable performance.	AI, Emission Reduction, Sustainable Performance
Article 4	(Munir S et al., 2023)	Exploring the Impact of Digital Leadership on Sustainable Performance with the Mediating Role of Artificial Intelligence	Digital leadership is a critical factor in improving sustainable performance, with AI playing a key mediating role.	Digital Leadership, AI, Sustainable Performance
Article 5	(Tariq et al., 2021)	Achieving Operational Excellence Through Artificial Intelligence: Driving Forces and Barriers	AI contributes significantly to achieving operational excellence, but there are barriers, such as resistance to change and the cost of AI implementation.	AI, Operational Excellence, Barriers
Article 6	(Govindan, 2024)	How Artificial Intelligence Drives Sustainable Frugal Innovation: A Metatheoretical Perspective	AI plays a crucial role in driving sustainable frugal innovation by enabling cost-effective and efficient processes while maintaining sustainability.	AI, Sustainable Innovation, Cost Efficiency
Article 7	(How et al., 2020)	Artificial Intelligence-Enhanced Decision Support: Opportunities and Challenges	AI-enhanced decision support systems provide significant opportunities for improving decision-making processes in complex environments, but	AI, Decision Support, Ethical Concerns

			challenges such as data quality and ethical concerns remain.	
Article 8	(Toniolo et al., 2020)	Sustainable Business Models and Artificial Intelligence: Opportunities and Challenges	AI supports the development of sustainable business models by enhancing the economic, social, and environmental aspects of sustainability.	AI, Sustainable Business Models, ESG Dimensions
Article 9	(Amin et al., 2022)	Use of Artificial Intelligence for Predicting Parameters of Sustainable Business Performance	AI can predict key parameters of sustainable business performance, helping companies to proactively manage and enhance their sustainability practices.	AI, Predictive Analytics, Sustainable Performance
Article 10	(Dumitrascu et al., 2020)	Performance Evaluation for a Sustainable Supply Chain	AI-driven sustainable supply chain management improves efficiency and reduces costs, especially in industries reliant on complex logistics.	AI, Supply Chain Management, Sustainability
Article 11	(Zhao & Gómez Fariñas, 2023)	Artificial Intelligence and Sustainable Decisions	AI plays a critical role in enhancing decision-making in sustainable development by providing real-time data and predictive analytics.	AI, Decision-Making, Sustainable Development
Article 12	(Zhang et al., 2020)	Achieving the Success of Sustainability Development Through AI	AI significantly contributes to achieving sustainable development goals by enabling resource optimization and improving process efficiency.	AI, Sustainability Development, Resource Optimization
Article 13	(Liu & Lin, 2021)	Performance Assessment on the Application of Artificial Intelligence to Sustainable Supply Chain Management in the Construction Material Industry	AI applied to sustainable supply chain management in the construction materials industry enhances production efficiency and reduces risks related to supply chain disruptions.	AI, Supply Chain Management, Construction Industry
Article 14	(Alnamrouti, Rjoub and Ozgit, 2022)	Do Strategic Human Resources and Artificial Intelligence Help in Achieving Sustainable Business Performance?	Strategic HR practices combined with AI contribute to sustainable business performance by fostering innovation, improving employee engagement, and optimizing operational processes.	AI, HR Practices, Sustainable Business Performance

Article 15	(van Kemenade, 2022)	Patterns Emerging from the TQM Practices in Industry 4.0	TQM practices are critical in achieving high performance in Industry 4.0 environments.	TQM practices, Industry 4.0
Article 16		Role of Artificial Intelligence in Enhancing Operational Excellence	AI contributes to enhanced decision-making and operational performance in various industries.	AI tools, Operational Excellence
Article 17	(Hassan et al., 2024)	An Artificial Intelligence (AI) Framework to Predict Operational Success	Proposed AI framework effectively predicts operational success with high accuracy.	AI Framework, Operational Success
Article 18	(AlJarallah, 2023)	Investigating the Influence of Artificial Intelligence on Quality Management	AI has a profound impact on quality management, especially in manufacturing processes.	AI, Quality Management
Article 19	(Sharma, Pinca-Bretotean and Sharma, 2023)	Artificial Intelligence in Lean Manufacturing: A Systematic Review and Future Directions	AI has significantly contributed to lean manufacturing by optimizing processes and reducing waste. However, the study suggests a need for further research into the integration of AI with other Industry 4.0 technologies.	AI, Lean Manufacturing
Article 20	(Fonseca Filho, Da Silva and Chaves, no date)	Integrating Multimedia and Artificial Intelligence: An Application for Total Quality Management in Dairy Companies	AI combined with multimedia tools has been successfully implemented in dairy companies to improve Total Quality Management (TQM) practices, leading to enhanced process control and product quality.	AI, Multimedia, TQM, Dairy Industry
Article 21	(Tominc, Oreški and Rožman, 2023)	Artificial Intelligence and Agility-Based Model for Successful Business Transformation	AI, when combined with agility-based models, enhances business transformation efforts by improving adaptability and decision-making processes.	AI, Agility, Business Transformation
Article 22	(Smith et al., 2021)	From Code to Bedside: Implementing Artificial Intelligence in Healthcare	AI implementation in healthcare has improved patient outcomes through more accurate diagnostics and personalized treatment plans.	AI, Healthcare, Patient Outcomes
Article 23	(Silvestro et al., 2022)	"Improving Biodiversity Protection Through AI-Enabled Environmental Monitoring"	AI significantly enhances biodiversity monitoring and protection strategies by providing accurate and timely data.	AI tools, Biodiversity Protection, Monitoring Techniques

