MEGAPROJECT GOVERNANCE'S IMPACT ON MEGA CONSTRUCTION PROJECT CPEC SUCCESS: THE MEDIATING ROLE OF AGILE PROJECT MANAGEMENT AND THE MODERATING EFFECTS OF PROJECT COMPLEXITY AND PROJECT MANAGEMENT OFFICE

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MEGAPROJECT GOVERNANCE'S IMPACT ON MEGA CONSTRUCTION PROJECT CPEC SUCCESS: THE MEDIATING ROLE OF AGILE PROJECT MANAGEMENT AND THE MODERATING EFFECTS OF PROJECT COMPLEXITY AND PROJECT MANAGEMENT OFFICE

ABSTRACT

In the last few decades, mega project governance has become an essential subject for discussion in project management literature. Organizations used the project governance approach to meet the organizational objectives and goals. Yet, many projects fail, and the reasons are sometimes obscure because of the many problems involved in the governance and management of a project. Therefore, current study examined the influence of mega project governance on mega construction project success through mediating role agile project management, moderating effects of mega project complexity and the project management office as a moderated moderator. Data were collected from 327 project managers, middle management personnel, and CEOs involved in various mega construction projects in Pakistan under CPEC, utilizing purposive and convenience sampling techniques. The Partial Least Squares-Structural Equation Modeling (PLS-SEM) approach was employed to test the hypotheses using SmartPLS 4 software. The results indicate that mega project governance significantly and positively influences the success of mega construction projects. Furthermore, agile project management was found to mediate this relationship, demonstrating a positive and significant effect. Additionally, mega project complexity was observed to have a negative and significant moderating effect on both mega project governance and project success, while not significantly impacting the relationship between mega project governance and agile project management. Lastly, the project management office was found to be a significant moderated moderator, reducing the effects of both mega project complexity on mega project governance and the success of mega construction projects, as well as between mega project governance and agile project management. These findings demonstrate that mega project governance within a company, supported by effective agile project management, is the primary driver of sustained high performance and successful completion of mega construction projects. These results will make a valuable contribution to the field of project management.

Keywords: Megaproject Governance, Mega Construction Project Success, Agile Project Management, Project Complexity, Project Management Office

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Table of Contents

List of Figures

List of Tables

Abbreviations

Abbreviation	Acronym
Mega Construction Project Success	MCPS
Project Management Office	PMO
Agile Project Management	APM
Business Monitor International	BMI
Public Sector Development Programme	PSDP
National Economic Council	NEC
National Development Programme	NDP
Annual Development Programmes	ADPs
Project Management Institute	PMI
China-Pakistan Economic Corridor	CPEC
Organization For Economic Co-Operation and Development	OECD
Confirmatory Factor Analysis	CFA
Common Method Variance	CMV
Construct Level Correction	CLC
Item Level Correction	ILC
Human Resources	HR
Chief Executive Officers	CEOs
Composite Reliability	CR
Average Variance Extracted	AVE
Partial Least Squares -Structural Equation Modeling	PLS-SEM
Covariance-Based Structural Equation Modeling	CR-SEM
Project Breakdown Structure and Work Breakdown Structure	PBS/WBS
Design Structure Matrix	DSM
Analytical Design Plan Technique	ADePT
Quality Function Deployment	QFD

List of Appendices

Chapter 1: Introduction

This chapter introduces the overall study. It describes the background of the study including the mega constructions project governance in the context of Pakistan, an overview of project complexity, agile project management, and project management office role in mega construction project success. Furthermore, this chapter explain the research problem statement, research questions, research objectives, and research significance, as well as the arrangement of chapters within the thesis. To conclude, a summary of this chapter is provided at its conclusion.

1.1 Research Background

Mega construction projects today constitute one of the world's most crucial development sectors (El-Sabek et al., 2018; Chattapadhyay et al., 2021; Malla, 2023). Between 2013 and 2030, construction spending (primarily delivered as large projects) is estimated at approximately US$ 3.4 trillion annually (Ershadi et al., 2021a). The increasing global urbanisation is leading to bigger and more complicated construction projects, especially those dealing with urban infrastructure. Regional economic and social growth depends critically on large-scale infrastructure investments. The term ‘megaproject’ was developed and widely used to describe large-scale projects. At the international level, there is a growing trend in using megaprojects to facilitate the provision of a wide range of products and services. These megaprojects are often characterised by their substantial financial investment, with a minimum threshold of

US$ 1 billion, and have a tendency to progressively increase the amount invested (Hoseini et al., 2020; Yang et al., 2020). Projects with a large number of stakeholders are generally high-risk, unclear, and difficult to organise because of the number of stakeholders involved. The majority of megaprojects (90%) had cost overruns and schedule delays, leading to an average budget shortfall of 28%, according to an analysis of 258 megaprojects conducted by Flyvbjerg et al. (2004) across five continents. However, modern megaprojects have shown traditional project management principles and tactics to be less effective (Wu et al., 2018; Yang et al. 2020; Wang et al. 2021; Lin et al. 2023).

In recent years, political science, economics, and management have all paid more attention to governance challenges. Governance research has a solid theoretical grounding in principal-agent, transaction cost, and stakeholder theory. Institutional theory and practise are therefore becoming more integrated. Project management has recently been added to the growing body of knowledge in the subject of project governance. The failure of a mega project is attributed to a lack of project governance (Khan et al., 2021). Major project failures may often be traced back to a lack of project-specific governance. The lack of a project governance framework in mega-construction and the need to address it has been highlighted by previous studies (Brunet et al., 2018; Akimova, 2020; He et al., 2021; Xiaolong et al., 2021; Luo et al., 2023).

Organizations used the project governance approach to meet the organizational objectives and goals (Ullah et al., 2021). Organizations are initiating projects with the best intention. Yet, many projects fail, and the reasons are sometimes obscure because of the many problems involved in the governance and management of a project (Khan et al., 2021). The results of the projects have traditionally been measured to comply with scale, time, costs, and quality constraints. However, project evaluations are increasingly being expanded to include governance, such as their ability to produce sustained success in reaching operating goals over long periods (Ul Musawir et al., 2017).

The construction industry is supposed to be one of the most challenging industries to work in because new projects come with more complexities (Assaad et al., 2020; Ershadi et al., 2021a). Developing countries are highly interested in construction projects to achieve economic success. The current study focused on the developing country Pakistan, the country has grappled with terrorism for three decades, leading to increased government spending on security at the expense of developmental expenditure (Iqbal et al., 2023). Over the past 14 years, terrorism has cost Pakistan Rs 8,702.75bn (Khattak et al., 2019). Long-term crime and government spending on law and order negatively impact Pakistan's economic growth. Terrorism creates instability and risks within a country, leading to lost working hours and infrastructure damage (Khattak et al., 2019). During 2013-2015, terrorist attacks caused US$ 0.92bn in physical infrastructure damages, and expenditure overruns amounted to US$ 0.91bn in Pakistan (GoP, 2015). Such adverse law and order situations create uncertainty in project completion and have negative national and international repercussions. Consequently, local and international construction companies are reluctant to work in remote areas.

The expansion of Pakistan's economy is hindered by terrorism (Zakaria et al., 2019). There is a negative correlation between terrorist attacks and foreign direct investment

(FDI), and the gross domestic product (GDP) growth rate has slowed as the number of terrorist occurrences has increased (Chishti et al., 2023). Inflation has been on the rise and the Pakistani rupee has been depreciating due to the fight on terror, making it harder to finish projects within budget. Another major factor that adds complexity to projects is land difficulties. Potential conflicts of interest between various land users are common. Land disputes are a common source of resistance to building projects in developing nations, and these conflicts have only grown in severity on a worldwide scale (Sabir et al., 2017). Property conflicts and the lack of available adequate land are common causes of project delays, cost overruns, and time overruns in Pakistan (Magsi et al., 2021; Torre et al., 2021). This problem is more critical in remote areas than in urban or settled ones. Residents may demand unnecessary benefits before handing over land to the executing agency. Addressing land dispute issues during development interventions requires good governance. Political stability is essential for a country's economic development and is crucial for a healthy macroeconomic and business environment (Farooq et al., 2023). The well-being of society and the economy relies on a stable political system, necessary for implementing consistent and coherent policies. According to Ashraf (2023) and Uddin et al. (2023), there is a strong correlation between political instability and inflation, which is a major problem in developing countries. This is a problem everywhere, including Pakistan.

In Pakistan, political instability has led to frequent changes in administrations and the rise of military rulers, which has further complicated public sector large construction projects (Noor et al., 2017; Khattak et al., 2019). This fragile political environment makes it difficult for projects to be completed as planned (Farooq et al., 2023).

Inflation, inconsistent policies, and shifting priorities are consequences of this instability, with long-term plans and regional development priorities changing whenever a new government takes office. Public sector development mega projects are adversely affected as a result. McComb et al. (2007) and Howick et al. (2020) noted that successful, highly complex projects reported high levels of project manager empowerment. This suggests that granting full authorization to project managers is crucial for success in complex projects. However, construction organization in Pakistan face issues of limited managerial autonomy (Maqsoom et al., 2018; Ayat et al., 2023). These organizations are not project-based, often having weak setups for project execution and rigid, pyramid-shaped structures where policies and decisions are made at the top. Responsibilities and tasks are assigned through a hierarchical chain of command, resulting in weak authorization for project managers. Mega project governance management is a vital factor in project success, but a lack of support for development intervention and the application of new project management skills and knowledge in Pakistan reveals weak authorization for project staff. This weak authorization, along with interference from MPG, project complexity and project management issue, further complicates public sector construction projects.

According to Fathalizadeh et al. (2021), developing countries have recently dedicated substantial capital budgets to construction projects. These projects are mainly financed by public funds and must be successfully delivered (Thneibat et al., 2021). The search to understand and apply project governance has been fueled by the failure of large capital projects. Regardless of industry or sector, setting up a governance process is an important and ideally the first stage in the development of a project (ul Musawir et al., 2020). Effective governance ensures the input and legitimacy of project decisions and outcomes from key stakeholders (Navalersuph et al., 2021; Olsson et al., 2023). The developing countries should focus on large construction to achieve/sustain economic growth and satisfy industrialized economic standards (Banihashemi et al., 2017). Structures and processes of governance define and create operating procedural subsystems and are designed to provide common guidance for distributed effort. The ability to navigate projects through a variety of uncertainties and unexpected events is a key feature of good governance (Unterhitzenberger et al., 2021).

Every construction project is unique, with its own set of social and environmental requirements, and with it comes its own set of challenges and uncertainties (Bosch-Rekveldt et al., 2011). In order to achieve its strategic goals, the organisation had difficulties in negotiating its internal management and governance structure (Dhanshyam et al., 2021). Building on previous research by Waseem et al. (2022) and Lin et al. (2023), this study assesses the importance of project governance in construction projects and the factors that contribute to their success or failure. Although there has been a rise in both academic and professional interest in the field of project management, projects continue to fail and get more complex (Shafiei et al., 2020). Due to the execution of projects in dynamic contexts with numerous risks, this tendency grows with time (Howick et al., 2020). Additionally, projects are managed by teams in a complex working environment (Wu et al., 2017), and these complexities have posed significant challenges in effectively managing these projects.

The concept of "agility" has recently gained prominence in this context, emphasizing its attributes of quickness, adaptability, intricacy, uncertainty, and transition (Zaman et al., 2024). Agility, in essence, transcends mere speed, entailing a sophisticated process of transition and change. To effectively navigate volatility, uncertainty, and complexity, project governance must embrace agile methodologies, enabling it to surpass competitors and swiftly adapt to environmental shifts. Agile project governance entails the capacity to employ flexible and diverse strategies that encompass both external and internal factors (Liu et al., 2024; Magistretti & Trabucchi, 2024). It employs broad perspectives to assess various situations and respond promptly. Demonstrating agility and resilience, agile project governance effectively leads in complex and unforeseen scenarios. Within the realm of agility, complexity, and uncertainty, institutional theory serves as a valuable tool for understanding evolving mega project governance dynamics and achieving mega construction project success (Nawaz & Guribie, 2024). Interest in applying institutional theory to project governance performance is on the rise, transitioning from natural to social sciences. This theory posits that project governance can comprehend, anticipate, and effectively mitigate significant challenges, ensuring project success through adaptive measures.

Moreover, institutional theory sheds light on how leaders with a linear thinking style perceive present situations and offers guidance on linear approaches to solutions in project governance. By integrating institutional theory into project governance practices, the likelihood of completing mega projects on schedule with controlled quality while considering environmental factors is increased.Therefore, agile practises are becoming more common in many organisational and industrial contexts, it is crucial to comprehend agile governance, and more especially, agile project governance (Lappi et al., 2018). Agile approaches prioritise informal cooperation over formalised planning and control techniques, and they rely on the iterative creation of project objectives and content to accommodate change and uncertainty. Despite agile development's origins in software engineering, the methodology is now gaining interest in a number of different industries and communities (Ragas et al., 2021). According to a worldwide survey conducted by Conforto et al. (2014), 35 percent of 856 respondents from the software industry reported using agile practises. Other industries that reported using agile practises included financial services (15 percent of the sample), consulting (10 percent of the sample), and even the traditionally iron manufacturing (3% of the sample, or 8% of the total) and defence industries (2% of the sample, or 7% of the total).

The current study aims to enhance understanding of the management of agile projects management techniques and as a mediator on the relationship between MPG and MCPS. It is also difficult to comprehend, predict, and manage a project due to its inherent complexity (Brandl et al., 2021). Stakeholder expectations drive today's mega construction projects, which in turn increase complexity to project management procedures due to the multitude of designs, engineering, and construction requirements (Ma et al., 2020). The interconnected subsystems, participation of different stakeholders, disciplines, and overlap phases characterize the complex project management environment (Gil, 2021). The complexity of projects significantly increases when a diverse array of projects, varying in size, share a common pool of resources and have different deadlines (De Toni et al., 2021). While some projects are still in the planning stages, others are nearing completion, and yet others are just waiting to be started. Managing multiple projects at once and being accountable for the resources provided, supervised, and coordinated by subcontractors is a huge challenge for large construction companies (Gao et al., 2018). They are supposed to assure great performance from all parties engaged, yet the complicated issues they encounter might interrupt their primary tasks. They need integrated strategies to handle cross-functional interdependencies and conflicting objectives, and they can't depend on conventional methods to handle complexity-driven uncertainty (Luo et al., 2017). Robust organisational control mechanisms may help with projects that are too complicated to manage. Since its early adoption in the construction industry, the Project Management Office (PMO) has served as an effective integrated monitoring tool for centrally supervising projects (Silvius, 2021). This shift in emphasis from conventional stand-alone methods to more systematic technologies has been ongoing in the field of project management (Ershadi et al., 2021a).

PMO has been suggested as having the ability to improve the effectiveness of the project management procedures and provide technical support to project teams (Bredillet et al., 2018). The complexity of construction contracting requires an integrated application of PMOs for resources to be managed and intense interactions coordinated. The recent studies argue that the sophistication of services that are delivered by PMOs increases with the level of project complexity (Aubry, 2015). Furthermore, research has shown that the level of organizational complexity in terms of the number of departments (Matinheikki et al., 2021), the capacity of transferring information (information complexity) (Luo et al., 2017), the dependence of relationship among tasks (task complexity) (Danner-Schröder et al., 2020), knowledge of new technology (technological complexity) (Brem et al., 2021), environment of changing policy and regulation (environmental complexity) (Mirmoezzi et al., 2021), and the uncertainty of goals (goal complexity) (Trinh et al., 2020), should be taken into account as features determining PMO characteristics in a construction company.

The directors of Swedish PMOs were surveyed by Widforss et al. (2015) on their strategies for tackling the difficulties that arise in complicated projects. Their research showed that PMOs were helpful to project teams before, during, and after awards, particularly during the negotiating phase and the implementation phase (when they monitored and reported). In their case study on supporting functions, Ershadi et al. (2021c) also stated that PMOs may aid in the discovery of optimal solutions to complex issues by enhancing partnerships across different functional areas. Regardless of this research, there is still a lack of comprehensive knowledge on how PMOs assist to tackle the complexity of megaprojects in the current literature. Further study into the process by which functional capabilities impact complexity factors is necessary to comprehend how PMOs handle complexity-related challenges.

1.2 Research Gap

In developing countries like Pakistan, institutional complexity significantly influences the structures (such as vertical levels) and processes within the governance system of mega construction projects, impacting their operational performance during execution. Usman (2018) underscores the importance of institutional analysis in comprehending these structures and processes within mega project governance systems, aiming to enhance planning and execution. Mega projects, characterized by uncertainty, ambiguity, and substantial risk, pose challenges in predicting outcomes and adapting to changing circumstances (Xiaolong et al., 2021). This research offers a comprehensive analysis of how mega construction projects within the public and private sectors under the China-Pakistan Economic Corridor (CPEC) are influenced by both mega project governance and agile project management. It contributes fresh insights to the current body of literature by addressing the lack of clarity and coherence in the methods employed to manage mega projects and apply agile project management, particularly within public sector mega construction projects.

Currently, decision-makers and legislators lack a cohesive framework to address performance issues in mega construction projects. Policymakers and business leaders can benefit from this research because it adds to the existing literature on public sector mega project governance by identifying and analysing the three sub- dimensions (i.e., Governance Structure, Governance Mechanism, and External Environment). These dimensions will aid in the development of policy frameworks and implementation mechanisms aimed at improving mega project performance. In the current study, agile project management mediates the relationship between mega project governance and the success of mega construction projects. Furthermore, the complexity of mega projects, based on six sub-dimensions (i.e., information complexity, task complexity, technological complexity, organizational complexity, environmental complexity, and goal complexity), acts as a moderator between MPG and MCPS, as well as between MPG and APM. Lastly, the project management office serves as a moderated moderator in the relationship between mega project governance and mega construction project success also MPG and APM.

Ershadi et al. (2023) indicated that there is still a lack of in-depth knowledge of how the PMO helps to overcome the complexity of project. There is a lack of study on how each functional skill (i.e., facilitated processes, improve collaboration, addressed uncertainties and integrated oversight) contributes to solving each part of the project management difficulties. PMOs have not yet been studied in depth for the mechanisms via which functional capabilities effect complexity factors. The current study concentrates on firm-level PMOs that are created as a distinct department for centralized monitoring of several projects. In light of the aforesaid research gap, this work seeks to address how PMO moderate project complexity to improve the relationship between project governance on agile project management and mega construction project success.

1.3 Problem Statement

Mega construction project success is often judged based on concrete criteria such as timely completion, cost efficiency, and technical proficiency (Ma et al., 2020; He et al., 2021). Similarly, project success is frequently measured on a time, budget, and quality basis. A key indicator of a successful project is efficient scheduling, even when delays may occur as a result of unforeseen events like floods or earthquakes (Wang et al., 2021). In terms of project budgets, 89% of projects went over their allotted budgets, indicating poor performance, while just 11% completed within their budgets (Chattapadhyay et al., 2021). Mega construction projects are successful in terms of quality when all their actors achieve their goals. In addition, numerous human relationships inside the project also affect the project's results. In this respect, megaproject governance aids in making a variety of managerial decisions that may impact on project success. *Therefore, the current study investigate the influence of mega project governance on mega construction project success through the mediating role of* *agile project management and moderator of project complexity also project management office as moderated moderator in the context of Pakistan.*

Employees are also given performance feedback through megaproject governance, which helps them to see how their work compares to the prescribed criteria. Lack of megaproject governance can make people unclear about their tasks and responsibilities and hinder their ability to deal with various workplace difficulties (Khan et al., 2021; Ullah et al., 2021). Mega construction project managers must deal with massive activities, tasks, and phases to complete a project's final deliverables, putting pressure on project managers to properly design an effective project plan that allows all involved parties to communicate effectively and collaborate toward common goals (Caldas et al., 2017; Balali et al., 2020; Kassem et al., 2020). According to Galvin et al. (2021), megaproject governance establishes a structure for management action and decision-making by fostering responsibility, openness, and clearly defined responsibilities.