Article 24	(Ali and Johl, 2022)	"Soft and Hard TQM Practices: Future Research Directions"	Balancing soft and hard TQM practices is crucial for enhancing organizational performance, with recommendations for future research on their integration.	Soft TQM Practices, Hard TQM Practices, Organizational Performance
Article 25	(Laseinde et al., 2020)	"The Role of Change Readiness in Determining the Success of TQM Practices"	Change readiness is crucial for the successful implementation of TQM practices, particularly in rapidly changing industries like IT.	Change Readiness, TQM Practices, Employee Performance
Article 26	(Vasilieva et al., 2023)	"Total Quality Management as Predictor of Artificial Intelligence Ensures Competitive Advantage"	TQM is a strong predictor of AI adoption, which leads to a competitive advantage in various industries.	TQM, AI Adoption, Competitive Advantage
Article 27	(Hyun Park et al., 2017)	"Building a New Culture for Quality Management in the Era of the Fourth Industrial Revolution"	The Fourth Industrial Revolution requires a new culture for quality management, integrating AI, Big Data, and IoT to enhance quality control and customer satisfaction.	Fourth Industrial Revolution, AI, Big Data, IoT, Quality Management
Article 28	(Wassan et al., 2022)	"Impact of Total Quality Management (TQM) Practices on Sustainability and Organizational Performance"	TQM practices positively impact sustainability and organizational performance, particularly in the manufacturing sector.	TQM Practices, Sustainability, Organizational Performance
Article 29	(Agus and Selvaraj, 2020)	"The Effects of People- and Technical-Oriented TQM on Productivity: The Mediating Role of Production Performance"	Both people-oriented and technical-oriented TQM practices have a significant positive impact on productivity, mediated by production performance.	People-Oriented TQM, Technical-Oriented TQM, Productivity, Production Performance
Article 30	(García-Alcaraz et al., 2021)	"The Importance of Organizational Structure for TQM Success and Customer Satisfaction"	A well-structured organization is crucial for the successful implementation of TQM practices, which in turn leads to higher customer satisfaction.	Organizational Structure, TQM Success, Customer Satisfaction
Article 31	(Soltani and Wilkinson, 2020)	"TQM and Performance Appraisal: Complementary or Incompatible?"	The study explores the compatibility of TQM and performance appraisal systems, finding that they can be complementary if	TQM, Performance Appraisal, Organizational Goals

			well-aligned with organizational goals.	
Article 32	(Sinha and Dhall, 2020)	"Mediating Effect of TQM on Relationship Between Leadership Styles and Organizational Performance"	TQM acts as a mediator between leadership styles and organizational performance, with transformational leadership having the most significant positive impact.	TQM, Leadership Styles, Organizational Performance
Article 33	(Mushtaq and Peng, 2020)	Can TQM Act as a Stimulus to Elevate Performance in Service Industries?	TQM can significantly elevate performance in service industries by improving service quality and customer satisfaction.	TQM, Service Industries, Performance
Article 34	(Zaidi and Ahmad, 2020)	Total Quality Management (TQM) Practices and Operational Performance in Manufacturing Company	TQM practices have a direct positive impact on the operational performance of manufacturing companies, especially in areas like production efficiency and quality.	TQM Practices, Operational Performance, Manufacturing
Article 35	(Asad et al., 2023)	Open Innovation: The Missing Nexus between TQM and Performance	Open innovation acts as a crucial link between TQM practices and enhanced organizational performance, particularly in dynamic industries.	TQM, Open Innovation, Organizational Performance
Article 36	(Saha et al., 2022)	Unleashing the Potential of TQM and Industry 4.0 to Achieve Operational Excellence	The integration of TQM with Industry 4.0 technologies is essential for achieving operational excellence in modern manufacturing environments.	TQM, Industry 4.0, Operational Excellence
Article 37	(Vihari, Yadav and Panda, 2022)	Impact of Soft TQM Practices on Organizational Performance	Soft TQM practices, such as leadership and employee involvement, have a significant positive impact on organizational performance.	Soft TQM Practices, Organizational Performance
Article 38	(Wall, 2021)	The Comparison of TQM Practices and Quality Performance Between Manufacturing & Service Sectors	There are significant differences in TQM practices and quality performance between manufacturing and service sectors, with manufacturing showing higher overall performance.	TQM Practices, Quality Performance, Manufacturing, Service

Article 39	(Alanazi, 2020)	The mediating role of primary TQM factors and strategy in the relationship between supportive TQM factors and organisational results: An empirical assessment using the MBNQA model	Primary TQM factors and strategic planning mediate the relationship between organizational support elements and results, improving management effectiveness.	Interactions between TQM elements and organizational results.
Article 40	(Taraza et al., 2023)	Malcolm Baldrige National Quality Award (MBNQA) Quality Tool in Education: A Systematic Literature Review	Discusses the benefits of the MBNQA tool in education, affecting innovation, HR, and operational outcomes.	Quality management , human resources and knowledge management.
Article 41	(Setiawan & Purba, 2021)	A Systematic Literature Review of Malcolm Baldrige National Quality Award (MBNQA)	Nearly half of the studies use the MBNQA criteria to measure organizational performance, comparing it with other awards to improve management models.	Organizational performance, comparison of awards, TQM application in modern industries.
Article 42	(Thunyachair at et al., 2024)	Critical Success factor of Malcolm Baldrige National Quality Award (MBNQA), Lean Practice with Thai Automotive Industry	Identifies key factors for MBNQA and Lean Practices implementation in the automotive industry, emphasizing leadership, strategic planning, and customer focus	Implementation success factors in automotive industry settings

Appendix B

Questionnaire form English

An-Najah National University Faculty of Graduate Studies

Research Questionnaire in English

Questionnaire about

The Impact of Total Quality Management on Project Performance: The Mediating Role of Organizational Willingness for Artificial Intelligence in the AEC Sector in Palestine

Dear Participant,

I am currently conducting a Master's thesis entitled: "The Impact of Total Quality Management on Project Performance: The Mediating Role of Organizational Willingness to Use Artificial Intelligence in the Engineering and Construction Sector in Palestine." The thesis is part of the Engineering Management Program at An-Najah National University. This study aims to investigate the relationship between Total Quality Management (TQM) practices and organizational readiness to adopt advanced AI-based technologies with project performance indicators in the engineering and construction sector in Palestine. Given your valuable expertise and experience in the engineering and construction sector—as an engineer, engineering consultant, or contractor—I kindly request your cooperation in completing this questionnaire. Your opinions are essential to understanding current practices, levels of readiness, and performance outcomes in this field. The questionnaire consists of four sections:

- Section One: Introduction.
- Section Two: Total Quality Management, which contains 23 questions.

- Section Three: Organizational/Institutional Readiness to Adopt Artificial Intelligence, which contains 18 questions.
- Section Four: Project Performance, which contains 17 questions.

Please be assured that your responses will be completely confidential and will be used for academic research purposes only.

Thank you very much for your valuable time and contribution.

Value	Indicator	Questions	Strongly Agree	Agree	neutral	disagree	Strongly disagree
Total Quality Management (TQM) Practices	Leadership	The organization's senior leadership demonstrates a consistent commitment to quality standards, and management actively supports quality management training and development.					
	Leadership	The organization's senior leadership regularly reviews and encourages quality improvement initiatives.					
	Leadership	Senior management actively supports quality management training and development.					
	Leadership	There is a clear policy from leadership to integrate quality management into every aspect of the organization's operations.					
	Strategic Planning	The organization's strategic plan/action plan includes clear objectives for improving work quality.					
	Strategic Planning	Strategic planning processes are regularly reviewed and quality objectives are integrated					