Traditional project management has gradually revealed its shortcomings over the last few decades. In today's fast-paced, technologically-driven world, the Traditional approach that prioritises controlling scope, cost, and schedule is inefficient. Due to these recent developments, agile project management (APM) was established (Bergmann et al., 2018; Ciric et al., 2019). According to Mohammed et al. (2020), agile approaches and concepts can assist any project that face uncertainty, complexity, volatility, and risk. While APM was once used mainly in software development, it now can have a significant impact on other project management areas (Tomek et al., 2015; Buganová et al., 2019). Additional study in domains outside of software development is necessary, since the literature on APM is in its early phases. To realize its full potential, the notion of agility and the practices that go with it must be further developed so that it may be applied to projects in general (Sohi et al., 2016; López-González et al., 2021; Mata et al., 2023).

The governance of megaproject selection should encompass the integration of a project quality management system, project strategy, and business strategy (Zhai et al., 2017; Lu et al., 2020). Beyond their significant economic, societal, technological, and environmental implications, mega construction projects are characterized by their extended timelines, inherent uncertainties, complexity, and the involvement of numerous stakeholders. Zhai, Shan, and Le (2020) have asserted that the presence of government stakeholders can introduce heightened political uncertainties into these projects.

In the current research project complexity was a moderator on the relationship between megaproject governance and MCPS (Luo et al., 2017). *Also, the current study assumes that project complexity is a moderator that can significantly affect the relationship between agile project management and MCPS.* Because conflicts of interest, a fragmented implementation process, and unplanned complexity are common in construction projects. According to experts, the top 10 factors contributing to project complexity include weak project director authorization, political instability, political interference in projects, various land issues, increased tasks within projects, lack of organizational support for project activities, unclear project goals, large project scopes, inexperience with technology used in project execution, and unavailability of required resources and skills (de Rezende et al., 2022; Singh et al., 2022). The complexity of a project can be influenced by its level of ambiguity and uncertainty, which is tied to the clarity of the project's objectives and values (Ma et al., 2020; Qazi, 2020). As the number of worldwide megaprojects rises, complexity is becoming an increasingly significant factor in project management. Regardless of how well-planned and well-executed, every project has its own set of unique challenges and opportunities. Considering all unforeseen elements and enforcing strict limitations on opportunistic behavior from both parties are unfeasible.

Furthermore, the PMO practice is often claimed to be ‘best practice’ to improve the results of the organizational project (Silvius, 2021). Earlier research has identified several PMO activities (i.e., project planning, monitoring and reporting, risk management, resource management, stakeholder communication, and budget and cost management, respectively), but limited studies have looked at the influence of PMO involvement in these activities on mega construction project success (Ershadi et al., 2021a). The current study helps to understand the role and influence of PMOs in mega construction projects success by examining their practices and how this involvement control project complexity and the overall project success. Therefore, PMOs used as moderated moderator on the relationship between mega project governance and mega construction project success, such that the positive relationship is at highest when PMO is high and mega project complexity is low. Also, PMO used as moderated moderator on the relationship between mega project governance and agile project management, such that the positive relationship is at highest when project management office is high and mega project complexity is low. According to a earlier study by Szalay et al. (2017), 75% of PMOs in the MCPs were shut down within three years of their inception due to a lack of usefulness, while other research underlines the frequent changes in the shape of PMOs (Bredillet et al., 2018). Therefore, it is a need to understand PMO practices, including what makes them ‘best’ if they are, what enables them to contribute value, whom these benefits are appropriated to if they add value, and, most importantly, where does PMO best practices come from.

1.4 Scope of the Study

The current study aims to analyze how mega project governance (MPG) and agile project management (APM) influence mega construction project success (MCPS) in developing country Pakistan. About 25-35% of jobs are directly or indirectly linked to the construction sector. According to business monitor international (BMI) research, the construction sector has had a healthy growth indication, with annual growth rates of 11.8% from 2016-20 and 9.1% over 2016-25 (Malik et al., 2020). Hence, the Pakistani construction sector has become important for providing jobs and attracts international investors to support the transformation of Pakistan's economy, ranked among the emerging markets economies (Naveed et al., 2021). *Current study focused on several mega construction projects all over Pakistan those have been seriously affected Pakistan's economy (i.e., Railways, Metro Buses, Airports, Hydropower Projects, Motorways and others). The current study also emphasised on mega projects under the umbrella of the China-Pakistan Economic Corridor (CPEC).In which many mega projects are completed and many more are in process. Consequently, the current study offers valuable insights for these projects on how to effectively manage mega construction projects by employing a combination of megaproject governance, agile project management approaches, and best practices from PMOs.* This integrated approach aims to control project complexity and enhance the likelihood of successful project outcomes. The current study findings serve as a guide for future projects and those currently in the works.

1.5 Significance of the Study

Both researchers and construction experts have identified the significant challenges and particular importance of complex projects in the field of project management, as discussed by Howick et al. (2020) and Marshall et al. (2020). The research was conducted with the expectation that it would add to the existing body of literature on mega project governance, APM and mega construction project management, whereby experts and researcher are always trying to figure out what goes wrong with mega construction projects. Data shows that over 80% of mega constructions are unsuccessful. Thus, it was expected that the research would be useful for organizational decision-makers.

In recent years, megaprojects have usually been classified as capital investment projects of at least US$1 billion (Hoseini et al., 2020; Yang et al., 2020). Besides the price tag, initiatives with high sensitivity and significant societal results have grown increasingly complex, risky, and connected with various stakeholders (Kamal et al., 2019; Zhao, 2019; Akimova, 2020). A fundamental requirement for effective megaproject governance is the careful examination of how stakeholders should allocate resources and manage risks when formulating control strategies to achieve objectives as stipulated by legal and regulatory frameworks, with the goal of optimizing the utilization of state funds. Over recent decades, Pakistan has undergone a rapid transformation, resulting in a burgeoning market for mega construction projects. Within Pakistan, construction development initiatives have faced criticism due to issues such as subpar construction quality and cost overruns, as highlighted by Khattak et al. (2019), Ud Din et al. (2020), and Nawaz et al. (2021). Failure to address uncertainties can lead to project delays or interruptions. Despite the challenges faced, the construction sector in Pakistan, while experiencing difficulties, remains a pivotal sector crucial to the country's economic progress, as emphasized by Xiaolong et al. (2021).

There has been growing concern regarding the concept of project complexity, and it has been discovered that traditional instruments and tactics established for megaprojects are inadequate for complicated projects (Owolabi et al., 2020; Wu et al., 2020). The construction firm recently noticed the rapid growth in large-scale and complex projects (Lehtinen et al., 2019). As an example, rapid development expanded the size of worldwide mega construction projects and cost more than US$ 700 million in every megaproject (Lu et al., 2020). In general, these projects are quite complex (Trinh et al., 2020). According to Ud Din et al. (2020) because of innovation, new technologies, advanced equipment, and tools, the complexity of the construction project has grown. Pollack et al. (2018) illustrated that the time delay and cost overrun are the standards in mega-construction projects. It is scarce for construction projects to be completed without delay in Pakistan. The most severe consequence is that construction delays give an erroneous image to international or foreign investors, resulting in a downward trend in the country's progress (Howick et al., 2020). It has been discovered that delays are caused by ineffective management of several components such as equipment, labor, material, consultants, clients, and contractors (Amri et al., 2020). Therefore, construction consultants and academics have been involved to achieve these goals (Luo et al., 2020).

The Asian Development Outlook (ADO, 2021) reported that Pakistan has paid nearly US$ 100 million to the Asian Development Bank (ADB) as a penalty for not fulfilling a specified number of public projects over a 15-year timeframe. The role of the project manager is pivotal in this context. Pakistan has seen a significant decrease in its foreign currency reserves, losing almost US$ 100 million since 2006, largely due to inadequate project governance in the completion of donor-funded programs (Zada et al., 2023). Consequently, effective public project governance plays a critical role in clearly defining project objectives and enhancing project efficiency (Joslin et al., 2016). *Therefore, the current study is significant because it fills a vacuum in the literature on the subject and address Pakistan's construction industry challenges. This research also provides insight into the matter to various construction businesses in Pakistan, allowing them to develop appropriate strategies to deal with project failures. Moreover, current research results are expected to provide the project managers with a crucial insight into literature techniques to resolve project governance and complexity, and also cope with the unfavorable implications of project success. Furthermore, APM has also been explored primarily on software and product development, leaving a gap in the literature regarding it's on other project areas. There is also a lack of awareness of the influence of APM practice on the result of a project success. This research contributes significantly to the information on APM and project success in light of the project governance and complexity.* It does this by addressing several gaps in current literature and assessing the extent to which APM methods are used and their influence on mega construction project success.

Mega construction projects such as the London Cross Rail Project in London, Dubai Airport Al Maktoum, and various China Airport projects can face failure when insufficient project management approaches and methodologies are employed to facilitate their execution, as highlighted by Ochieng et al. (2017). There is evidence of failures worldwide, with 9 out of 10 projects experiencing cost and time overruns (Ismail et al., 2021). Moreover, the failure of mega construction projects is a more prevalent issue in developing countries. These megaprojects demand advanced technical and design expertise, a skilled workforce, and substantial investments (Qureshi et al., 2015). Despite the fact that developing countries rely on MCPS to achieve their economic, social, and environmental objectives, they often grapple with a shortage of the necessary skills and expertise, financial constraints, and inadequate project implementation practices. For this reason, a more comprehensive understanding of crucial aspects contributing to project success is vital to assure the success of the mega construction projects, which is essential for the development of the developing countries. Therefore, current research investigates the impact of megaproject governance on mega construction project in Pakistan through mediating role of agile project management and moderating role of project complexity and moderated moderator project management office. A PMO is an organizational unit established to standardize project management and enhance efficiency by deriving best practices from the execution of a project portfolio.

The PMO approach to project management has been adopted across various sectors, including construction information systems, the public sector, and research administration. This is a response to the increasing trend of organizations delivering activities through projects. Projects, as temporary entities, can be seen as a production capability, a resource allocation unit for change initiatives, and a means to manage uncertainty. The project management office serves as a mechanism for organizations to increase the likelihood of project success (Sergeeva & Ali, 2020). Additionally, the PMO can develop best practices in project management through the successive delivery of multiple projects (Tshuma et al., 2018). This knowledge can be enriched by various tools, techniques, and standard operating procedures that a PMO develops to support the organization's project management community. In this context, having the requisite systems and processes for effective performance measurement, especially when a PMO manages a portfolio of projects, is crucial. This article details an investigation into the use of the Balanced Scorecard as a tool for performance measurement in support of a PMO focused on delivering a portfolio of collaborative research projects.

1.6 Research Questions

Based on the background of the study, the main research question is as follows:

- *How does megaproject governance influence mega construction project success through mediating role of agile project management and moderating role of project complexity and moderated moderator project management office in developing country Pakistan?*

The specific research questions of the current study are as follow:

RQ1: Does megaproject governance predict mega construction project success?

RQ2: Does megaproject governance predict agile project management?

RQ3: Doea agile project management predict mega construction project success?

RQ4: Does agile project management mediate the relationship between megaproject governance and mega construction project success?

RQ5: Does mega project complexity moderate the relationship between megaproject governance and mega construction project success?

RQ6: Does mega project complexity moderate the relationship between mega project governance and agile project management?

RQ7: How Project management office and mega project complexity jointly moderate the positive relationship between mega project governance and mega construction project success, such that the positive relationship is at highest when project management office is high and mega project complexity is low?

RQ8: How Project management office and mega project complexity jointly moderate the positive relationship between mega project governance and agile project management, such that the positive relationship is at highest when project management office is high and mega project complexity is low?

1.7 Research Objectives

Research objectives comprise the reasons to study particular relationships. Based on the typology of research objectives, the current study derived the following objectives of our research.

RO1: To examine the influence of megaproject governance on mega construction project success.

RO2: To examine the influence of megaproject governance on influences agile project management.

RO3: To examine the influence of agile project management on mega construction project success.

RO4: To investigate if agile project management mediate the relationship between megaproject governance and mega construction project success.

RO5: To investigate if mega project complexity moderate the relationship between mega project governance and mega construction project success.

RO6: To investigate if mega project complexity moderate the relationship between mega project governance and agile project management.

RO7: To investigate the joint moderating role of project management office and mega project complexity on the relationship between mega project governance and mega construction project success, such that the positive relationship is at highest when project management office is high and mega project complexity is low.

RO8: To investigate the joint moderating role of project management office and mega project complexity on the relationship between mega project governance and agile project management, such that the positive relationship is at highest when project management office is high and mega project complexity is low.

1.8 Research Hypotheses

The study is based on eight hypotheses:

H1: Mega project governance is positively influence mega construction project success.

H2: Mega project governance is positively influence agile project management.

H3: Agile project management is positively influence mega construction project success.

H4: Agile project management positively mediates the relationship between mega project governance and mega construction project success.

H5: Mega project complexity negatively moderates the relationship between mega project governance and mega construction project success.

H6: Mega project complexity negatively moderates the relationship between mega project governance and agile project management.

H7: Project management office and mega project complexity jointly moderate the positive relationship between mega project governance and mega construction project success, such that the positive relationship is at highest when project management office is high and mega project complexity is low.

H8: Project management office and mega project complexity jointly moderate the positive relationship between mega project governance and agile project management, such that the positive relationship is at highest when project management office is high and mega project complexity is low.

1.9 Summary

This chapter provided a brief history of the field of research, the problem statement, and scope of the study, significance, research questions and objectives. This chapter highlighted mega project governance in the context of Pakistan, an overview of mega project complexity, agile project management, and project management office role on mega construction project success. Based on Figure 1.1, the current study is divided into five chapters. The upcoming chapter provides a review of the relevant literature in the research field of the current study.

Chapter 1: Introduction

In this chapter, the research background, problem statement, scope of the study, research significance, as well as research questions and objectives, will be outlined.

Chapter 2: Literature Review

This chapter encompasses various facets of the subject, outlining diverse models and frameworks pertinent to the topic. It culminates in the formulation of hypotheses following an in-depth discussion.

Chapter 3: Research Methodology

In this chapter, selected methodological research decisions are detailed, supported by reasoning for these choices. Subsequently, an elucidation of the various tools employed for the present study is provided.

Chapter 4: Research Findings

In this chapter, the empirical data obtained through questionnaires from respondents is presented. Furthermore, the discussion of hypothesis results is conducted with the aid of inferential statistics.

Chapter 5: Discussion

This chapter discusses the findings of the research through illustrating the recommending models and framing based on findings.

Chapter 6: Conclusion

This chapter encapsulates concluding remarks centered on revisiting the purpose and problem statement. Additionally, it delves into discussions regarding contributions, limitations, and avenues for future research.

Figure 1. 1 Research Thesis Sections

Chapter 2: Literature Review

2.1 Introduction

The current study evaluates the impact of selected variables such as mega project governance on mega construction project success. This chapter provides a review of the literature on the key topics pertinent to this investigation. This chapter is split into three sections. The initial section of this chapter defines all variables and supporting theories. The second section explains the issue of constructions sector, which begins with an overview of the constructions industry in Pakistan, definition, and relevance of constructions sector. It also emphasizes the significance of Pakistan's constructions sector and reviews several significant researches on it. Finally, this section highlights the concepts and literature study on mega project governance, project complexity, agile project management, and the role of the project management office in the success of mega construction projects.

2.2 Definitions of the Studying Variables

2.2.1 Projects

By definition, a project is a one-of-a-kind, temporary undertaking with a distinct set of goals and objectives that must be accomplished within the specified time, cost, and scope, entails the deployment of several stakeholders and organizations, and lasts only as long as the project does (Fiori et al., 2005). Pollack et al. (2018) defines a project as a specific expenditure of resources to accomplish a certain set of goals, such as developing a product or service to benefit the community or to generate revenue.

Product, service, or outcome development; organisational change (in terms of structure, procedures, personnel, or style); research effort (in terms of both hardware and software) with a properly documented outcome; building, industrial plant, or infrastructure construction; and system implementation, improvement, or enhancement are all examples of projects listed by the Project Management Institute (PMI, 2017).

2.2.2 Megaprojects

The development of megaprojects is much riskier since they are a distinct kind of project with high costs, stakeholder participation, complicated boundaries, and a llong-term planning process (Lehtinen et al., 2019). “If managers of conventional projects need the equivalent of a driver's licence to do what they do, then managers of megaprojects need the equivalent of a pilot's jumbo jet licence,” says Dr. Patrick O'Connell of Oxford University's Said Business School, who is also the director of Major Program Management (Flyvbjerg, 2014). Wang et al. (2021) state megaprojects cost usually 1 billion US$ or more. But the cost of defining megaprojects should not be limited. Invernizzi et al. (2018) argue that smaller project budgets, like 100 million US$, may take a relatively context-based approach. Zhao (2019) defines mega projects based on five factors (huge costs, high complexity, high risk, high standards and high visibility).

Table 2.1 presented different definitions related to mega-projects by recent research. Most of the definitions in Table 2.1 imply that a minimum megaproject cost of one billion US$ is a widely accepte value. While many researchers agree to utilize this figure, some claim that the threshold value may change in the country where the project is carried out depending on specific circumstances, such as the economic condition. Hu et al. (2015) advise taking into account the ratio between the country's project costs and GDP, i.e., United States: 0.01% of gross domestic product (GDP), European Union Countries: 0.02% of GDP, China: 0.01% of GDP, Hong Kong: 0.01% of GDP, South Korea: 0.05% of GDP.

Table 2. 1 Different megaproject definitions in the literature

Definitions	Source
“Megaprojects are large-scale, intricate businesses often costing US$1 billion or more, taking several years to conceive and build, involving a wide range of public and private actors, transforming and impacting millions.”	Flyvbjerg (2014, p.2)
“Mega-projects have been classified as mega-infrastructure projects for multibillion dollars, generally commissioned by governments and carried out by the private sector; and they are regarded as uncertain, difficult, politically sensitive and involving many partners.”	Van Marrewijk et al. (2008, p. 3)
“Projects that fast, deliberately and deeply modify landscapes and demand coordinated applications of capital and the state.”	Gellert et al. (2003, p. 16)
“A construction project, or a collection of such projects, characterized by: increased cost, extreme complexity, increased risk, lofty ideals, and high visibility, in a combination that poses a significant challenge to stakeholders, has a significant impact on the community, and tests the boundaries of construction experience.”	Fiori et al. (2005, p.3)
“Major infrastructure projects that cost more than 1 billion USD, or projects of a significant cost that attract a high level of public attention or political interest because of substantial direct and indirect impacts on the community, environment, and state budgets.”	Cap Mišić and Radujković (2015, p.72)
"MCPs involve a large number of participants with significant social and economic repercussions, considerable works of the company and wide-ranging geographical coverage as well as a close relationship to other major developments." (According to the Development Bureau in Hong Kong)	Mok et al. (2015, p.446)

Megaprojects are intricately linked to globalization, regionalization, and urbanization processes (Hu et al., 2015; Boonstra & Reezigt, 2023). Factors such as institutional impact, public policy, strategic research, and decision analysis have become increasingly significant in the examination of megaprojects (Flyvbjerg, 2014; Söderlund et al., 2017). From this perspective, prior research has determined that poor decision-making and cost overruns in megaprojects may be attributed to a variety of complex socio-economic and political factors (Locatelli et al., 2017; Wang et al., 2020). According to Shenhar and Holzmann (2017) due to large economic value, significant social and environmental impact, and fundamental promotion of product, process, and service growth, megaprojects are essential.