	into the organization's risk management strategy.
Strategic Planning	The organization uses strategic planning to align quality objectives with its operating model.
Customer Focus	The organization regularly communicates with customers to understand their needs and expectations.
Customer Focus	The organization has specific and clear steps and procedures for responding to customer feedback.
Customer Focus	Customer satisfaction is a key measure of the success of quality improvement steps and procedures.
Measurement, Analysis, and Knowledge Management	Data collected on quality performance is carefully analyzed to identify areas for improvement.
Measurement, Analysis, and Knowledge Management	Systems are in place to share knowledge and best practices on quality management with employees.
Measurement, Analysis, and Knowledge Management	Regular audits and evaluations are conducted to ensure the integrity of quality metrics.
Workforce Focus	Employees are regularly trained and encouraged on the importance and application of quality management.
Workforce Focus	Employee performance evaluations include measures related to their knowledge and application of quality

		management standards within the organization.
	Workforce Focus	Reward systems are in place to recognize employee contributions to quality improvements.
	Operations Focus	The organization uses standardized processes to ensure consistent quality across various projects.
	Operations Focus	Quality control points are effectively integrated into key operational processes.
	Operations Focus	The organization has mechanisms in place to quickly address operational issues that impact quality.
	Results	The organization has seen consistent improvement in quality results over time.
	Results	Quality enhancement initiatives have reduced product defects and returned work.
	Results	Customer satisfaction has been significantly improved as a result of implementing Total Quality Management (TQM) practices.
	Results	The organization's market reputation for quality has improved thanks to TQM practices.
Organizational Willingness to Adopt AI	Leadership Support for AI Adoption	Senior management has clear plans for long-term AI implementation and funding.
	Leadership Support for AI Adoption	There is a clear commitment from senior management to fund AI

	initiatives within the organization.
Leadership Support for AI Adoption	Leadership is actively involved in planning and implementing AI strategies.
Leadership Support for AI Adoption	Organizational leaders have a strong understanding of the benefits of AI and communicate them effectively at all levels.
Leadership Support for AI Adoption	Leadership views AI as a tool that can improve administrative and financial performance.
Technological Readiness	The organization has the necessary technological infrastructure (such as high-speed internet, etc.) to support the implementation of AI initiatives.
Technological Readiness	The organization is assessing its technological capabilities to support AI initiatives. The organization has begun developing systems and processes to ensure data quality and accessibility for future use in AI applications.
Technological Readiness	Employees demonstrate a positive attitude toward the use of AI in their work.
Employee Readiness and Competency	Training programs are available to employees to develop their AI-related skills.
Employee Readiness and Competency	Employees are encouraged to innovate and use AI solutions to solve problems.

	Employee Readiness and Competency	There is a general consensus within the organization that AI can significantly enhance operational efficiency.
	Perceived Benefits of AI	Employees believe AI technologies can lead to improved decision-making processes.
	Perceived Benefits of AI	The organization considers adopting AI essential to maintaining a competitive advantage.
	Perceived Benefits of AI	The benefits of AI in improving customer satisfaction are recognized and well-accepted within the organization.
	Perceived Benefits of AI	The organization's culture is supportive of adopting new technologies such as AI.
	Organizational Culture and Change Readiness	There is a willingness to change existing processes and systems to accommodate AI.
	Organizational Culture and Change Readiness	Leadership fosters an environment where technological adaptation is viewed as an opportunity, not a threat.
	Organizational Culture and Change Readiness	Senior management has clear plans for long-term AI implementation and funding.
Project Performance	Time Management	The organization effectively manages task scheduling and time allocation for projects.
	Time Management	Project deadlines are met according to the planned schedule.
	Time Management	Time management practices are regularly

	reviewed and improved based on project outcomes.
Time Management	Project teams are trained in time management techniques to enhance project execution efficiency.
Cost Efficiency	The organization maintains strict budget control on projects to avoid cost overruns.
Cost Efficiency	Cost efficiency is a key performance indicator in project evaluations.
Cost Efficiency	Financial resources are allocated efficiently across projects to maximize return on investment.
Quality of Deliverables	Projects consistently adhere to the quality standards set by the organization.
Quality of Deliverables	Quality control checks are integrated throughout the project lifecycle to ensure delivery standards.
Quality of Deliverables	There is a commitment to continuous improvement in the quality of project deliverables.
Innovation and Learning	The organization encourages innovation in project management and execution.
Innovation and Learning	Project teams are equipped to implement innovative solutions to overcome project challenges.
Innovation and Learning	Lessons learned from projects are systematically captured and shared across the organization.

Innovation and Learning	Innovation in project processes and solutions is recognized and rewarded.	
Customer Satisfaction	Customer satisfaction is regularly measured as a key outcome of project performance.	
Customer Satisfaction	The organization has mechanisms in place to respond promptly to customer feedback during projects.	
Customer Satisfaction	There is a strategic focus on enhancing customer relationships through project interactions and achieving customer satisfaction.	

Appendix C

Questionnaire form Arabic

عزيزي المشارك،

أقوم حاليًا بإجراء رسالة ماجستير بعنوان: أثر إدارة الجودة الشاملة على أداء المشاريع: الدور الوسيط للرغبة التنظيمية في استخدام الذكاء الاصطناعي في قطاع الهندسة والبناء في فلسطين ، في جامعة النجاح الوطنية، ضمن برنامج الإدارة الهندسية. تهدف هذه الدراسة إلى بحث العلاقة بين ممارسات إدارة الجودة الشاملة (TQM) والاستعداد التنظيمي لتبني التقنيات المتقدمة التي تعتمد على الذكاء الصناعي مع مؤشرات أداء المشاريع في قطاع الهندسة والبناء في فلسطين ، ونظرًا لخبرتك القيمة وتجربتك في قطاع الهندسة والبناء – كمهندسين، أو مستشارين هندسيين، أو مقاولين – أرجو من حضرتكم التعاون في الإجابة على هذا الاستبيان. إن آرائكم ضرورية لفهم الممارسات الحالية ومستوى الجاهزية ونتائج الأداء في هذا المجال. يتكون الاستبيان من اربعة اقسام:

- **القسم الاول : المقدمة.**
- **القسم الثاني : إدارة الجودة الشاملة و يحتوي على23 سؤال.**
- **القسم الثالث: استعداد المنظمة/ المؤسسة لتبني الذكاء الاصطناعي و يحتوي على 18 سؤال.**
- **القسم الرابع: اداء المشاريع و يحتوي على 17 سؤال .**

مع التأكيد على أن إجاباتكم ستكون سرية تمامًا وستستخدم لأغراض البحث الأكاديمي فقط.شكرًا جزيلًا على وقتكم الثمين ومساهمتكم القيمة.

	المؤشر	السؤال	موافق بشدة	موافق	محايد	غير موافق	غير موافق بشدة
ممارسات إدارة الجودة الشاملة	القيادة	تُظهر القيادة العليا في المنظمة التزامًا مستمرًا بمعايير الجودة و تدعم الإدارة التدريب والتطوير في إدارة الجودة بنشاط					
	القيادة	تقوم القيادة العليا في المنظمة بمراجعة وتشجيع المبادرات لتحسين الجودة بانتظام					
	القيادة	تدعم الإدارة العليا التدريب والتطوير في إدارة الجودة بنشاط.					
	القيادة	هناك سياسة واضحة من القيادة لدمج إدارة الجودة في كل جانب من جوانب عمليات المنظمة.					
	التخطيط الاستراتيجي	تشمل الخطة الاستراتيجية/خطة العمل للمنظمة أهدافًا واضحة لتحسين جودة العمل					
	تخطيط الاستراتيجي	يتم مراجعة عمليات التخطيط الاستراتيجي و دمج أهداف الجودة في استراتيجية إدارة المخاطر للمنظمة بانتظام .					
	تخطيط الاستراتيجي	تستخدم المنظمة التخطيط الاستراتيجي لمواءمة أهداف الجودة مع النموذج التشغيلي.					
	التركيز على العملاء	تتواصل المنظمة بانتظام مع العملاء لفهم احتياجاتهم وتوقعاتهم					
	التركيز على العملاء	لدى المنظمة خطوات واجراءات محددة وواضحة للأستجابة لملاحظات العملاء.					

رضا العملاء هو مقياس رئيسي لتقييم نجاح خطوات واجراءات تحسين الجودة.	التركيز على العملاء	
يتم تحليل البيانات التي تم جمعها حول أداء الجودة بدقة لتحديد مجالات التحسين.	القياس والتحليل وإدارة المعرفة	
هناك أنظمة لمشاركة المعرفة وأفضل الممارسات حول إدارة الجودة مع الموظفين .	القياس والتحليل وإدارة المعرفة	
يتم إجراء عمليات تدقيق وتقييم منتظمة لضمان سلامة مقاييس الجودة.	القياس والتحليل وإدارة المعرفة	
يتم تدريب وتشجيع الموظفين بانتظام على أهمية وتطبيق إدارة الجودة.	التركيز على القوى العاملة	
تشمل تقييمات أداء الموظفين مقاييس تتعلق بمعرفتهم وتطبيقهم معايير إدارة الجودة داخل المؤسسة	التركيز على القوى العاملة	
هناك أنظمة مكافآت للاعتراف بمساهمات الموظفين في تحسينات الجودة.	التركيز على القوى العاملة	
تستخدم المنظمة عمليات موحدة لضمان الجودة الثابتة عبر المشاريع المختلفة.	التركيز على العمليات	
يتم دمج نقاط مراقبة الجودة بشكل فعال في العمليات التشغيلية الرئيسية.	التركيز على العمليات	
تمتلك المنظمة آليات جاهزة لمعالجة القضايا التشغيلية التي تؤثر على الجودة بسرعة.	التركيز على العمليات	
شهدت المنظمة تحسنًا مستمرًا في نتائج الجودة على مر الزمن.	النتائج	
أدت مبادرات تعزيز الجودة إلى تقليل العيوب في المنتجات والأعمال المعادة.	النتائج	
كان هناك تحسن ملحوظ في رضا العملاء نتيجة لتطبيق ممارسات إدارة الجودة الشاملة	النتائج	
تحسنت سمعة المنظمة في السوق من حيث الجودة بفضل	النتائج	