2.2.3 Project Management

Project management is the process of applying knowledge, skills, tools, and techniques to project activities in order to achieve project requirements. A project is defined as "a temporary activity undertaken to generate a unique product, service, or outcome" (PMI, 2013). For decades Ma et al. (2020), the generally used criteria to measure project success have been budget, schedule, and output quality, which have been further qualified into the process and project performance. The performance of the process is projected efficiently and measures according to budget and timetable. Project performance pertains to the project's results, specifically its scope and quality in terms of the benefits realized by stakeholders (PMI, 2017). Lin Moe and Pathranarakul (2006, p.399) define a project as a ‘temporary endeavor undertaken, to generate a unique product or service. Unique means that the product or service is somewhat different from all similar products or services.

In the words of practitioners, project management is the use of project-related knowledge, skills, tools, and processes (PMI, 2017). Execution, monitoring and control of project management procedures are accomplished via their appropriate implementation and integration. These processes are divided into four groups (PMI, 2017): Identification of requirements; Addressing the various stakeholder needs, concerns, and expectations in planning and executing project activities; Establishing active communications between stakeholders, maintaining active communications among stakeholders, and conducting collaborative communications; Managing stakeholder towards meeting project requirements and creating project deliverables. Constraints, including but not limited to scope, quality, schedule, budget, resources, and risks, are carefully balanced throughout the project. The specific constraints that the project management team has to concentrate on may be influenced by the defined project features and conditions. The project manager is a crucially important individual in the project management process (Irfan et al., 2021). In order to assure project success and fulfill project goals within time, money, and scope limits, the project manager needs a specialized set of project management abilities, including planning, organizing, managing, and controlling and monitoring resources (Lester, 2006). According Too et al. (2014), Project management integrates project teams' strengths and competences to help them accomplish the project's goals.

2.2.4 Project Governance

Governance comes from the Greek word kubernao, which meaning “to guide” (Bevir et al., 2003). It involves directing or overseeing the policies, management, and functions of an organization at its most authoritative level (Harrison et al., 2000). Numerous scholars have explored governance from different perspectives, emphasizing the socio-economic links between operations in various public and private entities. As per Goldsmith et al. (2005), governance emerges through autonomous decision-making within interconnected networks aimed at delivering public services. Aspects of governance were also addressed inside organizational units such as projects. Similarly, Navalersuph et al. (2021) assert that projects implement and drive business strategy, making project governance a critical challenge for organizations.

The term ‘governance management’ refers to the process of establishing and enforcing policies, regulations, relationships, stakeholder involvement, organizational structure continuity, and provisions for supporting external stakeholders in the design of a project (Klein et al., 2019). Organizational accountability, the capacity to support the enhancement of project performance, good financial management, and the ability to regulate and coordinate project activities are thus fundamental to effective governance (Derakhshan et al., 2019; Li et al., 2019). Thus, it is essential to priorities projects in accordance with available resources, in order to meet the public's service and resilience expectations and to include a wide range of stakeholders in identifying, negotiating, and implementing necessary adjustments. The selection and execution of projects depend on the governance management's decision-making structure, benefits management, and transparency (Luo et al., 2023). Advancements in project performance and organizational value can be achieved through four key governance factors (Lindhard & Larsen, 2016): (i) choosing the right projects, (ii) keeping stakeholders and the project manager in the loop, (iii) regularly monitoring and reporting on projects, and (iv) an efficient governance system also risk and quality can only be managed reasonably with good project governance.

According to Ul Musawir et al. (2017), governance was identified as aggregate approaches and processes that define organizational goals and provide the mechanism for monitoring progress in achieving these goals. Though, Unterhitzenberger et al. (2021) described governance as a holistic process, aimed at achieving stakeholders' interests. Dhanshyam et al. (2021) suggested that success should be achieved by the overall function of governance. In the context of projects, governance is a structure that defines the project goals and defines ways to achieve those goals and to monitor performance (Müller, 2017). The word governance is related to words such as government, authority, and control (ul Musawir et al., 2020). Within an organizational context, governance establishes a structure for ethical decision-making and managerial conduct, rooted in principles of transparency, accountability, and well-defined duties (Unterhitzenberger et al., 2021). Furthermore, project governance emphasizes the connection between the management, sponsor, owner, and stakeholders of a project.

Following a thorough literature review, a conceptual framework for megaproject governance was developed. Table 2.2 presents the results of a three-dimensional analysis of fifteen factors related to governance, including organisational structure, stakeholder role, supply chain management, project financing, and target management systems; governance mechanisms, including communication, coordination, conflict resolution, incentives, supervision, and decision-making mechanisms; and external governance environment, including organisation culture, market environment, and social supervision (Filatotchev et al., 2010; Li et al., 2019).

Table 2. 2 Dimensions of Project Governance

Dimensions	Description
Governance Structure	
Organizational Structure	The structure of an organization may be considered as the method in which authority and responsibility are distributed within the company, and the method in which work operations are carried out by employees (Pugh et al., 1968). An organization's internal system of connections, authority, and communication is defined as its organizational structure by Child (1972). Organizational structure is defined as "the network of connections and functions that exist across the organization" by Goldhaber (1984). It is becoming more difficult to manage a big and complicated infrastructure project without the involvement of numerous stakeholders and various levels. Instead of a basic collection of smaller projects, megaprojects are integrated for better coordination and administration from an organizational perspective. Organizational or institutional framework adaptation is required for project governance or megaproject governance in order to enable successful management and execution (Van Marrewijk et al., 2008).
Stakeholder Role	In 1963, the Stanford Research Institute introduced the term ‘stakeholder’ to the management field, describing stakeholders as those groups or persons that are critical to the sustainability of a business. Freeman (1999) defined stakeholders as the ones “who can affect or is affected by the achievement of the firm's objectives”. There are four basic phases that Cleland (1997) describes in his innovative research: identifying stakeholders, classifying them, performing analysis, and developing a plan. Stakeholder management in the construction industry has received a lot of attention in recent years, with a particular focus on stakeholder role in MCP due to the difficulties involved in managing stakeholders of complex project environments (Mok et al., 2015). The most common cause of project failure is a failure on the part of project stakeholders to respond adequately to their responsibilities. At the beginning of a megaproject's lifecycle, stakeholders play an essential role in its design and implementation. Analysing the megaproject governance structure requires a thorough understanding of the roles and responsibilities of stakeholders at various points in the project life cycle.
Supply Chain	Throughout a construction project's lifespan, supply chain management helps bring together and organise all parties involved,

Management	especially those at the beginning and end of the supply chain (Lee, 2011). Complexity, which is one of the key features of a construction project, may be explained by the wide range of materials and parties (suppliers and subcontractors) involved (Chen et al., 2020). In addition, the complexity of the supply chain increases as the scope of the project increases since more people, parties, and materials are required to complete the project, which may lead to a rise in transaction costs or a decline in project management effectiveness. Planning, organizing, and working together with other members of company supply chain will be necessary, which might add to its complexity. Due to supply chain management's role in megaproject governance, a well-ordered supply chain is vital to minimize miscommunication between stakeholders and assure the quality and timely delivery of mega construction projects (Li et al., 2019).
Project Financing Structure	States and governments in many countries have historically been responsible for financing and providing MCPs, particularly following World War II. Financial money, domestic loans, foreign investment, self-financing methods, land-leasing revenue and other forms of funding are employed alternately to alleviate the financial constraints in MCPs (Othman et al., 2013). Mega construction projects have a different financial structure than smaller ones because of the bigger investment amounts, longer investment cycles, and greater public benefit. As a result, a new kind of project financing involving the private and public sectors has evolved to expedite the completion of mega projects. Effective governance and rational funding are interconnected and interdependent (Zaman, 2020).
Target Management System	The purpose of target management systems is to define hierarchical organizational objectives for team members to regularly and collectively put forth their best efforts (Pezzulo et al., 2018). Core or essential goals are crucial to a well-developed system that is carried out from several project aspects. In addition, it ensures that the project's development and construction are in accordance with the terms of the contracts and applicable legislation. There are more parties and a greater degree of technical expertise required for megaprojects, which are also vulnerable to more disruptions since they are open, dynamic, and complex systems. A comprehensive, methodical, and engaging target management system is essential for achieving the overall goal and subgoals of various stages (Martyakova et al., 2018). Through it, the project management team may take complete control and analyse project progress, ultimately leading to a successful project deliverable.
Governance Mechanism	
Communication	Communication is like a pipeline through which information travels from one person to another. As proposed by Lizarralde et al. (2013), communication can be defined as the sharing and exchanging of ideas, facts, feelings, and opinions. Communication

Mechanism	is a recursive process in which people exchange information over time. There are many different types of organizational communication, but they all have one thing in common: they are all aimed at achieving organizational goals. The destructive uncertainty of project risks can be reduced by establishing a good communication mechanism, which in turn can improve project performance (Li et al., 2019). Project management problems are often caused by poor communication or misinterpretation. The term "megaproject" refers to a coordinated effort involving several entities with varying areas of skill and areas of interest. Developing efficient communication methods and increasing intensity and productivity are necessary for project coordination across organisational activities (Qiu et al., 2019).
Coordination Mechanism	Coordination mechanisms allow all parties to work together in a coordinated manner (Okhuysen et al., 2009). Without adequate and efficient coordination, a project system cannot work with growing complexity, nor can resources be optimally used at the organizational level, resulting in project delivery failures. Coordination is the core of management. Coordination mechanisms at the institutional level have previously been shown to aid in the successful management of mega-projects (Narayanan et al., 2021). Distributed coordination mechanisms were investigated as examples by Johanson et al. (2002) in order to highlight the relevance of such mechanisms in a complex project management framework. Others argued that megaproject governance and the underlying coordination mechanism should become more complex and stress inter-project connections and self-regulations.
Conflict Resolution Mechanism	Conflicts are unavoidable in project environments and at any level of project organization due of individual or organizational differences in aims, expectations, or interests (Um et al., 2021). With more organizations and participants participating in megaprojects, disputes are certain to be more severe and intense (Susman et al., 2021). Project timelines and performance may suffer if they are not handled in a timely and appropriate way. In other words, the capacity to resolve issues immediately might have a significant impact on project management and development. Organizational challenges may be brought to the attention of team members through conflict, which can lead to creative problem-solving and team-building exercises (Hekkala et al., 2021). The effective completion of a megaproject requires complex procedures for resolving conflicts.
Incentive Mechanism	Cooperative project networks include an incentive mechanism, which refers to a person or organization's or a group's encouragement from the customer. A comparative study has shown that the appropriateness of project incentive systems has a significant influence on overall project performance (Biesenthal et al., 2018). A study by Mohd-Sanusi et al. (2007) looked at three real contracts and concluded that the requirements of the client and contractor need to be aligned in order to effectively allocate risk. A financial incentive, on the other hand, may have a limited influence if participants' relationships are weakened.

	Effective incentives and penalties are essential for megaproject governance in order to unite and define the roles of the many stakeholders (Sanderson, 2012).
Supervision Mechanism	Creativity and supervision are two opposing yet interconnected processes that must be integrated into one (Too et al., 2014). In the context of project governance, supervision mechanisms are seen as a framework allowing the senior management team to successfully inspect, audit, or oversee project participants (Miller et al., 2005). Stakeholders' opportunistic conduct might be readily facilitated if the internal supervision mechanism for project organization is not clearly defined (Stafford et al., 2017). Lack of quality control or even inability to identify fraud and corruption might be the result of weak or nonexistent supervision mechanisms. Thus, the project's success might be compromised as a result. Stakeholders can be adequately regulated and managed by a clear and systematic monitoring and supervision mechanism.
Decision-Making Mechanism	It is the process of assessing and discovering possible options that is referred to as decision making. Each member in the project has the ability to make choices. It is the goal of project governance to ensure that the interests of all stakeholders are protected by making sound decisions (Shi et al., 2020). As a result, if a project is to go smoothly, it requires the construction of a scientific decision-making framework. Megaproject governance places a high value on decision-making systems since individual decision-makers have limited authority (Zhu et al., 2018). This can be considered a potential advantage stemming from the decision-making capabilities of team members, aimed at enhancing the overall team performance. As authority is distributed and balanced, a decision-making system also emerges, providing decision-makers with a degree of control over the project management accountability framework.
Organizational Culture	When it comes to a company's fundamental competitiveness, an organization's culture represents its distinct values, beliefs, and code of conduct, as well as its unique identity (Zheng et al., 2010). Schein (1983) used empirical research to support the beneficial influence of organizational culture on organizational performance and discovered that high participation rates in organizational culture had a higher impact on organizational performance. As a large-scale environmental project progresses, the project manager may need to change the culture (Zeb et al., 2021). To the contrary, institutional processes and specialized governance mechanisms must help support organizational culture and not serve as a substitute (Egan et al., 2004). To put it another way, it is impossible to adopt a governance system in a project organization without taking into account the influence of organizational culture.
External Environment	

Market Environment	There are a number of external elements that have an impact on the creation and execution of a project, collectively known as the market environment (Jamali et al., 2008). The process of project transactions and the external market environment are frequently intertwined when handling mega construction projects, as noted by Love et al. (2021). Beyond the capital, engineering consultancy, contracting, and labor markets, the project life cycle encompasses various other market systems. An organization's governance environment is profoundly influenced by the current state of the market. Another essential consideration is the influence of social and cultural contexts on project governance in addition to external market environments on the construction side (Biesenthal et al., 2014). Building of mega infrastructure is strongly tied to and regulated by the occurrences in the surrounding area in terms of social, economic, and cultural development (Chattapadhyay et al., 2021).
Government Regulation	Most megaprojects are government-invested non-profits, a feature that sets them apart from traditional construction projects. These megaprojects have greater management standards and have achieved high public attention (Zhai et al., 2017). As a way of reducing or eliminating market failures and protecting public interests, government regulation is essential (Shaffer, 1995). Disciplinary measures and legal consequences may be used to deter companies from engaging in unlawful or unethical behavior, and this can be done in order to prevent additional losses. There are several layers of government control, like a multi-layered firewall. A key function in the governance of megaprojects, it may effectively prevent external environmental influences and secure the project's daily operation and economic and social advantages (Storey et al., 2003; Pohlner, 2016).
Social Supervision	The term ‘social supervision’ refers to the use of the public, social organizations, and public opinion to exert control over the government and its officials. Direct beneficiaries and regulators are both members of the public (Li et al., 2019). For megaprojects, social supervision is critical as the market continues to expand (Liu et al., 2020). Government-funded infrastructure may retain its public character if it is subjected to democratic oversight and extensive public engagement, both of which help guarantee that project decision-making processes adequately reflect the views of a wide range of stakeholders. The construction of procedures for public information, hearings, complaints, and the news media may be used to integrate social supervision into the public sphere and assure the public's involvement in the process (Xie et al., 2019).

2.2.5 Construction Project Success

The project's success is a hotly debated topic in project management (Imam, 2021). During the 1960s to the 1980s, the success criteria for projects were dominated by the iron triangle (i.e., money, time, and quality) (Ika, 2009). However, the scholars and experts acknowledged that project success was a high-level concept through their accumulation of theoretical research and practical experience (Majeed et al., 2021). Successful project management and a successful product are essential components of any project (Baccarini, 1999). In order to be successful, project management must be able to demonstrate that the project building process has met its goals (Dainty et al., 2003). Unfortunately, the project manager will frequently consider it a success if the cost, time, and quality all meet the established requirements (Irfan et al., 2021). Despite this, customers consider the project a failure since it falls short of their expectations.

Product success is therefore considered another significant aspect of the success of the project. In short, the success of project management means ‘doing things well,’ whereas ‘doing the right things’ is product success (Griffin et al., 1996). Mega construction projects vary in terms of their level of ambition, stakeholder involvement, project duration, and project complexity compared to regular projects (Chattapadhyay et al., 2021). A study conducted by AlAmeri et al. (2020) found that mega construction projects should be evaluated for their long-term impacts and outcomes rather than short-term costs and benefits. Many scholars have concentrated on the success of the project because of the challenge of defining project success. Project success is generally defined by the scope, timeliness, budget, and overall quality of the project's deliverables (He et al., 2019).

Banihashemi et al. (2017) identified key actors in a project, including the project manager, client, contractor, consultant, subcontractor, supplier, and manufacturers. However, as noted by Mok et al. (2015), a single set of project success criteria may not apply universally to all stakeholders in the construction sector. Therefore, the emphasis should be on the primary participants in the project. The client is often represented by one or more consultants. Ershadi et al. (2021a) classified clients into two groups, public and private company. The next critical player is the contracting firm (contractor), which holds the sole responsibility for ensuring the project's timely completion and flawless execution (Jarkas, 2017). The project's staff members play a vital role in achieving both short-term and long-term objectives. Silva et al. (2016, p.701) defined as “A mission undertaken to create a construction facility or a service with predetermined performance objectives with the involvement of different project participants with different expectations, examples for construction projects include: construction of road and highways, bridges, high-rise buildings, port, airports, damand irrigation systems etc”.

2.2.6 Agile Project Management

Agile project management is a method to handle projects to reach customer value by adapting to change planning, rapid feedback, continuously improving, collaborating, and engaging project stakeholders (Sohi et al., 2016). Agile development structures are becoming popular in the industry and thus companies and professionals face the challenge of understanding this new paradigm and embracing it. They are excited to know what it is, how it works (Albuquerque et al., 2020). Companies or professionals interested in agile frameworks are confronted by the transitional challenge. There are challenges to traditional roles and to revamp processes so as to reflect new development frameworks (Conforto et al., 2014). Agile frameworks follow an iterative and incremental development style that adapts dynamically to changing demands and improves risk management (Buganová et al., 2019). The following are the four fundamental agile principles as defined in the agile policy.

- Individual and interactions with processes and instruments
- Working software over comprehensive documentation
- Customer cooperation through contract negotiations
- To respond to changes in a plan

Some recent studies have shown an interest in moving agile outside of software development (Niederman et al., 2018); nevertheless, it remains unclear whether or not this results in more successful projects when comparing software and non-software domains (Lappi et al., 2018). According to Nowotarski et al. (2015) and Tomek et al. (2015) the effects of agile methodologies on project success outside the software domain, where traditional approaches were more prevalent, have been anecdotal, reliant on small sample sizes, or constrained by industry or location. Early agile adopters argue that it can positively influence project success (Vijayasarathy & Turk, 2008). In contrast, proponents of traditional methods view agile as more disorganized and lacking the structured procedures characteristic of conventional approaches (Vinekar et al., 2006), which can impact project success. This raises questions about the value and efficacy of various project management methodologies under different circumstances. Several authors have recommended empirical comparisons between traditional and agile project management approaches (Buganová et al., 2019; Ciric et al., 2019).

2.2.7 Project Complexity

The word ‘complexity’ is intentionally imprecise since it's impossible to quantify accurately (De Toni et al., 2021). In the field of complexity research, there are several interacting components that are classified as complexity (Trinh et al., 2020). As a consequence, one of the most important project characteristics is its complexity, which arises from the interplay of many components and structural, dynamic, and unpredictable aspects (Vidal et al., 2011). Numerous researchers have conducted multiple studies to identify the elements for measuring and categorizing projects because of their complexity (see Table 2.3) (Vidal et al., 2011; Qureshi et al., 2015; Gao et al., 2018; Luo et al., 2020; Ma et al., 2020; Trinh et al., 2020). The project complexity is closely connected with interactions between organizational elements and subtasks. During the present research, project complexity is defined as the difficulty of understanding, foreseeing, and controlling the overall behavior of a project, even when relatively comprehensive knowledge about the project system is accessible.

Table 2. 3 Prior studies about evaluating project complexity in construction projects, performance measurement

Researcher	Studies
(Geraldi et al., 2011)	“Now, let's make it really complex (complicated)”
(Vidal et al., 2011)	“Measuring project complexity using the Analytic Hierarchy Process” and “Used analytic hierarchy process

	(AHP) and formulated a project complexity measure model to assist in the decision making of project managers”
(Bosch-Rekveldt et al., 2011)	“Grasping project complexity in large engineering projects: The TOE (Technical, Organizational and Environmental) framework”
(Hu et al., 2016)	“Megaprojects Performance Measurement Criteria”
(Luo et al., 2017)	“Construction project complexity: research trends and implications”
(Wu et al., 2018)	“Success Factors”
(Kamal et al., 2019)	“Risk factors influencing the building projects in Pakistan: from perspective of contractors, clients and consultants”
(Khattak et al., 2019)	“Management competencies, complexities and performance in engineering infrastructure projects of Pakistan”
(Farid et al., 2020)	“Critical Risk Factors of Construction Industry of Pakistan for Improving Project Outcome”
(Nguyen et al., 2020)	“Interactive Effects of Agile Response-to-Change and Project Complexity on Project Performance”
(Zhai, Shan, & Le, 2020)	“Investigating the impact of governmental governance on megaproject performance: evidence from China”
(Trinh et al., 2020)	“Impact of Project Complexity on Construction Safety Performance: Moderating Role of Resilient Safety Culture”
(Hoseini et al., 2020)	“Cost Contingency and Cost Evolvement of Construction Projects in the Preconstruction Phase”
(De Toni et al., 2021)	“Investigating organizational learning to master project complexity: An embedded case study”
(He et al., 2021)	“Developing a List of Key Performance Indictors for Benchmarking the Success of Construction Megaprojects”
(Qazi et al., 2021)	“Impact of Risk Attitude on Risk, Opportunity, and Performance Assessment of Construction Projects.”
(Joseph et al., 2021)	“Measuring Information Systems Project Complexity: A Structural Equation Modeling Approach.”
(Wang et al., 2021)	“Identification of Critical Factors for Construction Megaprojects Success (CMS).” (book)
(Kim et al., 2021)	“Mapping the Complexity of International Development Projects Using DEMATEL Technique.”

The present study defines project complexity through six sub-dimensions: information complexity, task complexity, technological complexity, organizational complexity, environmental complexity, and goal complexity, outlined in Table 2.4.

Table 2. 4 Dimensions of Project Complexity

Dimensions	Description
Information Complexity	Complex communication between excessive numbers of project stakeholders is information complexity that's under complex prescribed schedules during the total project transfer method. Information reliance between several project members' growth information density, consequently in the result of the escalating scale of super projects. Information density is generally impacted by different factors, for example, information systems (Shi, 2020). Incomplete and complex information delay the project schedule (Kumaraswamy & Chan, 1998).
Task Complexity	Task complexity arises due to the structure of the task. Megaprojects involve various members and have a mutual impact and time restriction within task activities (Pasarakonda et al., 2020). Mega construction projects involve various tasks from different fields such as organization management, engineering and technology, ecological protection, finance, energy-saving, and social stability. These tasks cannot be separated from one another because these are interconnected strongly. Change in one task effects on other tasks. All tasks have a complex nonlinear relationship; it leads to increase complexity in mega construction projects (Lu et al., 2015). Consequently, construction schedule delays.
Technical Complexity	Technical complexity involves several technologies used in a project and the expertise of the team to use these technologies. Mega construction projects include several technical and organizational complexity factors (Ma et al., 2020). Mega construction projects are subject to the high technical complexity, such as design overlapping, dependency on project operation, type of the building, and construction. Mega construction projects need to manage the growing technical complexities that arise in the result of innovation and increased usage of technologies in construction, for example, three-dimensional technologies, new

	construction materials, and conservation technologies (Luo et al., 2017). The scholars reported several types of technological complexity in handling mega projects, common examples include technological process dependency, diversity of technology, the relationship of the external environment and technological system, and complicated technology risk (Bosch-Rekveldt et al., 2011). Technical complexity is one of the reasons in construction projects schedule delays. In a broad sense, technology is the transformation of inputs into outputs using materials, methods, techniques, knowledge, and skills (Trappey et al., 2022). This process of transformation is known as the technological process. The most essential aspect of technology is the variety of tasks that need to be accomplished. This factor, also known as task scope, has been identified as a predictor of horizontal differentiation (Szczepańska-Woszczyna & Gatnar, 2022). It explains why a number of distinct technologies and a degree of expertise in each of them are required. (de Rezende et al. (2022) argues that technical complexity can be characterised by differentiation and interdependence. The phrase "technical complexity by differentiation" describes the intricacy of a project as a whole, broken down into its constituent parts. These parts might range from the quantity and variety of inputs and outputs to the variety and quantity of operations that need to be carried out. Tasks, networks of tasks, teams, technologies, and inputs are all parts of the technical complexity that is measured by interdependency. There are three types of technological interdependence: pooled, sequential, and reciprocal, with the latter being the most common in construction projects.
Organizational Complexity	It is the point of difference between the components of the organizations where the corporate components include common objectives, composed exertion, splitting up of work, and progressive system of authority (Ma et al., 2020). The execution of a mega construction project is conducted by a project organization that involves project staff and teams, and organizational structure to execute a project (Mohseni et al., 2019). That's why project complexity is also manifested by organizational complexity. In mega construction projects, diversity of the experience is a prerequisite, for this, organizations are required to hire employees from different cultures and the handling of them is considered as the biggest part of the organizational complexity. Consequently, it becomes the ultimate

	reason for the mega construction project delay (Uner et al., 2018).
Environmental Complexity	The complexity in which a project controls the market, natural, regulatory, and political environment is known as environmental complexity. The density of the project stakeholders (whom comforts and wishes are impacted by this environment) is inclined by this complexity Bosch-Rekveldt, 2011; Godoy-Bejarano et al., 2020). The environment is most important in construction projects because it is an external factor that is not in the control of project organization. Environmental complexity is considered as a critical complexity in mega construction projects that lead to schedule delay (Pheng & Chuan, 2006). Proposal of social density is to clear the density due to the number and variety of project stakeholders (Girmscheid & Brockmann, 2008).
Goal complexity	Goal complexity is regularly triggered by quite a few factors; like that many project contributors' desires, assignment task density, and partial resources. Goal complexity is a sort of structural density because nearly all projects have several objectives (Williams, 1999). Alternatively, researchers stated that this complexity might twig from opacity that happened in many latent explanations of goal line and purposes, for instance, the unshared areas and goal paths (Remington & Pollack, 2007). Megaprojects are subdivided into the number of goals, achieving goals in time is difficult due to goal complexity (Dou et al., 2020).

2.3 Theories Supporting Research

2.3.1 Institutional Theory

Early institutional theorists perceive organizations as entities endowed with significance, value, and legitimacy by their leaders and members (Peters, 2022). Tina Dacin et al. (2002) define institutions as the regulations governing social interactions among individuals and groups. Neo-institutionalism extends this perspective, proposing that society comprises interconnected institutional systems, each with varying degrees of authority influencing people's and businesses' behavior (Willmott, 2011). The concept of institutional logics becomes relevant when change occurs. These represent socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules through which individuals create and sustain their material existence, organize temporal and spatial dimensions, and attribute significance to their social environment (Glynn & D'aunno, 2023).

Institutional complexity arises from the presence of multiple, often conflicting, logics within an organization; however, recent research has focused on how organizations manage this complexity (Jarzabkowski et al., 2013). The presence of conflicting and incompatible institutional logics results in organizational systems that are intricate (Sjöstedt, 2019). To put it differently, the challenge of achieving consensus is exacerbated by the emergence of institutional complexity when organizations confront conflicting cognitive frameworks. Qiu et al. (2019) contend that megaprojects serve as arenas where conflicting logics influence their processes, as the individuals and entities involved bring their respective perspectives to bear on the undertaken and omitted actions. For example, conflicts and uncertainties may arise in megaprojects due to institutional disparities among various groups, political regimes, stakeholders, and macro-environments. Discussions on conflict in project governance literature have increased, which Brunet (2021) defines as a distinct form of interaction among institutional components. According to Hu et al. (2018), the fragmentation of initiatives within institutions can create significant hurdles, thereby complicating decision-making and necessitating considerable effort from managers.

Recent interdisciplinary research on institutional complexity has concentrated on how organizations are affected by and respond to such complexity. According to Qiu and Chen (2023) internal issues within institutions may lead organizations to either dissolve or become paralyzed. Esposito and Terlizzi (2023) suggest that organizations confront intricate institutional environments where they must accommodate the demands of resource holders with potentially conflicting interests. According to Miller and Hobbs (2005), discrepancies in institutional requirements lead to specific conflicts, which in turn contribute to institutional project complexity. Organizations employ various strategies to address the conflicting logics that emerge in complex institutional environments. Moreover, complexity often breeds uncertainty, prompting organizations to either adapt or take action. Mahalingam (2022) suggest that organizations facing such institutional challenges may develop strategies to remain competitive by effectively navigating the complexity of these dynamics.

The interest among project management scholars in applying institutional theory to mega projects has been on the rise, especially since Zhao et al. (2017) advocated for broadening the conceptualization of projects across three dimensions: Institutional, technical, and strategic. Biesenthal et al. (2018) further promoted the use of institutional theory as a perspective to advance the development of project management as a field of study. Bresnen (2016) highlighted the potential for creating value through a critical and reflective examination of the processes associated with the professionalization and institutionalization of project management, both as a body of knowledge and a professional practice. Mahalingam et al. (2007) and Biesenthal et al. (2018) suggested that megaprojects could enhance their resilience by closely collaborating with institutions.König (2020) has shown that institutional theory may help professionals organize the issues of organizations, determine the sources of such problems, and judge such issues relatively quickly. The current study wants to understand mega project governance as a multi-dimensional concept and adopted institutional theory as a conceptual framework. Institutional theory is a term used to describe the study of society's long-term development of normative as well as behavioral systems. In accordance with Friedland and Alford (1991, p. 232), institutions can be defined as: supraorganizational patterns of human activity by which individuals and organizations reproduce their material subsistence and organize time and space". The perspective of institutional theory offers understanding into organizations by scrutinizing the interactions among individuals, organizations, and society within an institutional setting (Vadasi et al., 2020).

A project-based approach, in contrast to transaction cost economics, institutional theory emphasizes actions that do not presume prior conditions about human behavior or, for instance, the mega project governance structure. According to institutional theory, there is a wide variety of mega project governance mechanisms since they are difficult tasks that individuals perform through their situated actions (Henisz et al., 2012; Vadasi et al., 2020). Rather than starting with the structures to explain the behavior at the bottom, a project-based view on mega project governance emphasizes the importance of paying attention to what people in the organization really think and do (Zhang & Keh, 2010; Friedland, 2018).

For instance, the Kattadam case study conducted by Mahalingam and Levitt (2007) and the ideas from institutional theory allow us to articulate the challenges brought about by cultural variations in mega project. According to the predictions of institutional theory, Kattadam mega projects reflected national differences in the construction sector in the United States, France, and Germany. American, French, and German participants had different assumptions about several institutional factors, including contractual methods, the responsibilities of specialized experts, aesthetic ideals, and local materials (Mahalingam et al., 2007). Participants from the United States and Europe worked together on a project, but everyone sought to operate in accordance with the norms established by their respective country's institutions. As a result, there were often competing schools of thought on how to proceed. These inconsistencies needed settling before the project could go further. Several of the national organizations working on Kattadam's projects started out without a full understanding of the underlying variations in institutionalized perspectives (Lee et al., 2011). According to the research on institutional persistence, participants were unable to immediately abandon the methods they had employed for years in their home environments, while being aware of the difference in institutional perspectives on elements like aesthetics and contractual processes (Dong et al., 2021). This prompted a string of protracted discussions, which ultimately led to the smooth settlement of the underlying institutional disputes. Poor project performance resulted from the delays induced by these debates.

According to this reasoning, mega project governance is not the outcome of established institutions but rather the consequence of the efforts of individuals who are driven for one reason or another to behave in a certain manner (Friedland, 2018). Mega project governance is a new approach to leadership that raises the prospect of project success (Crawford et al., 2008). When properly implemented, MPG creates a structure for managing project accountability and benefits (Ul Musawir et al., 2017). During the process of a project's execution, unexpected risks might arise, and MPG provides a structured framework for recognizing and addressing these issues. MPG improves project efficiency by facilitating quick and effective risk allocation. MPG is an irresistible factor in facilitating the need for top management of public sector projects. However, a lack of an efficient governance system has been identified as a major contributor to the failure of a number of projects (Van Marrewijk et al., 2008).

Regulation, normative, and cultural cognition are all part of institutional theory's definition of social life's stability and purpose (Scott, 2005). An institution's existence is made possible by the social conduct of its constituents (individuals and organizations). An organization's regulative features include formal rules, laws, and property rights that are typically imposed on it from the outside (Scott, 2008). Environmental laws may be amended, and regulatory components can be implemented through public-private partnerships, relational contracts, and other approaches. Informal norms, values, standards, and formal and informal roles are all examples of normative aspects. The standards set by professional groups and the project management procedures produced inside corporations is two examples of mega construction projects (Biesenthal et al., 2018). The use of formal mentorship, training, and informal interactions as well as internal peer pressures is also part of this strategy. Cultural–cognitive aspects include common conceptions that determine the essence of social reality and establish the frameworks through which meaning is produced, as well as shared ideas, symbols, identities, and logics of action. The three pillars work together to support various elements of institutional stability or even development in their respective contexts.

The normative aspects, on the other hand, offer the foundation for common commitments among the parties and the creation of their members' identities through shared values. Institutional assertions might be viewed as legitimate and self-evident because of the institution's cultural–cognitive aspects (Dong et al. 2021). Together, the three pillars' combined might may be effective. However, misalignment may lead to a variety of consequences, including conflict and change, depending on the motivations of the many people involved. By examining the possible conflicts between project managers and shareholders, Biesenthal et al. (2018) connects this theory to institutional theory. Project managers (agents) have varying levels of power, which is linked to their decision-making and risk-averseness. Institutional theory states that project managers are accountable for making decisions on behalf of shareholders or project owners in a company (Campbell, 2007). Thus, the short-term aims of these principles (time and cost performance) may be realized via the construction of management and monitoring systems that regulate project managers' conduct. It is widely accepted in project management literature that contracts play a critical role in regulating these interactions.

Recently, institutional research has become a vital tool for studying the relevant impact on megaprojects management e.g., (Lu et al., 2020; Wu et al., 2020; Zhai et al., 2020). However, major developing countries that are newly involved as sponsors in mega projects often lack a research tradition. Therefore, establishing research partnerships with developed countries that excel in megaproject research can be highly advantageous. While there have been some collaborative examinations, they have been insufficient in addressing our research goals. The current study primarily concentrates on investigating the intricate and evolving relationships within megaprojects. Specifically, to explore the connections between operational-level outcomes and anticipated megaproject performance or benefits. This exploration is carried out through the adoption of agile project management methodology at the strategic level during the early stages of the project.

Institutional theory suggests that successful businesses tend to emulate those already established in their industry. However, neo-institutional scholars challenge this restrictive viewpoint by proposing that businesses can adapt to new circumstances by modifying their institutional logics, which encompass the underlying assumptions, values, and beliefs that shape their day-to-day operations. In this regard, institutional PMO, as explained by Esquierro et al. (2014) as actors with an interest in specific institutional arrangements who leverage resources to create new institutions or transform existing ones, play a pivotal role in facilitating adaptability. While there is a prevalent narrative portraying the solitary ‘hero’ effecting systemic changes, others argue that PMO development is often the outcome of collaborative efforts.

Given the substantial challenge of managing institutional complexity stemming from the constantly changing environment in modern societies, the subject of managing multinational mega construction projects within a complex institutional context is an intriguing area of study within the field of organizational research (Matinheikki et al., 2021). This is particularly relevant for mega construction projects in developing countries undergoing market transitions, where the involvement of both local and foreign providers with varying levels of institutional sophistication is necessary. The management of Pakistan mega construction projects, including dams, highways, airports, and bridges, is becoming increasingly complex due to the rapid urbanization in the country. This complexity poses challenges at both internal and external levels. Failure to recognize institutional complexity in these endeavours can lead to project underperformance, including cost overruns, delivery delays, and adverse social consequences (Qiu et al., 2019).

2.4 Pakistan Construction Sector Overview

The construction industry is critical to a country's economic well-being and is often regarded as the best way to spur physical development (Ershadi et al., 2021a). The greater the prosperity and prominence of a country's construction sector, the more it contributes to economic stability. The pivotal factors in this context are quality, time, and price (Stanitsas et al., 2020). The assessment of a construction project's effectiveness and success at a given point in time revolves around the achievement of these three criteria and the fulfillment of the project's initial business scenario. In the past five years, various analyses have highlighted key factors leading to delays in construction projects across Africa, Australia, and Asia (Ogunnusi et al., 2021). As Pakistan continues to develop, the construction industry plays an important role in the country's growth and development. Many projects have recently ended construction, while many more are in the planning stages.

Part of China's ‘One Belt, One Road’ initiative is the China-Pakistan Economic Corridor (CPEC). Development of infrastructure and other facets of the economy such as politics, ecology, and regional development are enormously important (Amin, 2021). In developing and implementing this project, however, there are several problems and concerns. Safety and environmental preservation are two essential aspects (Rehman et al., 2021). The CPEC program has introduced several modern and groundbreaking projects aimed at fostering economic development. This includes the construction of railways, the establishment of new commercial zones, the expansion of the Gwadar port as depicted in Figure 2.1, and the enhancement of the road network, as noted by McCartney (2021) and Xiaolong et al. (2021). Efficient transportation infrastructure is vital for economic regions and other infrastructure ventures. Capital loans amounting to 11 billion dollars have been allocated, and these loans indeed contribute to economic progress in Pakistan. Another significant development in the industrial sector is the initiation of a project to construct a liquefied oil and gas pipeline. Both countries' economy has benefited from the new and rising CPEC trends. Following the start of the CPEC, international investment in Pakistan has increased significantly (McCartney, 2020).