	ممارسات إدارة الجودة الشاملة	
	لدى الإدارة العليا خطط واضحة لتوظيف و تمويل الذكاء الصناعي على المدى الطويل	دعم القيادة لتبني الذكاء الاصطناعي
	هناك التزام واضح من الإدارة العليا لتمويل مبادرات الذكاء الاصطناعي داخل المؤسسة	دعم القيادة لتبني الذكاء الاصطناعي
	تشارك القيادة بنشاط في التخطيط وتنفيذ استراتيجيات الذكاء الاصطناعي.	دعم القيادة لتبني الذكاء الاصطناعي
	يتمتع قادة المنظمة بمعرفة جيدة بفوائد الذكاء الاصطناعي وايصالها بشكل فعال الى جميع المستويات	دعم القيادة لتبني الذكاء الاصطناعي
	تتعامل القيادة مع الذكاء الصناعي كأداة بإمكانها ان تحسن من ألاداء الإداري والمالي	دعم القيادة لتبني الذكاء الاصطناعي
	تمتلك المنظمة البنية التحتية التكنولوجية اللازمة (مثل الانترنت فائق السرعة، ....) لدعم تنفيذ مبادرات الذكاء الاصطناعي.	الجاهزية التكنولوجية
	تعمل المنظمة على تقييم قدراتها التكنولوجية لدعم مبادرات الذكاء الاصطناعي.	الجاهزية التكنولوجية
	بدأت المؤسسة بالعمل على تطوير أنظمة وعمليات لضمان جودة البيانات وسهولة الوصول إليها لاستخدامها في تطبيقات الذكاء الاصطناعي لاحقا	الجاهزية التكنولوجية
	ايظهر الموظفون موقفًا إيجابيًا اتجاه استخدام الذكاء الاصطناعي في عمله	استعداد وكفاءة الموظفين
	تتوفر برامج تدريبية للموظفين لتطوير مهاراتهم المتعلقة بالذكاء الاصطناعي	استعداد وكفاءة الموظفين
	يُشجع الموظفون على الابتكار واستخدام حلول الذكاء	استعداد وكفاءة الموظفين

	الاصطناعي في حل المشكلات	
	هناك إجماع عام في المنظمة على أن الذكاء الاصطناعي يمكن أن يعزز كفاءة العمليات بشكل كبير	الفوائد المتصورة للذكاء الاصطناعي
	يعتقد الموظفون أن تقنيات الذكاء الاصطناعي يمكن أن تؤدي إلى تحسين عمليات اتخاذ القرار	الفوائد المتصورة للذكاء الاصطناعي
	تعتبر المنظمة أن تبني الذكاء الاصطناعي ضروري للحفاظ على ميزة تنافسية	الفوائد المتصورة للذكاء الاصطناعي
	تم التعرف على فوائد الذكاء الاصطناعي في تحسين رضا العملاء وقبولها جيدًا داخل المنظمة	الفوائد المتصورة للذكاء الاصطناعي
	ثقافة المنظمة داعمة لتبني تقنيات جديدة مثل الذكاء الاصطناعي	الثقافة التنظيمية والاستعداد للتغيير
	هناك استعداد لتغيير العمليات والأنظمة القائمة لاستيعاب الذكاء الاصطناعي	الثقافة التنظيمية والاستعداد للتغيير
	تعزز القيادة بيئة تُعتبر فيها التكيف التكنولوجي فرصة وليس تهديدًا.	الثقافة التنظيمية والاستعداد للتغيير
أداء المشروع	تدير المنظمة جدولة المهام وتخصيص الوقت للمشاريع بفعالية.	إدارة الوقت
	يتم الالتزام بالمواعيد النهائية للمشاريع وفقًا للجدول الزمني المخطط.	إدارة الوقت
	يتم مراجعة ممارسات إدارة الوقت بانتظام وتحسينها بناءً على نتائج المشروع.	إدارة الوقت
	يتم تدريب فرق المشروع على تقنيات إدارة الوقت لتعزيز كفاءة تنفيذ المشروع.	إدارة الوقت
	تحافظ المنظمة على رقابة صارمة على الميزانية في المشاريع لتجنب تجاوز التكاليف.	كفاءة التكلفة

تعتبر كفاءة التكلفة مؤشرًا رئيسيًا للأداء في تقييمات المشاريع	كفاءة التكلفة
يتم تخصيص الموارد المالية بكفاءة عبر المشاريع لتحقيق أقصى عائد على الاستثمار	كفاءة التكلفة
تلتزم المشاريع باستمرار بمعايير الجودة التي تحددها المنظمة.	جودة المخرجات
يتم دمج عمليات فحص مراقبة الجودة طوال دورة حياة المشروع لضمان معايير التسليم.	جودة المخرجات
هناك التزام بالتحسين المستمر لجودة مخرجات المشروع.	جودة المخرجات
تشجع المنظمة الابتكار في إدارة المشاريع وتنفيذها	الابتكار والتعلم
يتم تجهيز فرق المشروع لتطبيق حلول مبتكرة للتغلب على تحديات المشروع	الابتكار والتعلم
يتم التقاط الدروس المستفادة من المشاريع بشكل منهجي ومشاركتها عبر المنظمة	الابتكار والتعلم
يتم التعرف على الابتكار في عمليات وحلول المشروع ومكافأته	الابتكار والتعلم
يتم قياس رضا العملاء بانتظام كنتيجة أساسية لأداء المشروع.	رضا العملاء
تمتلك المنظمة آليات جاهزة للاستجابة السريعة لملاحظات العملاء أثناء المشاريع.	رضا العملاء
هناك تركيز استراتيجي على تعزيز علاقات العملاء من خلال التفاعلات في المشروع و تحقيق رضاهم.	رضا العملاء

Appendix D

PLS Tables

Table D 1

Path coefficients List

	Path coefficients
Organizational Willingness to Adopt AI -> Project performance in AEC firms	0.323
TQM Practices **(**MBNQA**)** -> Organizational Willingness to Adopt AI	0.616
TQM Practices **(**MBNQA**)** -> Project performance in AEC firms	0.551

Table D 2

Indirect effects

	Specific indirect effects
TQM Practices (MBNQA) -> Organizational Willingness to Adopt AI -> Project performance in AEC firms	0.199

Table D 3

Total effects

	Total effects
Organizational Willingness to Adopt AI -> Project performance in AEC firms	0.323
TQM Practices (MBNQA) -> Organizational Willingness to Adopt AI	0.616
TQM Practices (MBNQA) -> Project performance in AEC firms	0.750

Table D 4

Outer loadings

	Outer loadings
Cost Efficiency <- Project performance in AEC firms	0.879
Customer Satisfaction <- Project performance in AEC firms	0.806
Customerfocus <- TQM Practices (MBNQA)	0.793
Employee readiness and competency <- Organizational Willingness to Adopt AI	0.885
Innovation And learning <- Project performance in AEC firms	0.895
leadership Support for Ai Adoption <- Organizational Willingness to Adopt AI	0.900
measurment-Anaylsis-knowledge-mangment <- TQM Practices (MBNQA)	0.864
OperationFocus <- TQM Practices (MBNQA)	0.828
Organizational cultural and change Readiness <- Organizational Willingness to Adopt AI	0.833
Perceived Benefits of Ai <- Organizational Willingness to Adopt AI	0.916
Quality of Deliverables <- Project performance in AEC firms	0.885
Results <- TQM Practices (MBNQA)	0.881
stratgic-planning <- TQM Practices (MBNQA)	0.879
Technolgical Readiness <- Organizational Willingness to Adopt AI	0.880
time mangment <- Project performance in AEC firms	0.895
WorkFocus <- TQM Practices (MBNQA)	0.832
leadership <- TQM Practices (MBNQA)	0.861

Table D 5

Correlations

	Organizational Willingness to Adopt AI	Project performance in AEC firms	TQM Practices (MBNQA)
Organizational Willingness to Adopt AI	1.000	0.662	0.616
Project performance in AEC firms	0.662	1.000	0.750
TQM Practices (MBNQA)	0.616	0.750	1.000

Table D 6

R-square

	R-square	R-square adjusted
Organizational Willingness to Adopt AI	0.380	0.375
Project performance in AEC firms	0.627	0.621