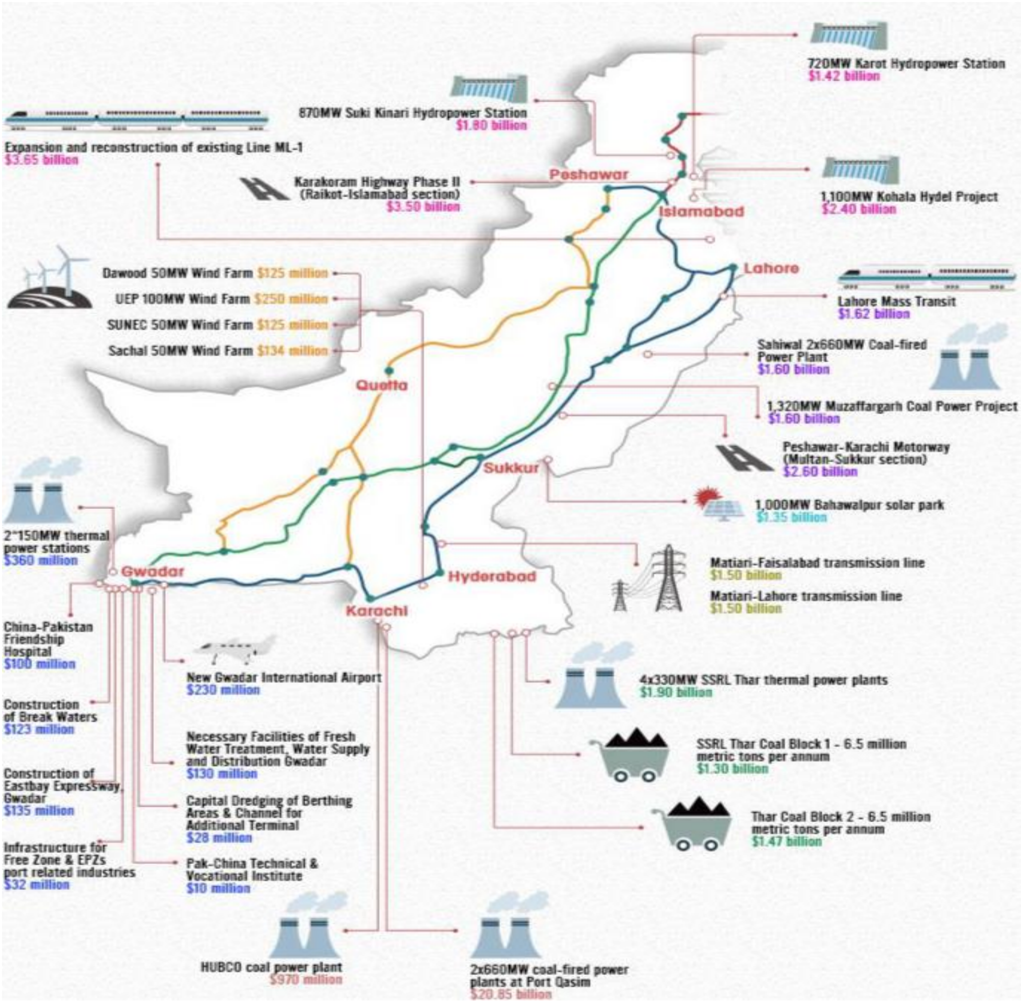

Figure 2. 1 Major projects under Projects of China-Pakistan Economic Corridor (CPEC)

(Source: https://www.globaltimes.cn/page/201612/1026144.shtml)

The energy and economic sectors will undoubtedly be enhanced after this project, but all environmental losses must be avoided (Baloch et al., 2019). Environmental risk assessment should be seen as the primary obligation of both countries' laws on environmental protection (Zhang et al., 2017). Both Pakistan and China are highly populated, and environmental pollution poses a severe risk to managing CPEC projects. The quality of air and lack of water resources are two critical issues. The construction of roads has a detrimental impact on water and air quality, as well as the depletion of biodiversity and natural reserves. These aspects should be viewed critically, and management methods must be enhanced to ensure the sustainable progress of these projects. It's important to note that the CPEC plan is a product of international cooperation and has received support from various nations worldwide. In 2018, Saudi Arabia joined as a third partner by contributing 10 billion dollars to this project (Naz et al., 2019). This substantial investment is expected to significantly accelerate the rate of development. Moreover, investments in development projects in Saudi Arabia also have implications for the growth of Pakistan's mining industry (Kazakova et al., 2017). Infrastructure development has played a pivotal role in shaping the economies and associated characteristics of both countries. The exchange of skilled workers has given rise to diverse new social growth programs. The exchange of economic and social resources has had a notable impact on Asia's overall economic landscape. Additionally, economies from around the world have invested in comparable CPEC initiatives, making it undeniable that CPEC serves as a driving force for economic advancement and foreign wealth within Pakistani markets (Wolf, 2021).

In Pakistan's unique natural reservoirs and parks, infrastructural development and a massive inflow of visitors have caused a serious environmental danger to the tourist sites and biodiversity. Joint efforts are needed to promote the rehabilitation and protection of these places. Research has shown a great deal about all of the threats that the ecosystem has encountered. A study carried out in Gilgit Baltistan recently indicated the unfavorable effects on construction and tourists' flow in these zones climate and air quality index (Gilani et al., 2020; Feroze et al., 2021). Gilgit Baltistan's unique geographical location is the center of CPEC. Improved air quality and water management measures in this field must be implemented.

CPEC is poised to generate a significant economic boost, offering promising prospects that will attract companies from all over the world to establish businesses in the region. This, in turn, will create employment opportunities, a key driver of economic growth. The competitive environment that emerges as a result of this market will incentivize the production of high-quality goods. The Gulf, Europe, and Asia are all pivotal players in this extensive network that spans three parallel segments to the east, connecting China to the Arabian Sea (Xiaolong et al., 2021). In the long term, CPEC has the potential to yield countless benefits for numerous countries (Kong et al., 2020). These corridors are instrumental in establishing a global market, making trade accessible and open to the rest of the world through this platform. The development of skills within a digitalized system is paramount for the effective management of mega projects, and the government of Pakistan is actively dedicated to achieving this objective.

The actual or precise delay in construction organizations in Pakistan is so challenging to detect (Ud Din et al., 2020). Time is regarded to be an essential resource and must be monitored before the project starts. Delays and their consequences are often regarded as one of the most damaging aspects of Pakistan's construction industry (Iftikhar et al., 2021). In Pakistan's situation, the implementation of a mega construction project at the given period is rare (Irfan et al., 2021). There is much evidence that massive projects were delayed or that projects faced abandonment or suspension. Many mega construction projects have been put on hold, such as the Kalabagh Dam, the National Highways, Pakistani Motorways, the Port Tower Complex in Khyber Pakhtunkhwa, China's industrial cities in Sindh, Punjab, and Baluchistan, and reconstruction of roads damaged by earthquakes and floods (Kakar et al., 2021).

In all of the vital infrastructure projects around the region, the researcher has obtained access to the ‘Planning and Development Department of Gilgit-Baltistan’ (Gilani et al., 2020). A surviving report of 43 Diamer district infrastructure projects, costing Rs 2247,090 million, has been prepared by the three-member staff of the Planning and Development Department, Gilgit-Baltistan (Khan et al., 2018). The system of monitoring the progress of a project in implementation aids in identifying/analyzing and removing bottlenecks and speeding activities where projects are stopped or behind schedule. The district Diamer's development projects are lower than those carried out in other districts in Northern Pakistan (Gilgit-Baltistan). The Diamer district is a prime example of misallocated public funds for infrastructure development. According to Waris et al. (2017), the projects in district Diamer were beset by issues and a massive cost overrun due to a slew of tribal/political, financial, management, and governance flaws. Of the 43 projects, over 30 are troublesome and slow-moving/sick; in some cases, project expenses have grown by over 200%. Due to design difficulties, incorrect selection of locations, land purchase challenges, abandonment of the work by contractors, these projects have missed their implementation tables and completed their project deadlines.

2.5 Need of Project Governance for Mega Construction Project Planning in Pakistan

As one of the most important industries for creating new economic prospects, the construction industry in Pakistan must continue to develop rapidly (Hussain et al., 2019). An essential engine of the country's economic progress, this industry is critical. It is also one of the areas that have the potential to provide a large number of jobs for both skilled and semi-skilled workers (Ali et al., 2018). Mega construction projects in Pakistan are becoming more necessary, but the country's financial resources are unable to keep up with the increased demand (Kanwal et al., 2020). Not just because of the economic constraints, but also because public sector organizations lack the ability to function at a higher level. Yet the government seems unconcerned about the issues facing this industry. Planning and managing public sector construction projects have long been seen as major difficulties in emerging countries (Ali et al., 2018). A country's political and economic situation has a greater impact on infrastructure initiatives in emerging nations. Pakistan has suffered from widespread poverty and inadequate government mechanisms ever since it gained independence. Government-sponsored project performance has been on a downward trend for many years due to an unstable political structure. Concerned about the existing state of Pakistan's economic infrastructure, government agencies and construction sector players must look for more efficient and effective methods to carry out projects than they have previously explored (Rehman et al., 2021). As a result, project governance has been advocated in this research as a critical technique for improving project performance in public and private mega construction projects of Pakistan.

2.6 MCPS Challenges in Pakistan

Lehtinen et al. (2019) revealed that MCPS in emerging countries have faced difficult conditions. Many initiatives have to be abandoned due to their inability to secure long-term funding. The Pakistani government assumes a crucial role in rural communities, acting as the sole service provider for project initiation, planning, financing, execution, and overall management until the project's completion. Starting with the identification of the project's requirement in a specific location, the community's needs are recognized; for example, government-managed rural education, healthcare, energy, and road infrastructure projects. For the year 2016, the World Bank estimates that 60.776 percent of Pakistan's population lives in rural regions (Padda & Hameed, 2018). Even the most basic of facilities are in short supply, and construction projects are already behind schedule. As a result, the responsibility for Pakistan's government is to assess the effect of project delays on the country's economic and social situations. Neither practitioners nor academics deal with delays in construction projects that have the potential to harm rural communities' economic and social growth.

In developing countries, the construction sector and projects have radically different features and levels of complexity than in developed countries. According to Erol et al. (2018) in developing countries, project types and context vary from those in developed countries which are the origin of the development of project management. Even if a generally established standard exists, every project has its own unique dynamics, which begun and performed locally with the appropriate adaptation to the situation. Makhdumi et al. (2017) state that the project's characteristics, such as its purpose, location, sponsors, stakeholders, and timeframes all have a significant influence on the project management techniques that must be used to accomplish the project's objectives. Since the projects in developing countries faced several problems, they are more likely to be unpredictable, unstable, and have poor ethical behavior than those in more developed countries where MCPS are more common. In Othman et al. (2013) classification, these problems are divided into four categories: engineering problems, human development problems, management and political problems, and sustainability problems. When it comes to the implementation of MCPS in developing countries, Banihashemi et al. (2017) say that there are two major obstacles: a lack of trained scientific and technical practitioners and bad judgments.

Inadequate professional training and quality education have led to a shortage of qualified individuals prepared to undertake essential roles. According to Othman et al. (2013), mega construction projects in developing countries are hindered by bureaucracy and corruption. Additionally, Ahuja et al. (1994) argue that proficient project management processes are essential for mega construction projects. Moreover, political factors significantly impact the outcomes of mega construction projects worldwide. As noted by Meredith et al. (2017), the execution of mega construction projects often extends beyond the lifespan of state-run administrations, and changes in government (particularly shifts in alliance parties) can lead to alterations in project goals and scope. From a sustainability perspective, El-Sabek et al. (2018) assert that mega construction projects in developing countries grapple with issues like a lack of financial resources, cost control, and access to venture capital. Consequently, project governance elements that are inflexible in nature, such as governance structures, governance mechanisms, and the external environment, are more pertinent in the context of developing countries compared to developed ones. Rondinelli (2013) discovered that project managers working in developing countries face greater difficulties and complexities than their counterparts in developed countries.

External complexity is one of the most critical barriers to managing mega construction projects in developing countries that arise from moderate risk. China, Pakistan, and India considered the fastest-growing business sectors in the mega construction projects, face a very high level of vulnerability in terms of social and economic problems (Irshad, 2015; Ahmed et al., 2016). It is difficult to manage megaprojects when there is such a high degree of information complexity, task complexity, technological complexity, organizational complexity, environmental complexity, and goal complexity. Project planning and procurement, monitoring and control, risk analysis and management are just a few of the subjects that are impacted by this level of complexity. As a general rule, these issues include illegal legislation, lack of financial resources, withdrawal of donors due to political struggle, lack of unusual trade, contract conditions, political systems, expansion, social and environmental conditions, lack of interest of end customers and local environment, pollution, and catastrophic events, such as conflict and draft.

2.7 Literature of Mega Project Governance and Mega Construction Project Success

According to Dhanshyam et al. (2021), the fundamental aim of any project is to create and optimize value for organizations. They asserted that maximizing value was intrinsically linked to project success, which in turn contributed to the overall organizational performance. Consequently, employing appropriate mega project governance frameworks becomes crucial in managing these initiatives. There exists a perceived governance gap between mega project governance and the success of mega construction projects. It is presumed that project governance frameworks play a pivotal role in achieving success, a notion supported by Müller (2017) and Young et al. (2019). Similarly, Joslin et al. (2016) discovered a small yet significant correlation between project governance and success. Müller et al. (2015) delved into how project governance influences the success of project management approaches. Their research revealed that project governance did not exhibit moderating or mediating effects on the relationship between methodology and success. However, they noted that project governance could serve as a predictor of project success. Moodley et al. (2021) examined the correlation between project governance and project success in large-scale investment projects in South Africa. Their interviews with respondents unveiled a significant association between project governance and success.

Over the last several years, governance concerns have been a major focus in the domains of politics, economics, and management. Before the 1980s, corporate governance was mostly the domain of lawyers, but economists began interested in how corporations made choices in the 1990s. After that, Gilson said economists believed that governance and performance were connected (Gilson, 1996). From this point on, scholars began to use management theories (i.e., institutional theory) to better understand how project governance and project success are affected. A significant contribution has been made by Locatelli et al. (2017), according to which it is necessary to address the causes for cost and time escalation and inadequate benefits provided in complex project contexts. While Dhanshyam et al. (2021) claims project structure and governance are responsible for overruns, delays to timelines and poor outcomes. The concept and origins of project governance remains a subject of ongoing debate among academics, lacking a definitive and universally accepted definition. Ahola et al. (2014) identified two distinct streams in the literature on project governance: one perceives project governance as an external process independent of any specific project, while the other considers project governance as an internal process specific to individual projects. Young et al. (2019) introduced integrated project-governance framework outlining varied governance and management functions. It appears that the definition of project governance is primarily shaped by the expertise, professional backgrounds, and specific domains of researchers. A well-structured institutional framework for project governance clarifies the connection between stakeholders, including their obligations, privileges, and advantages. For example, it may assist in improving project organization models based on internal project structures as well as external laws.

To successfully complete a mega-construction project, several commercial companies and government organizations must work together in close harmony, and this is impossible without close coordination. Short-term mega-construction projects represent the varying project objectives set by various stakeholders at various phases of the project. Various stakeholders join and depart projects during the course of their life cycles, particularly for megaprojects; hence project governance structures and procedures are always evolving. The governance models for mega-construction project, therefore, need be modified in line with the project's progress, either actively managed or passively. The project's organizational structure, stakeholder interactions, and oversight systems are all likely to alter as the project proceeds. As part of their research on the multilevel governance of mega-event projects, Li et al. (2019) looked into governance challenges at the World Expo 2010 to develop a new evolutionary governance theory (EGT). Project governance has the potential to mitigate some of the problems of conventional project management. Project management has taken on new significance in light of the growing complexity, variety, and unpredictability of megaprojects. The governance of megaprojects has been studied; however, the majorities of the studies are static and contain descriptive qualitative research and a complete conceptual megaproject governance model that aids in understanding and assessing project performance is missing. As a way to bridge the knowledge gap on megaproject governance, the current study suggests a dynamic and quantitative method.

2.8 Literature of Agile Project Management

At Lehigh University's Iacocca Institute (USA) in 1991, researchers developed the concepts of ‘agility’ to the manufacturing industry. In their definition of agility, they described it as manufacturing system with capabilities (hard and soft technologies, human resources, educated management, information) to meet the rapidly changing needs of the marketplace (speed, flexibility, customers, competitors, suppliers, infrastructure, responsiveness) (Yusuf et al., 1999). Organizations must be able to quickly adapt to changing business conditions and consumer expectations in order to thrive in a competitive climate (Gunasekaran, 1998). The ‘agile enterprise’ method of changing and keeping competitive was shown to be the most successful way to break down a large firm into smaller groups (Bessant et al., 2002; Moreira, 2017). Dove (2005) describes the capabilities of an agile company as the ability to respond quickly to changes and to remain successful in an unpredictable environment marked by constantly changing customer expectations. They also describe how an agile company can respond quickly to changes in the marketplace.

Agile approaches are a combination of software development techniques. They are founded on the Agile Manifesto, which was developed in 2001 by information technology (IT) industry experts (Fowler & Highsmith, 2001). Agile methodologies, often known as agile software development, are a collection of iterative and incremental software engineering techniques (Hohl et al., 2018). There are a variety of definitions for agile approaches between the top-down management style and the bottom-up management system approach. Researchers like Brendebach (2020) have proposed agile techniques as a radical alternative to command-and-control management, which represents one type of management. Agile techniques are meant to accept uncertainty and change as a constant condition that must be handled, as compared to traditional approaches that emphasize careful preparation in advance. As per Paluch et al. (2020), agile methods are rooted in four fundamental values: prioritizing individuals and interactions over processes and tools; favoring incremental delivery of functional software over exhaustive documentation; emphasizing customer collaboration over contract negotiation; and prioritizing adaptability to change. Implementing these core values necessitates specific behaviors and technologies, as outlined by Sommer (2019).

Research by Ismail et al. (2011), Nowotarski et al. (2015), and Gren et al. (2017) presents agile approaches as a collection of practical strategies that have been successful in the software sector and are now starting to be used in other service and construction industries. Most practitioners and suppliers of hands-on training focus their talks on helping companies pick among the many techniques since there are a vast variety of methods used in different industries. The dynamic systems development method (DSDM), Scrum, custom techniques, XP, a mix of Scrum and XP, lean software development, and feature-driven development are among the most popular (Gren et al. 2017). The problem of this limited and utilitarian perspective is that it clearly opposes the necessity for documentation (formalization in organizational-design terms) and the use of techniques for the purpose of methods.

Dong et al. (2021) contend that projects should not be characterized solely by their complexity or time constraints. Instead, they propose defining them as intricate norms that represent an ongoing and repetitive enhancement of institutions. They critique the conventional approach in existing project management literature, which tends to treat each project as an isolated and unique concept. Successful projects necessitate organizational support and coordinated human behavior to achieve maximum returns on investment (ROI) and effectively handle the inherent variability and complexity of project management. Picciotto (2020) shares this perspective, advocating for a fresh approach to managing substantial construction projects that incorporate a more adaptable evaluation process. There is a need for further research in both the theoretical and empirical exploration of agile project management from an organizational perspective (Olszewski, 2023). Organizations are viewed as subject to normative and cognitive influences, which are examined from both individual and institutional perspectives as influential drivers of change.

The integration of agile practices into public sector mega projects presents inherent complexities arising from the inherent contradictions between agile principles and established government policies, procedures, and extensive documentation (Baxter et al., 2023). A radical perspective suggests that agile methodologies are fundamentally at odds with the prevailing hierarchical and bureaucratic structures common in government organizations (Denning, 2015; Baxter et al., 2023). Conversely, an opposing viewpoint argues that agile approaches hold the capacity to fundamentally transform government operations, public management, and governance in their entirety. Consequently, it is imperative to delve deeper into the mechanisms, processes, and resulting effects that enable this transformation to occur and assess its feasibility. When a client learns about new things, the scope of the project is certain to vary, making the project more complex and unclear. APM is an iterative method that prioritizes customer value, engagement over tasks, and adjusting to the actual business reality rather than following a prescriptive plan (Azanha et al., 2017). This method focuses on iteratively delivering small pieces of a mega project over time. These steps are taken so that project clients may provide input and have their experiences included in final product design. As a result, the client is able to influence the project's progress, as well as manage and regulate the project structure (Puri, 2009; Mergel, 2016). The use of an APM system allows the contractor to quickly respond to work site changes, thereby shortening the period between the discovery of a risk and its correction. It also provides a highly motivated and well-trained work technique throughout the design process by producing more value for the customer (Sohi et al., 2016).

Agile surpassed traditional development methods in the private sector IT industry as early as 2009 and has since become the recognized best practice for software development. Nonetheless, its adoption within the public sector has been considerably slower, and research in this domain remains limited (Mergel et al., 2021). Recent systematic reviews focusing on Agile in the public sector have highlighted the scarcity of research on this subject. Exhaustive searches yielded no papers presenting a methodology for assessing agile approaches in public sector projects (specifically in construction). Only 17 articles discussing its adoption in the public sector were found, alongside a total of 33 articles, including 25 conference papers, addressing the broader topic of agile methodologies in government (Mergel et al., 2018). The absence of comprehensive research in this sphere is particularly surprising, given that Agile is recommended by the U.S. government (GAO, 2020) and mandated by the UK government (Agile Delivery Community, 2016). There's a consensus that the government sector faces considerable challenges in implementing Agile. Factors contributing to this difficulty include a noticeable reluctance among public sector managers to embrace informal leadership or self-management practices, coupled with a lack of awareness regarding these trends. Additionally, the successful deployment of Agile in the public sector requires adjustments in government policies and practices (Baxter et al., 2023).