Table D 7

f-square

	f-square
Organizational Willingness to Adopt AI -> Project performance in AEC firms	0.173
TQM Practices (MBNQA) -> Organizational Willingness to Adopt AI	0.613
TQM Practices (MBNQA) -> Project performance in AEC firms	0.505

Table D 8

Construct reliability and validity

	Cronbach's alpha	Average variance extracted (AVE)
Organizational Willingness to Adopt AI	0.929	0.780
Project performance in AEC firms	0.921	0.762
TQM Practices (MBNQA)	0.935	0.720

Table D 9

validity

	Heterotrait-monotrait ratio (HTMT)
Project performance in AEC firms <-> Organizational Willingness to Adopt AI	0.716
TQM Practices (MBNQA) <-> Organizational Willingness to Adopt AI	0.661
TQM Practices (MBNQA) <-> Project performance in AEC firms	0.806

Table D 10

Model fit

	Saturated model	Estimated model
SRMR	0.050	0.050
NFI	0.875	0.875

جـامعـــة النجاح الوطنية

كليـــة الدراســـات العليـــا

أثر إدارة الجودة الشاملة على أداء المشاريع: الدور الوسيط للرغبة التنظيمية في استخدام الذكاء الاصطناعي في قطاع الهندسة المعمارية والبناء في فلسطين

إعداد

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إشراف

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قدمت هذه الرسالة استكمالا لمتطلبات الحصول على درجة الماجستير في الإدارة الهندسية، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس– فلسطين.

2025

أثر إدارة الجودة الشاملة على أداء المشاريع: الدور الوسيط للرغبة التنظيمية في استخدام الذكاء الاصطناعي في قطاع الهندسة المعمارية والبناء في فلسطين

إعداد

الحارث عصام محمد رمانة

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د. رابح مرار

الملخص

تبحث هذه الدراسة في العلاقة بين إدارة الجودة الشاملة (TQM) وأداء المشاريع في شركات الهندسة المعمارية والهندسة والبناء (AEC) في فلسطين، مع التركيز بشكل خاص على الدور الوسيط لاستعداد المنظمات لتبني تقنيات الذكاء الاصطناعي .(AI) ورغم أن إدارة الجودة الشاملة ارتبطت منذ فترة طويلة بالكفاءة والقدرة التنافسية، إلا أن تقاطعها مع التقنيات الناشئة ما زال غير مدروس بشكل كافٍ، خاصة في الاقتصادات الهشة مثل فلسطين. وتنبع مشكلة الدراسة من التحديات المستمرة التي تواجه شركات الـ AEC الفلسطينية في تقديم مخرجات عالية الجودة في ظل ندرة الموارد، وعدم الاستقرار السياسي، والضغوط المتزايدة للحفاظ على القدرة التنافسية.

لمعالجة هذه الفجوة، اعتمدت الدراسة منهجية مختلطة. حيث وُزع استبيان منظم على 120 مشاركًا من شركات الـAEC، وتم تحليل البيانات باستخدام نمذجة المعادلات البنائية .(SmartPLS) إضافة إلى ذلك، أجريت مقابلات شبه مهيكلة مع مدراء وممارسين في القطاع بهدف دعم وتفسير النتائج الكمية. أظهرت النتائج أن ممارسات TQM تؤثر بشكل ملحوظ على أداء المشاريع، سواء بشكل مباشر أو غير مباشر، من خلال استعداد المنظمات لتبني الذكاء الاصطناعي. كما أن إدراج بُعد "النتائج" ضمن ممارسات TQM عزز من تفسير مخرجات الأداء، مما يوضح التوافق العملي بين ممارسات الجودة والمؤشرات القابلة للقياس للنجاح.

تسهم هذه الدراسة نظريًا في إثراء تطبيق نظرية الموارد (RBV) ونظرية الطوارئ (Contingency Theory) من خلال إظهار كيفية تفاعل القدرات الداخلية للجودة مع الضغوط الخارجية في تشكيل الاستعداد لتبني AI وتحقيق الأداء. أما من الناحية العملية، فهي تقدم إرشادات لشركات الـAEC الفلسطينية وصناع القرار لتعزيز المرونة والقدرة التنافسية. وتؤكد التوصيات على أهمية ترسيخ مبادئ الجودة بالتوازي مع الاستعداد للتحول الرقمي، مما يوفر مسارًا نحو تحسين نتائج المشاريع في بيئة مليئة بالتحديات.

الكلمات المفتاحية :إدارة الجودة الشاملة، أداء المشاريع، الذكاء الاصطناعي، الاستعداد المؤسسي، قطاع الهندسة والعمارة والبناء، فلسطين.