Agile techniques are defined as a kind of project management that emphasizes communication with the client, flexibility, responsiveness, and a rapid pace of development (Ribeiro & Fernandes, 2010). Micro-planning tools are a key component of agile techniques, allowing for the rapid development of deliverables in between major milestones. As soon as a new development project is started, the project development team may turn to agile methodologies for guidance and assistance in order to see the project through to completion. Each sprint or iteration of an agile project is often relatively short and is carried out by a dedicated (full-time) project team. At the conclusion of each sprint or iteration, the team has a viable prototype or at least a prototype that can be tested by users (Moe et al., 2010). The term "agile practitioners" is used by Kumara (2017) to describe those who participate in the development or execution of agile processes.

Aritua et al. (2009) suggested that APM is influenced by institutional theory and the study of complex adaptive systems. In accordance with institutional theory, new outcomes may emerge unpredictably, often reaching a 'tipping point' where order meets chaos (Daniel et al., 2019). When rigid procedures and extensive preparation give way to flexibility and improvisation, unexpected outcomes may arise. The next stage is mega projects, where the above-mentioned emergent structures provide the ability to learn from the collective experience of individuals participating, resulting in a library of potentially reusable actions that may be generated. The 'premise' of APM, as stated by Albuquerque et al. (2020), is that, in contrast to traditional project teams that depend on conventional routines and procedures, APM teams that combine aspects of institutional theory with 'adaptive teams' working together towards a common objective will generate outcomes that are closer to actual requirements at delivery. As a result, the deliverables of APM are seen to be more in line with requirements than those of standard APM output.

There are two distinct approaches to project management (Copola Azenha et al., 2021): traditional project management (TPM), which goes back to the 1950s and came from military and construction sectors; and APM (similar to concurrent engineering), which arose more recently. As a result, APM is rarely explored in academic literature, unlike agile manufacturing and agile methodology. Until 2009, the majority of agile initiatives were in the IT industry (Coram et al., 2005). Hence, the predominant focus of APM literature has been on the examination of software development projects, with only a limited number of projects in other industries adopting agile methods in the past decade (Almeida, 2020). The establishment of agile teams, characterized by low hierarchies, collaborative decision-making, a shared knowledge base, and strong communication skills, aims to enhance team productivity. The APM strategy is distinguished by continual updates to the project's execution detailed planning cycles grounded in short-term outcomes, and substantial customer involvement. In the contemporary landscape, most new products are created in dynamic and uncertain environments marked by project complexity, unpredictability, and frequent changes. An APM strategy provides improved solutions and project outcomes in these situations because of its ability to overcome the constraints of previous techniques. There is a lot of disagreement among APM and TPM supporters about which path to take (see Table 2.5) (Kumara, 2017).

Table 2. 5 Differences between traditional and agile project management

No.	Traditional Approach	Agile Project Management
1.	Rather of focusing on the end result, concentrate on the method of getting there	Focus on human beings rather than things.
2.	Work on all aspects of the project initially.	Focus first on the most critical portion of the scope, and then go on to the next.
3.	Changes are regulated by a strict set of rules.	Flexible and adaptive methods are essential for regulating change.
4.	Collaborative efforts are less likely to take place in teams.	All facets of the team are intertwined
5.	An organization's hierarchical structure aids in the development of	Constant and deliberate engagement in a complex system result in the

	order.	establishment of order
6.	Increased control leads to a rise in organizational efficiency.	Increased order is a product of self-organization, interaction, and basic laws.
7.	Static and inflexible hierarchies are the norm in most organizations.	There must be no superfluous bureaucracy in organizations.
8.	Managed with an authoritarian style	The manager's responsibility is to facilitate and provide assistance.
9.	When it comes to the organizational ‘machine,’ employees are interchangeable ‘parts’,	Employees play a critical role in the success of any business.
10.	During the requirements collecting and delivery stages, the customer is the primary stakeholder.	Throughout the project's lifespan, the customer is involved.
11.	The task breakdown and allocation (e.g., WBS and PBS) is essential for addressing issues	Teams and stakeholders benefit from incremental progress when iterative methods to certain tasks are used with on-going input from all parties involved.
12.	Projects and hazards may be appropriately predicted and managed by extensive and complicated planning.	Detailed forethought isn't necessary since projects and hazards are inherently unexpected owing to a variety of factors.
13.	Final testing is carried out after the end of this project.	Every time a feature is added, it is tested again and again.
14.	The documentation is comprehensive.	Only, when necessary, does documentation take place.

Traditional approach discouraged future modifications to the plan after it is in operation (Carew et al., 2017). As soon as a project's needs are outlined, they are broken down and rearranged into logical groupings. It's in the developers' best interest to fulfill these milestones since they're frequently linked to payment; change is seen as a potential threat. To ensure that the best value (to the client) is delivered within the limits of time and money, APM uses incremental and iterative development (Amorim et al., 2021).

Figure 2.2 illustrates the 'iron triangle' comparing the traditional approach to agile project management.

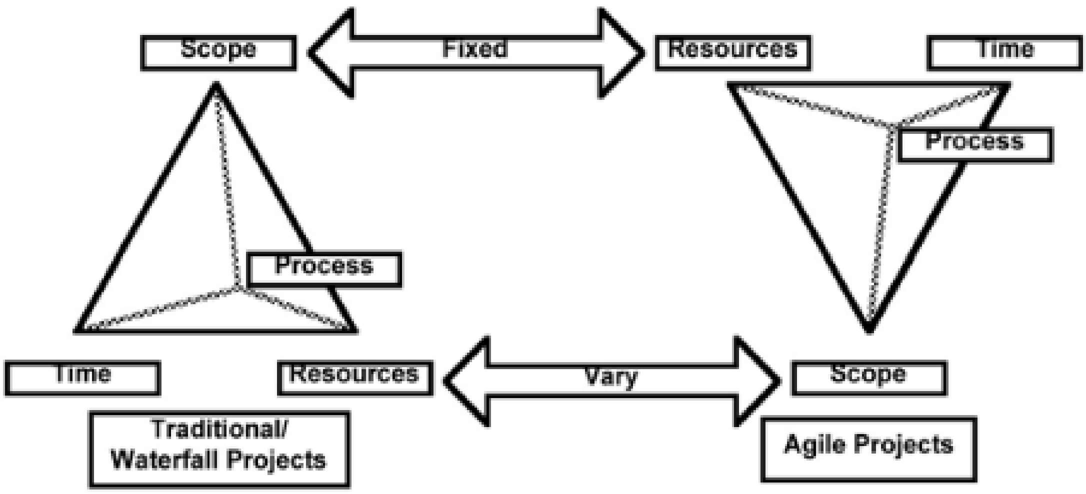

Figure 2. 2 Traditional vs Agile project management

(Source: Owen et al., 2006)

The concepts of agility and the Agile Manifesto play an essential role in APM's basic concepts. The importance of individuals and their ability to adapt to change in the face of uncertainty and complexity is emphasized strongly. Only what is necessary (e.g., processes, tools and procedures, documentation) is employed in an agile project management method that stresses an iterative and lean approach (Verma, 2022). An additional aspect of APM is an awareness of circumstances that need alternative approaches or methods. Fernandez et al. (2008, p.14) describe APM as “an approach based on a set of principles, whose goal is to render the process of project management simpler, more flexible and iterative in order to achieve better performance (cost, time, and quality), with less management effort and higher levels of innovation and added value for the customer.” This is consistent with Jim Highsmith's assertion that APM has had a significant influence during the last decade. Projects with high levels of ambiguity, a wide range of requirements, and short delivery timelines are ideal for agile methodologies. An important aspect of APM's approach to management is its emphasis on cooperation and goal and boundary setting. Finally, the classic iron triangle of scope, schedule, and cost is increasingly being replaced with an agile triangle of value, quality, and restrictions.

As far as quality and speed to market are concerned, studies show that agile project management techniques outperform other traditional methods (Manurung et al., 2021). However, there is a lack of research on the exact causes and processes of agile project management success. According to Inman et al. (2021), further study is needed to examine the relationship between agile projects and other organizational elements that might explain the performance disparities of agile methodologies in various situations. Many prior studies have shown a correlation between an agile approach's critical success criteria and the organization's structure, procedures, and other features (Bergmann et al., 2018; Albuquerque et al., 2020; Arefazar et al., 2022). When it comes to implementing agile approaches, data reveals that large organizations have a more difficult time. Research has focused on the obstacles and successful aspects of large-scale implementation of agile project management techniques. Organizational culture is another important fit aspect. Consider Manurung et al. (2021), who found that implementing agile concepts across diverse workplace cultures was more difficult because of the varying attitudes toward inclusion, the idea of collective responsibility, and the degree to which people were willing to communicate. The culture of the company was one of several aspects that contributed to the success of agile project management (Thorgren et al., 2019).

The competence and motivation of the project management team, together with the project's performance, are all aspects of project governance that organizations consider from an organizational standpoint (Joslin et al., 2015). In order to guarantee that projects are operationally efficient and strategically aligned with the organization, project governance systems specify processes and procedures, allocate roles and duties, and demand assurance from project management. The performance of a project may also be examined in this regard. Keeping costs, schedules, and quality under control is at the core of project management's tactical, short-term goals for a particular project. Organizational aspects are essential for long-term success in strategic, long-term initiatives like mega construction projects (Toor & Ogunlana, 2009).

There are a number of key differences between agile and traditional techniques when it comes to governance systems. As a contrast to traditional methods, which rely on large amounts of upfront preparation, agile methods encourage the participation of small teams in the process of iterative design modifications based on user feedback and testing (Mergel, 2016). The challenge of managing agile projects is to find a balance between empowering the project team and following traditional methods of communication and coordination so that even a single iteration of an agile project can be successfully completed while still being able to adequately oversee all other projects and initiatives (Kasauli et al., 2021; Mergel et al., 2021). In traditional models, management and control are centered on processes, whereas in agile models, the focus is on people and leadership. Individual specialization is not an option in an agile environment, which allows teams to be flexible and self-organize in terms of responsibilities. An alternative to the conventional, bureaucratic, and mechanical organizational forms that emphasize formalization is the organic (flexible, cooperative, and participatory) organizational structure of agile.

2.9 Literature of Mega Project Complexity

Construction projects are inherently complicated, extraordinary efforts have been undertaken to address the rising complexity of MCP (Yang et al., 2020). According to Larsen-Freeman (2013), the definition of complexity is based on systems modification, not linearity between variables, uncertainty, development, and radical eccentrics. While phrases like ‘The project is complex’ or ‘Project complexity is high’ are commonly used in both business and research, a universally accepted definition of project complexity remains elusive. In fact, the definition of complexity has been a contentious issue across a broad spectrum of academic fields. Despite various attempts at technical characterization within the physical, mathematical, computational, biological, and social sciences, a unified definition of system complexity is still lacking (Cicmil et al., 2017). The discourse on project complexity has only recently gained attention (Geraldi et al., 2011). One of the early academics to attempt characterizing project complexity was Baccarini (1996), who adapted the concept of integration and differentiation in organizations from Lawrence and Lorsch (1967). Since then, several researchers have endeavored to establish a single, all-encompassing definition of project complexity (Bosch-Rekveldt et al., 2011), but without conclusive results.

Despite the fact that complexity in engineering and construction (E&C) projects may have a substantial influence on project management, most people understand it intuitively because of the lack of clarity around the topic (Bosch-Rekveldt et al., 2011). It is commonly believed that the difficulty of managing and forecasting the results of a project is directly correlated with its complexity. Complexity is generally seen as proportional to the number of moving parts, procedures, stakeholders, systems, and technologies employed in the project. A more organised method of project ideation and planning is supposedly necessary for complicated initiatives (Gransberg et al., 2013). Various researches have proposed different ways to quantify project complexity (Ahn et al., 2017). One approach is to consider how it affects human cognition, specifically how much work decision-makers have to put in to understand a choice issue (Jia et al., 2023). As a result, a thorough explanation of project complexity is provided. Recognizing that a singular concept of complexity may fall short of explaining the complexity experienced by individuals in the field, it is appropriate to adopt a more inclusive approach for this investigation. Therefore, it is valuable to categorize the constituent elements of complexity in order to thoroughly assess it (Bakhshi et al., 2016; Ahn et al., 2017).

Since the late 1990s, practitioners of project management have begun using this approach (Curlee, & Gordon, 2010). Due to the growing complexities of today's project scopes and environments, a rising number of complicated projects are being initiated (Wood & Gidado, 2008; Açıkgöz et al., 2016; Cicmil et al., 2017). The complexity of a project may be compared to that of a system comprised of several components exhibiting emergent behavior (Bakhshi et al., 2016). Remington and Pollack (2007) present one of the most widely used frameworks for complicated projects. In this framework, the complexity of a project is divided into four categories: structural, technological, directional, and temporal.

Common examples of complex projects are megaprojects. Therefore, megaprojects may also be studied using the theory of complex project management. According to Bakhshi et al. (2016), megaprojects may be characterized by five factors: cost, complexity, risk, ideas, and visibility. Using this paradigm to analyses six completed megaprojects in the US, Japan, and Taiwan revealed that construction megaprojects often exhibit high levels of complexity, unpredictability, and enormous expense. Furthermore, Brockmann and Girmscheid (2007) distinguished three main aspects of megaproject complexity: task, social, and cultural. According to Bosch-Rekveldt et al. (2011), megaprojects are complicated for three reasons: technical, social, and implementation management. A plan that includes many projects that work closely together is sometimes called a megaproject (Galvin et al., 2021). A construction megaproject is used as a case study of a programme in the construction sector by Hu et al. (2015). Programs, as noted by Nyarirangwe, and Babatunde (2019), are a kind of common complicated project.

However, the increasing complexity that construction projects must contend with today is seen in the planning and execution of projects (Malla, 2023). No matter how you define it, most people agree that a project is a short-term undertaking with the goal of producing something new and original while adhering to strict deadlines and budgets that might lead to some degree of ambiguity about the final outcome. In order to better understand the variables involved in product, process, and business model innovation and to better deal with the aspects that cause complexity, dependency, ambiguity, and flexibility there is a need to identify the variables (Codini et al., 2023). Indeed, in today's dynamic, fast-paced, and competitive world, plans and projects' challenging features have a direct influence on their complexity (Bellini et al., 2023).

Managing complex projects with numerous interactions proves challenging, often hindering the establishment of trust. The current research landscape lacks substantial exploration on the moderator role between relational governance and project performance. Oh et al. (2019) suggested that project complexity positively influences the link between relationship teamwork and project success. Empirical findings by Wu et al. (2017) indicated that project complexity moderates the correlation between team communication and project success. In a similar vein, the present study posits project complexity as a moderator significantly impacting the relationship between trust and project performance (Ignatius et al., 2012; Qureshi et al., 2015). High project complexity in construction projects often entails extensive uncertainty and unforeseen challenges. Considering all unknown factors and rigorously restraining opportunistic behavior from both parties proves infeasible. Cannon et al. (2000) conducted an analysis using 396 data points from the American Purchasing Management Association, comparing governance model performance under varying degrees of uncertainty. Their empirical findings revealed that under high environmental uncertainty, contract governance proved inadequate. Consequently, they recommended reinforcing relational governance to mitigate opportunism.

Level of project complexity positively affects team cooperation quality and project success (De Toni et al., 2021). The level of project complexity has an effect on how well a team communicates and how successful the project is. Similarly, this study recommends that project complexity has a significant moderating role in the trust-performance relationship. Project complexity means that there is a large range of uncertainty and various unexpected challenges are predicted in the building process (Chattapadhyay et al., 2021). Müller (2017) defined MPG as the set of values, responsibilities, processes, and policies enabling projects to attain organizational objectives. It aims to facilitate implementation that serves the best interests of all stakeholders, both internal and external, as well as the corporation itself. Mega project governance arrangements including a client, an advisor, and a contractor were first described by Gurca et al. (2021) and highlighted the diverse forms of interactions amongst significant project stakeholders in their comprehensive study. According to (Locatelli et al., 2014; Ul Musawir et al., 2017), a project's organizational structure, shape of the project, the project's institutional framework, and the ability for self-regulation are all important characteristics of governance.

2.10 Literature of Project Management Office

A PMO is defined by the PMI (2007) as: “An organizational body or entity assigned various responsibilities related to the centralized and coordinated management of those projects under its domain. The responsibilities of the PMO can range from providing project management support functions, to actually being responsible for the direct management of a project”. The concept of a PMO, which supports the deployment of project management know-how, has become popular in many organizations (Rose, 2008). An organization's PMO is a professional entity that sets and maintains the standards for project management procedures inside the company. With the PMO, projects may be executed more consistently and efficiently. In the profession of project management, the PMO serves as a repository of established methods and guidelines (Jalal et al., 2015). Task environment is essential for identifying and defining the suitable tasks to be performed by PMOs and for describing the actions that ensure these tasks' goals are met. A PMO's organization’s first-tier senior management, who are often the owners of all of the company's project portfolios, is an important factor of its task environment. Essentially, the duties of PMOs may be inferred from the requirements of these important stakeholders and their need to assign management responsibilities.

In today's construction megaprojects, there are multiple design, technical, and construction requirements driven by stakeholder expectations, which in turn complicate project management (Bosch-Rekveldt et al., 2011). Interconnected subsystems, several stakeholders, and overlapping stages make up a complex project management environment. As a result, the complexity of project management grows when numerous projects of varying sizes and deadlines utilize the same pool of resources. Since there are several projects with varying deadlines that share the same resource pool, the complexity of project management grows (Bakhshi et al., 2016). It's particularly true for primary construction contracting firms, which often manage a large number of projects at once. Resources for subcontractors are provided by them, and they are in charge of overseeing and coordinating those resources.

Artto et al. (2011) claim that PMO might improve the efficiency of project management procedures and provide technical assistance to project teams. High-tech businesses have PMO capabilities in place, but the construction industry has yet to develop this capability. With the rising degree of complexity in construction contracting comes the need for a complete use of PMOs. The more complicated a project is, the more complex the services provided by PMOs (Szalay et al., 2017). Additionally, a follow-up study found that the number of divisions and branches (also known as ‘horizontal complexity’) inside an organization had an impact on the PMO characteristics of a construction firm. As a result, in order to fully grasp the idea of complex multi- project management, PMOs must take into account both project and organizational complexity. Widforss et al. (2015) questioned PMO directors in Swedish firms how they deal with the problems of managing several complicated projects. Pre-award (lobbying, staffing, and planning), post-award (support negotiations) and implementation phases were found to be supported by PMOs, according to their results. A further case study was undertaken by Ershadi et al. (2021b) to examine the role of PMOs in supporting cross-functional cooperation, and they concluded that PMOs may aid in identifying optimum solutions for complexity-related issues.

PMOs have been recognized in the literature for their role in enhancing project delivery and recommending appropriate solutions to problems. PMOs can help in six ways to deal with difficulties, such as: facilitated processes, improved decisions, enhanced alignment improved coordination, enhanced alignment, addressed uncertainties and integrated oversight. PM-related duties are made easier by the PMO's operations, which result in facilitated processes (Tshuma et al., 2018). Status/performance evaluation and feedback that organize and communicate project performance results or a uniform way for submitting and monitoring purchase requisition for materials or equipment may be used to assist this facilitation (Pellegrinelli et al., 2009). By providing timely information and gaining the support of the stakeholders, this outcome enhances the decision-making process and results in a better outcome. There are many factors to consider when making decisions about bidding tenders and outsourcing some of the work, liaising with original equipment manufacturers, selecting qualified suppliers/contractors, and other choices to which the project management office can contribute its expertise and best practices. At project and organizational levels, project sponsors and functional managers were pleased with the PMO's ability to improve collaboration among the many stakeholders (Pemsel et al., 2013). As a facilitator in attaining agreement on major milestones, the PMO uses communication tools to coordinate all stakeholders involved (Steyn et al., 2020).

There are convincing viewpoints on the design elements, procurement of equipment/material/resources, construction procedures, and handover that may be reconciled. Alignment with requirements, needs, culture, processes, and goals of the organization is essential to project management. Organizations with a PMO in charge of their project management environments may combine all of their stakeholders' perspectives into a single strategy that best satisfies the needs of all parties while still meeting the project's goals. Enhanced alignment can be defined as the ability of engineering, procurement, and construction teams to work together to guarantee that a project is completed in accordance with design requirements (Alsudiri et al., 2013; Aubry, 2015). The PMO uses a methodical approach to integrate the project's numerous components and match them with business goals (Pemsel et al., 2013). To addressed uncertainties experts also underlined that PMOs contribute value by resolving elevated issues since they may react to pertinent uncertainties by increasing awareness or presenting feasible solutions based on experience gained (Cleden, 2017; Zhong et al., 2018). Project teams benefit greatly by considering both the good and negative aspects of decision scenarios based on comparable occurrences in the past. Lastly, the term integrated oversight refers to a method of improving project supervision by monitoring both internal and external project partners in order to identify delays and take appropriate action (Ershadi et al., 2021c). It is important to identify problems early on, such as insufficient performance, in order to avoid substantial delays and delivery challenges. This entails an active intervention to improve the effectiveness of each team member in attaining the project's goals.

2.11 Conceptual Framework

The main theoretical underpinning for the current study is institutional theory, which adopts a positivist approach to investigate performance factors such as MPG, APM, MPC, and PMO in relation to the success of mega construction projects. Hanisch and Wald (2012) explained that “No project can be evaluated thoroughly without addressing its context: the congruence of a project to the external contingencies is a factor determining the efficacy”. Cohen et al. (2013) describe this layout as a positivist quantitative technique using nonexperimental correlational analysis like regression analysis. From the discussed existing literature, the current study makes several proposals. First, the study proposes that mega project governance: governance structure, governance mechanism and external environment influence mega construction project success through agile project management in the context of Pakistan. Furthermore, mega project complexity: information complexity, task complexity, technological complexity, organizational complexity, environmental complexity, and goal complexity act as a moderator on the relationship between MPG and MCPS, also MPG and APM.

Lastly, the PMO was used as a moderated moderator on MPC and MCPS, MPC and APM. Figure 2.3 illustrates these relationships.

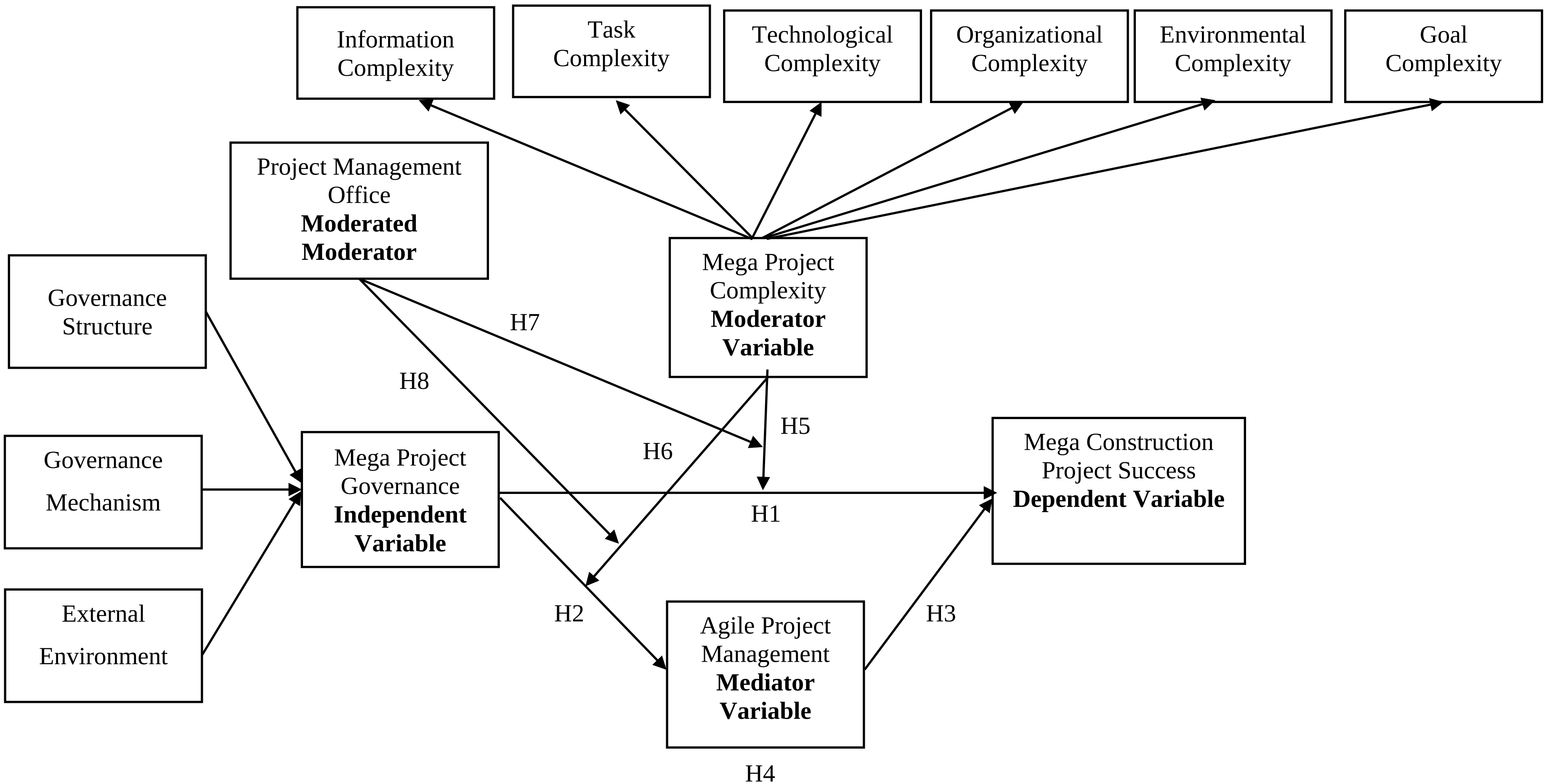

Figure 2. 3 Conceptual Framework

2.12 Research Hypotheses

2.12.1 Mega project governance on mega construction project success

Khan et al. (2019) governance is derived from governing, control, and government. Effective mega project governance is the organizational framework that links project objectives, directs them, and monitors their performance (Brunet, 2021). Project-based organizations place a premium on project governance (ul Musawir et al., 2020). It facilitates organizational processes, project administration, and models of decision-making. These frameworks facilitate the success of initiatives, programs, and portfolios. Effective project management requires project governance. Governance decreases project expenses (Wang et al., 2019). It can be accomplished by considering the level of administration and control along the three dimensions, the frequency with which project costs return, the uncertainty the project is subjected to, and the extent to which the project's precise assets support the project (Derakhshan et al., 2019). The governance of a project incorporates the project's proprietor, sponsor, management, and stakeholders. Project governance establishes project objectives, criteria for attaining them, and performance monitoring (Hedhili & Boudabbous, 2020). Project governance aligns project objectives with the sponsor's and team's strategies for achieving them.

Mathar et al. (2020) define the success of a construction project as a project outcome that meets expectations and the availability of resources when required. If the project satisfies technical requirements, objectives, and a high level of customer satisfaction (Welfolo, 2019). A successful project would exceed expectations. Success is determined by cost, quality, safety, schedule, and stakeholder satisfaction (Huynh et al., 2020). The type, size, complexity, stakeholders, and experience of the project's proprietors determine its success. Project success requires variables and criteria (Bilal Khan, 2022). The success of a project is determined by cost, quality, and schedule (Kamal et al., 2019). Effective project governance can increase project success if key governance roles are assigned in accordance with organizational strategies, such as the project owner establishing the project's mindset to achieve organizational benefit and embedding this mindset into the organization’s project management system (Khan et al., 2021). Effective project governance has a positive impact on project success in all of its dimensions, including investment success, ownership success, and management success (Zaman et al., 2022).

Müller et al. (2015) used this theoretical lens to explore project governance in order to address the social structures through which multilevel governance is carried out. Mega construction projects have a broad scope; thus, this technique may help us to better understand their complexities (He et al. 2015). The three factors of institutional theory – regulatory, normative, and cultural–cognitive – are used in accordance with Henisz et al. (2012) in order to investigate how mega project governance supported the success of construction project success. Among the most often used theories in project governance are institutional theory. There has been a tremendous amount of progress in the theory-to-practice integration of research in governance. Organizational governance study has recently included project management as an additional focus area (Too et al., 2014). But despite the obvious benefits, it's often believed that mega construction projects rarely succeed. Only 8 out of every 1,000 mega construction projects are completed successfully, according to a study, which is far lower than the industry standard of 15 out of 1,000. (25 percent) (Ma & Fu, 2020). Countries and regions' expectations for the construction of megaprojects are seriously affected by this low success rate (Flyvbjerg, 2014). General project failure is seen to be a result of an organizational breakdown in governance. As a result of inadequate project governance, several significant projects have failed. Shareholders' returns have continuously risen as a result of improving project governance.

In light of the frequent occurrences of project failures, Cobb (1995) posed a compelling question: “We know why projects fail; we know how to prevent their failure - so why do they still fail?” This query represents a genuine conundrum within the realm of scientific investigation. It is often the case that project failure is not primarily due to execution flaws but rather stems from deficiencies in project theory. The future of project management is intricately tied to the quality of its theoretical underpinnings, and an increasing number of experts concur that the field requires a more robust and comprehensive theoretical framework to replace the existing one (Koskela and Howell, 2002). As a result, the focus of research has shifted from viewing ‘project management’ as a collection of techniques to considering the ‘management of projects’ as an overarching philosophy (Morris, 1997). Moreover, the understanding of projects has evolved from a purely technical perspective, where they were perceived as rational objects, to a more nuanced perspective, recognizing them as rational actors (Ahern et al., 2014). Biesenthal and Wilden (2014) compiled data indicating a substantial increase in the number of journal articles dedicated to the topic of project governance in 2005, and this interest has remained consistently high since then.

According to the Project Management Institute (PMI), project governance is “an oversight function that is aligned with the organization's governance model and that encompasses the project lifecycle and provides a consistent method of controlling the project and ensuring its success by defining and documenting and communicating reliable, repeatable project practices" (Brunet et al., 2018). According to Laine et al. (2020), project governance helps with administrative and managerial tasks in construction projects and makes stakeholder management more efficient. Project governance offers a framework for managing projects in a structured way, ensuring that all involved parties are kept informed and consulted at every stage of the project's life cycle (Too et al., 2014).

In contrast to the lack of project achievement, Mir et al. (2014) presented project success. The project's success has been measured using traditional methods of project management and studies based on scope, budget, and schedule. Wang et al. (2021) discussed the governance of projects that give a structure to carry out projects, increasing the likelihood of success in the project. Marshall et al. (2020) noted that the project's key stakeholders have been concerned about which financial models the project may use to create viable economic returns or long-term benefits for local development. The project governance can combine three fundamental elements, i.e., control, flexibility, and trust, to eliminate organizational and environmental problems.

Contractors often do not adhere to engineering specifications due to a lack of sufficient oversight, as noted by He et al. (2021), Xiaolong et al. (2021), and Luo et al. (2023). This non-compliance results in cost overruns, project delays, the misallocation of public funds, and missed benefits, all of which contribute to the sluggish pace of development. It has also come to light that the overseeing departments have not been adequately supervising these infrastructure development projects, which has had a detrimental impact on the quality and speed of the work, as pointed out by Brunet et al. (2018) and Akimova (2020). To address these concerns, the implementation of a suitable project governance framework is imperative, as suggested by Waris et al. (2017) and Khan et al. (2018).The scenario has raised questions about the capacity of the executing agencies to manage, plan, execute and monitor development projects. The case mentioned above thus illustrates the requirement for project governance to manage the stakeholder network (Mok et al., 2015).

In addition to enhancing competitiveness through advanced management techniques, establishing positive relationships with relevant authorities is essential to facilitate construction projects and streamline approval procedures, as emphasized by Abednego et al. (2006). Effective mega project governance and the successful completion of projects have become substantial challenges for executing agencies. In cases involving high risks, complexities, and stringent performance requirements, the case study delves into the organization and management of mega construction projects, as examined by Othman et al. (2013). Owolabi et al. (2020) observed that Public Private Partnerships (PPPs) infrastructure development projects exhibit a high degree of complexity and unpredictability throughout their project life cycle. These complexities and instabilities manifest in the form of various political and legal uncertainties regarding mega project governance. Shah (2021) likewise contends that issues related to mega project governance are accountable for construction delays, prolonged project completion times, and significant cost impacts.

Managing stakeholder relationships and ensuring effective communication and collaboration becomes intricate due to the lack of project governance (Susman et al., 2021; Xue et al., 2022). Weak project governance presents hurdles to complete mega construction projects successfully (Damayanti et al., 2021; Elia et al., 2021). For instance, Xue et al. (2022) conducted a case study on the Hong Kong-Zhuhai-Macao Bridge, the world's longest sea-crossing megaproject spanning 55 kilometers, connecting major cities in Southern China's Greater Bay Area. Valued at $18.8 billion, the project encountered cost overruns and scheduling delays due to its dynamic and complex environment. Engaging various stakeholders, including government entities, construction companies, local communities, environmental organizations, and industry groups, the project utilized a design-build procurement approach, involving contractors, designers, subcontractors, and laborers responsible for design and construction tasks. These diverse stakeholders encountered challenges in risk management related to project issues, contributing to complexities among stakeholders. The project's 16-year duration (2003-2018) facilitated dynamic interactions among stakeholder groups, resulting in conflicts over cost, schedule, safety, environmental concerns, and more. Consequently, the Hong Kong-Zhuhai-Macao Bridge serves as an exemplar of a project operating within a dynamic and complex environment, offering an opportunity to validate an evolutionary model proposed for assessing stakeholder performance in risk management for megaprojects (Xue et al., 2022).

There have been several attempts by academics to create various types of project governance frameworks. Inter-firm projects, such as megaprojects, have prompted some study of project governance systems (von Danwitz, 2018). From this current perspective, the project is often a megaproject whose temporary organization involves a large number of separate, legally distinct businesses, and the challenge of project governance is to have everyone on the same page and working toward the same purpose

(Evans et al., 2023). Since the focus of the current study is on the mega project governance structure on MCPS, the literature on megaproject governance is not discussed in depth. Other studies investigate project governance at the intrafirm level (Farndale et al., 2010; Joslin et al., 2016). At this level, several frameworks for mega project governance are produced from a variety of perspectives and theories. Some research focuses on building mega project governance mechanisms to manage the interaction between governors and project managers (Müller et al., 2016), while others see project governance as a multi-level phenomena and emphasis the creation of a multi-level mega project governance framework (Biesenthal et al., 2014). Different project governance techniques exist underneath the framework level to influence the behavior of project managers. Relational and contractual modules of governance were investigated by Lu et al. (2015), who found a positive correlation between these two factors and the outcome of public projects. Therefore, the first hypothesis is established based on the above arguments.

H1: Mega project governance is positively influence with mega construction project success.

2.12.2 Mega project governance and agile project management

Mega project governance and agile project management are two distinct approaches to managing projects, each with its own set of principles, practices, and objectives (ul Musawir et al., 2020). Mega projects are typically large-scale, high-budget, and complex projects with long timeframes, often involving significant risks and numerous stakeholders (Zhao, 2019). Mega project governance is the process of establishing and maintaining control over such projects, ensuring that they are delivered on time, on budget, and with the desired outcomes (Khan et al., 2019; Musawir, 2023). Agile project management, on the other hand, is a flexible and iterative approach to project management, focused on delivering value to customers through adaptive planning, early delivery, and continuous improvement (Olszewski, 2023).

Institutional theory is a social science framework that emphasizes the role of formal and informal institutions in shaping the behaviour of organizations and individuals (Biesenthal et al., 2018). Institutions are the rules, norms, and practices that guide the actions of organizations and individuals, providing a stable structure for their interactions (Hu et al., 2015). In the context of construction projects, institutional theory can help us understand how mega project governance can influence agile project management. Mega project governance often involves compliance with various regulations, policies, and standards set forth by government agencies, industry bodies, or international organizations (Derakhshan et al., 2019). These formal institutions can shape the way agile project management is practiced in construction projects. For example, strict regulations may limit the flexibility and adaptability of agile methodologies, requiring project teams to adopt more structured and formalized processes to ensure compliance (Morris, 2013).

The study focuses on the main three categories of mega project governance (governance structure, governance mechanisms and external environment) (Li et al., 2019). Governance structure typically involves a hierarchical structure with well-defined roles and responsibilities for various stakeholders (Ebers & Oerlemans, 2016). This structure can impact the adoption of agile project management, which thrives on autonomy, collaboration, and self-organization. The hierarchical governance structure may limit the agility of project teams, making it challenging to adapt quickly to changing requirements and priorities (Zhai et al., 2020). Governance mechanisms often employ mechanisms such as standard operating procedures, reporting requirements, and performance metrics to ensure control over projects (Wang et al., 2019). These formal mechanisms can influence agile project management by requiring more structured processes and documentation, potentially limiting the flexibility of agile methodologies (Zhai et al., 2020). Additionally, the focus on long-term planning and fixed requirements in mega project governance may conflict with the iterative and incremental nature of agile project management. The external environment of mega construction projects consists of various factors, such as regulations, industry norms, market conditions, and stakeholder expectations (Hussain et al., 2021). These factors shape the project governance and influence agile project management as follows: a. Regulations: Compliance with regulations, policies, and standards set by government agencies or industry bodies can impact the implementation of agile methodologies by requiring more formalized processes, which may limit their flexibility and adaptability (Lappi et al., 2018). b. Industry norms and practices: The construction industry has established norms and practices, often rooted in traditional project management approaches. Conforming to these norms may hinder the adoption of agile methodologies or result in a hybrid approach that combines traditional and agile elements (Lappi & Aaltonen, 2017). c. Market conditions: Market conditions, such as competition, economic factors, and technological advancements, can affect the project's governance and influence the implementation of agile project management (Müller et al., 2016). For instance, a competitive market environment may encourage organizations to adopt agile methodologies to enhance responsiveness and innovation. d. Stakeholder expectations:

The expectations of various stakeholders involved in mega projects, including clients, regulators, and the public, can impact the implementation of agile project management (Uwadi et al., 2022). Pressure to meet stakeholder expectations may lead to more structured governance and less flexibility in applying agile principles (Lappi & Aaltonen, 2017).

Institutional logic may be characterized as a collection of material practices and symbolic constructs that serve as its organizing principles and are accessible for leaders and employees to develop (Thornton et al., 2012; Fuenfschilling & Truffer, 2014). It is the structuring of the roles of active actors by norms, values, and beliefs. It is hypothesized that this new mental model of the organization (Song et al., 2022., which emerged as a result of the use of this governance in organizations planning and action, will impact the organizational capacity to implement, assimilate, and realize benefits from new APM practices. Therefore, institutional theory can help elucidate how the structure, mechanisms, and external environment of mega project governance impact the implementation of agile project management in construction projects (Fuenfschilling & Truffer, 2014; Müller et al., 2016; Musawir, 2023). Understanding these institutional factors can help practitioners navigate the challenges and seize opportunities for applying agile methodologies in complex project settings. Therefore, based on the above discussions, the following hypothesis was formulated:

H2: Mega project governance is positively influence with agile project management.

2.12.3 Agile project management and mega construction project success

Kumara (2017), Lappi et al. (2018), Albuquerque et al. (2020), and Zhai et al. (2020) all point to the need for more research on the intersection of public sector policies and governance with project management, as well as on the organizational preconditions, enablers, processes, and project governance arrangements that affect the application of agile project management approaches in mega construction projects. Public sector mega construction projects, such as motorways, dams, railways initiatives, also have an influence on projects' governance practices that have not been well studied. The conflicts between conventional and flexible agile techniques, especially in public sector projects known for their stability and inflexibility, have been observed to lead to conflicts (Lappi et al., 2017). Based on an investigation of three Finnish public sector organizations, current research tries to better comprehend project governance in terms of the public sector construction project. Additionally, Fernandez and Fernandez (2008) intend to provide light on the various conflicts that impact agile project management.

Haider and Kayani (2020) indicate that the advantages of deploying agile methods include a quick and efficient and more flexible reaction to rapidly changing customer requirements, a better integration of the voice of the customer, enhanced team communication, higher development productivity, and a shorter time to market. Some case studies (Bjørnson et al., 2018; Senabre Hidalgo, 2018) and descriptive quantitative research have also indicated that using agile methods results in better team communication and coordination. Improved internal and external communication and coordination is a success for businesses of all kinds, not just those in the information technology sector (Ribeiro & Fernandes, 2010). Though often effective, agile approaches are not guaranteed to provide positive results in every situation. Some businesses see huge gains in productivity, speed to market, and customer and developer satisfaction after adopting agile practices like Scrum, Kanban, and lean development, while others fail to see any significant changes and complete project successfully. Agile approaches have been both criticized and praised, and studies have shown that a company's ability to adapt to change may be a major influence in its success or failure (Bjørnson et al., 2018).

The results of a case study conducted by Zuzek et al. (2020) suggest that APM practices have a positive effect on project success in terms of efficiency and stakeholder satisfaction and can therefore contribute to the creation of a more economically, socially, and environmentally sustainable workplace. Quality, customer happiness, and output all benefit with the use of at least one agile technique, with no appreciable increase in price (Abbas et al., 2010). To adapt to a business climate influenced by rapid technological change, project teams in many fields outside software development are adopting agile methodologies. The application of Building Information Modeling-based Agile in mega construction projects can lead to substantial improvements in design-operation efficiency. This is particularly evident in areas such as collaborative design, project coordination, reduced project duration, cost savings, minimized claims and disputes, and successful project completion (Sacks et al., 2010). The use of Agile methods enhances the success of mega construction projects by yielding several favorable outcomes, including increased productivity, improved quality, and heightened client and business satisfaction (Lalmi et al., 2022). Agile project management fosters an environment of open communication and cooperation among team members, stakeholders, and clients. This can lead to better decision-making and problem-solving, which is essential for the success of mega construction projects.

Mega construction projects often face uncertainties, changes in scope, and unforeseen challenges. Agile project management allows teams to adapt and respond to these changes quickly, reducing the risk of project delays and cost overruns (Ozorhon et al., 2022). Agile methodologies emphasize learning from mistakes and continuously improving processes and performance. This can help mega construction projects to identify and address issues early on, leading to project success. Agile project management can help teams to break down the project into smaller, manageable tasks or sprints (Arefazar et al., 2022). This can result in support to the complete project successfully on time and budget, as teams can work concurrently and make rapid progress. By engaging stakeholders and clients throughout the project lifecycle, agile project management can help to ensure that their needs and expectations are met. This can lead to higher levels of satisfaction and ultimately contribute to the project's success. However, it is important to note that agile project management may not be suitable for all mega construction projects, as it depends on various factors such as the project's complexity, team expertise, and the organization's culture (Ozorhon et al., 2022). Furthermore, successful implementation of agile methodologies in mega construction projects requires careful planning, training, and a shift in mindset among project stakeholders. By considering the institutional context in which these projects are embedded, the current study can better understand how these factors can impact the adoption and implementation of agile methodologies and their relationship with project success. Based on the above literature, the following hypothesis is proposed.

H3: Agile project management is positively influence with mega construction project success.

2.12.4 Agile project management as a mediator

In the context of mega construction projects, agile project management can positively mediate the relationship between mega project governance and project success by helping organizations adapt to the institutional pressures and expectations of their environments. Agile practices emphasize flexibility, collaboration, and stakeholder engagement, enabling project governance to be more responsive to the demands and expectations of various stakeholders (Ribeiro & Fernandes, 2010). By adopting agile methodologies, project governance can enhance their legitimacy, which in turn can contribute to the overall success of their mega construction projects. Mega project governance and agile project management are two approaches to project management that have different strengths and weaknesses (Lappi et al., 2018). Mega project governance is typically associated with large, complex projects that require a high degree of oversight and control (Zhai et al., 2020). Mega project governance is often used in construction projects, such as highways, airports, and railways, where the cost and risk of failure are high (Ng & Loosemore, 2007; Davies, et al., 2019).

Agile project management, on the other hand, is associated with smaller, more flexible projects that require a high degree of collaboration and adaptation (Albuquerque et al., 2020). Agile project management is often used in software development and other areas where requirements and priorities may change rapidly. Despite their differences, mega project governance and agile project management can be complementary approaches to project management. Mega project governance provides the structure and oversight necessary to manage large, complex projects (Abednego & Ogunlana, 2006), while agile project management provides the flexibility and responsiveness necessary to adapt to changing circumstances (Albuquerque et al., 2020). Mega project governance and agile project management can also be used together in a hybrid approach to project management, where the strengths of both approaches are leveraged to achieve project success (Gemünden, 2016).

However, scholars have also listed the obstacles and problems that might prevent project governance from successfully using agile methods (Serrador & Pinto, 2015; Almeida, 2020; Haider & Kayani, 2020). Furthermore, what difficulties arise when trying to use agile methodology at a mega construction project, beyond the initial scope of small and individual teams (Serrador & Pinto, 2015)? There is a lack of governance and management participation, and there is also a widespread misunderstanding of what agility requires among project management team (Haider & Kayani, 2020). Adopters often see agile methods as a collection of practices and tools, and not as a management philosophy that must be adapted to each organization's particular requirements and circumstances (Chan & Thong, 2009; Cobb, 2023). Agile project management supports the employees those working in mega construction projects by fostering a shift in mindset and the development of a culture that embraces flexibility, collaboration, and continuous improvement (Malla, 2023). This cultural change can be facilitated through training, effective project governance, and the sharing of successful agile implementation experiences among construction project employees. This highlights the need to learn how to adapt agile approaches to address the needs of a variety of mega projects. Project governance incompatibility may be avoided with this new knowledge, which is particularly useful when considering the importance of communication and coordination in light of the necessity to change traditional hierarchical and decision-making structures. Therefore, considering the above discussions, the following hypothesis has been formulated:

H4: Agile project management positively mediates the relationship between mega project governance and mega construction project success.

2.12.5 Mega project complexity as a moderator between mega project governance and mega construction project success

When it comes to managing construction projects, the concept of project complexity is a critical one that is always growing. Baccarini (1996) claims that “complex projects demand an exceptional level of management, and that the application of conventional systems developed for ordinary projects has been found to be inappropriate for complex projects”. One of the most important aspects of project management is how it deals with the problem of complexity. Constructions of airports, bridges, dams are just a few examples of mega projects that typically involve a large number of interrelated tasks. Therefore, project complexity may serve as a key moderator on the relationship between project governance and project success (He et al., 2015; Luo et al., 2017; Ma et al., 2020; Qazi, 2020). The complexity of a project may have a significant impact on its success (Ma et al., 2020). Many definitions of project complexity have been proposed based on various aspects of complexity, including information complexity (Naveed et al., 2021), task complexity (Park et al., 2008), technological complexity (Luo et al., 2017), organizational complexity (Qureshi et al., 2015), environmental complexity (Gao et al., 2018), and goal complexity (Ashmos et al., 2000). Project complexity has been thoroughly studied in project management literature.

Projects are difficult in many ways, and in order to tackle complexity and complete projects, several theoretical frameworks and practical methodologies have been developed. Howick et al. (2020) state that identifying what is meant by "complex project" is the first stage in developing solutions to handle such endeavours. The literature on project complexity is scarce, but a bibliometric review by De Rezende et al. (2018) found three stages of growth in the topic. Organisational dynamics and structure, large-scale projects, systems thinking, institutional theory, and scheduling and allocation of resources were the main focus of the first wave, which occurred prior to 1985. The second wave, which spanned the years 1990–2004, had an extensive number of related publications dealing with topics like as scheduling and resource allocation, moving on to more complicated topics like system dynamics, uncertainties, and ambiguity in projects. This third and most recent wave began in 2005 and addresses issues related to complicated engineering projects, knowledge integration, scheduling many projects at once, limited resources, and other similar issues.

Literature generally approaches project complexity through four key viewpoints: dimensions, capabilities, performance, and concerns. From the dimensions perspective, complex projects are analysed across various dimensions, including structural, uncertainty, novelty, dynamics, pace, social, political, and regulatory complexity (Qiu et al., 2019). Although a unanimous definition of project complexity is absent, it is commonly perceived as a project condition characterized by numerous interconnected elements interacting in a nonlinear, emergent, uncertain, and dynamic manner. The capabilities perspective emphasizes that managing complex projects necessitates developing capabilities within individuals, organizations, and supply chains (Thomé et al., 2016). This involves adopting strategies for integration, learning, and selecting optimal solutions. The performance viewpoint focuses on the continual pursuit of success in complex projects, deriving from both project complexity itself and the applied capabilities. Finally, the concerns perspective highlights critical issues linked to project complexity, including addressing scheduling, cost, resource allocation, and intricate decision-making problems. Overall, the evolution of the project complexity field has transitioned from scattered seminal works to a more centralized discourse aimed at characterizing and categorizing complex projects. The goal is to identify models and frameworks that can aid managers in adapting to and effectively managing their projects (Rezende et al., 2018).

The difficulty and originality of the various technologies needed during construction projects, as well as the organization and interdependence of mega construction projects, are all examples of technological complexity. Mega construction projects need multiple processes and are challenging to perform because of their size. Contractors' construction and management skills are put to the test by the intricate interrelationships and interdependencies among the different construction processes (Jarkas, 2017). Many modern technologies, such as new and advanced construction technology and building materials, are now extensively used in mega construction projects due to the advancement of science and technology. When working on mega construction projects, it is necessary to continually improve a wide range of specialized construction and operating methods and technologies (Pariès, 2017). Construction technologies and operational processes are typical specialized assets according to institutional theory, and acquiring these assets generally necessitates unique procedures such as collaboratively drafted procurement contracts. Asymmetry of information creates an incentive for providers to take advantage of the high specificity of these assets. High transaction costs and challenges in the delivery and operation of mega construction projects are the result of opportunistic behavior and efforts to facilitate transactions.

The technological complexity of a project is measured by the level of difficulty and originality of the technologies necessary for its execution, as well as the order and interdependence of construction processes (Brem et al., 2021). Because of their large size, mega construction projects have a complicated and time-consuming implementation procedure (Jussila et al., 2016). Contractors' construction and management skills are pressed to their limits by the extraordinary complexity of the interdependence and relationship between the various phases of construction (Boonstra & Reezigt, 2023). To improve performance, it is essential to determine the influence of complexity on success of the project and to investigate the complex connections between complexity and performance across the project life cycle (Luo et al., 2017). According to the Thomé et al. (2016), complexity may have both positive and negative influence on the project success. The relationship between project complexity and success has been studied extensively, but these studies have ignored the long-term criteria, such as organizational and stakeholders' benefits, in order to concentrate on traditional performance criteria such as time, cost, and quality (Ma & Fu, 2020; Mata et al., 2023). The direct relationship between complexity and success has been largely overlooked in research that has integrated a comprehensive analysis of success criteria (Ma & Fu, 2020; Boonstra & Reezigt, 2023).

An organization's complexity may be measured by comparing its various components (Eisenhardt et al., 2017). For instances, organizational diversity may be assessed by the number of professional skills available to employees, as well as their degree of education and experience (Stacey, 1996). Vertical and horizontal differentiations in an organization’s structure are two ways to break down structural differences (Schneider et al., 2017). Two instances of horizontal differentiation are organizational units and task structure. It is divided into many departments, each of which performs a certain duty (routine or specialized). Complexity is created by interdependencies between the project's organizational components; diversity and unpredictability are often used to describe the complexity of goals. Goal complexity is generally seen as a sort of structural complexity since practically all projects have several objectives (Ma et al., 2020). Mega construction projects, in particular, can have a high degree of goal complexity. As a result, these initiatives have a substantial impact on society, the environment, and even the national economy (Luo et al., 2017). Mega construction projects focus on both economic and social objectives. The greater the number of objectives, the more likely they are to conflict with each other. Mega construction projects might collapse if there is a lack of organizational coordination. A megaproject's objectives may be unclear from the beginning of development because of the complexities of technology and function, which poses a significant concealed risk to the successful completion of projects (Löfgren, 2020).

Geographical, climatic, and other natural, political, economic, and regulatory elements, as well as other social and physical environmental features, all contribute to what is known as environmental complexity (Godfrey-Smith, 1998). Experts in the field of project complexity studies have come to a consensus: external influences are very important. According to Bosch-Rekveldt et al. (2011), one of the main components of environmental complexity is the complexity of stakeholders. Design, construction, and decision-making are all influenced by the natural environment while a project is being implemented (Hartono et al., 2019). Mega construction projects are heavily influenced by the natural environment because of their size and length of development. As a result, constructing megaprojects needs a significant investment of time and money, as well as a high degree of public attention or political interest. Consequently, projects are greatly impacted by the local political and economic climate, as well as the multiple players that make up that ecosystem (Child, 1972).

Furthermore, some researchers use project complexity as a moderating factor when analyzing the interactions between two other variables (Ignatius et al., 2012; Açıkgöz et al., 2016). The moderating influence of project complexity on the link between the leadership competency of project managers and the success of their projects was studied by Müller et al. (2011). McComb et al. (2007) used data from 60 cross-functional project teams to discover that the flexibility–performance link is moderated by the two dimensions of project complexity. Experiments were done by Kennedy et al. (2011) and Açıkgöz et al. (2016), to evaluate how team communication and performance are affected by project complexity. Dossick et al. (2010) found that the difficulty of IT projects is closely connected to the complexity of the projects themselves. However, IT project success is adversely correlated with the complexity of the project (Harkema, 2003). In the end, several researchers looked at the link between project complexity and project performance, but research on project success was sparse. According to research, project complexity is detrimental to its success (Ma et al., 2020). It's widely accepted that more complex projects are less successful. Because of this, the classic golden triangle should not be the only success indicator considered when defining the scope of a successful project.

Qiu et al. (2019) and Brunet et al. (2018) use institutional theory to explain the significance of institutional logic and the sources of institutional complexity, which frequently result in unfavorable project outcomes. They also employ this theoretical framework to evaluate project and governance complexity. It's worth noting, however, that although complexity is a crucial element in project governance, it may not encompass the fundamental underlying factors. In order to learn more about the current state and future directions of research into project complexity, Luo et al. (2017) performed a comprehensive literature review covering the years 1996-2015. The results show that most studies on construction project complexity concentrate on four main topics: the variables that add to complexity, the effects of complexity, the ways in which complexity is measured, and the aspects that should be taken into consideration while managing mega projects. Numerous studies have examined how various types of project complexity affect project success. The current research findings on the influence of complexity on project success from six key dimensions, i.e., information complexity, task complexity, technological complexity, organizational complexity, environmental complexity and goal complexity, based on the research framework of project complexity constructed by He et al. (2015). Thus, the current investigation has proposed the following hypothesis:

H5: Mega project complexity negatively moderates the relationship between mega project governance and mega construction project success.

2.12.6 Mega project complexity negatively moderator between mega project governance and agile project management

Accordingly, the literature discusses the challenge of implementing agile approaches when project size increases (Dybå et al., 2014). Issues with coordination and governance have arisen because of the mega project complexity. As the mega project complexity expands, it becomes more vulnerable to discord and to taking actions that contradict the founder's objective. Similarly, mega project complexity increases the number of contacts across different areas of the same company where technical requirements and subsequently the nature of the work vary and where agile methodologies must be adapted to meet these specific needs (Sohi et al., 2016). Therefore, as the number and complexity of interdependencies increase, the mega project design required to cope should have the right level of complexity too (Malla, 2023). The six-dimensional framework of project governance in agile projects was reported by Lappi et al. (2018). A stakeholder-based project governance model was created by Derakhshan et al. (2019). While numerous studies have been conducted (Zwikael et al., 2015; ul Musawir et al., 2020), there is still a lack of consensus on how to define the idea of project complexity and the topics of project complexity as moderator on the relationship between project governance and agile project management are still scattered.

Mega project governance may struggle to provide the necessary oversight and control in the face of high levels of project complexity. Complexity plays a crucial role in decision-making processes, as it can impact various aspects of a project, such as the cost-benefit analysis, demand, production expenses, duration, and financial (Akimova, 2020). Although every project necessitates this analysis, it is particularly significant for megaprojects due to their heightened complexity. Chen et al. (2020) literature review reveals that numerous projects continue to fail; project intricacy increases over time; and there are doubts regarding the efficacy of prevailing industry risk management practices in addressing uncertainty and risk, particularly within complex project settings. Integrating aspects of institutional theory with what Fowler and Highsmith (2001) call "adaptive teams," working together towards a shared objective, is what APM is all about. The idea is that traditional project teams that stick to old ways of doing things won't be able to meet real requirements at delivery. Since agile APM places a greater focus on deliverables, it is believed that its output would better align with requirements than conventional APM. This theory encompasses a number of related concepts, including as improvisation and experimentation, with the underlying premise that reducing or eliminating structure might lead to cost and time savings. Within a regulated setting, such as a project or a programme of interconnected projects, complexity may lead to intricate systems of rules and processes; however, APM suggests that this is neither necessary nor desirable. Agile project management may struggle to adapt to changing circumstances and maintain collaboration in the face of complex stakeholder relationships. To address the challenges posed by mega project complexity, project managers can adopt a range of strategies (Van Marrewijk et al., 2008).

Nyarirangwe and Babatunde (2019) indicated state megaproject complexity often incurs significant cost overruns and prolonged timetable delays. Construction projects are often seen as high complexity, complicated projects due to the presence of both local and global hazards (Kardes et al., 2013). Complexity creates ambiguity regarding the influence of risks on project success and restricts its predictability. Sanchez et al. (2016) propose that effective project governance may be impossible to implement without addressing complexity. In the project management literature, it is widely acknowledged that there is a negative correlation between project complexity and project success (Luo et al. 2017; Luo et al. 2020). Project governance has always had to contend with the challenge of dealing with a project complexity (Laine et al., 2020), the design and execution of (local) government and public sector construction projects. To approach complexity systemically rather than mechanically is a genuine paradigm-shifting problem for public projects, especially in the creation of project governance to answer modern requirements and restrictions (Hass et al., 2008). Complex projects need a high level of project management and a methodology that can handle their complexity, such as an APM. Project complexity is mostly driven by four dimensions: project scale, project unpredictability, team dynamics, and the technicalities of achieving the desired result. According to the complexity perspective, rather than relying on a mechanical approach to management, new techniques of observation and study are needed to investigate APM for emerging conditions. It is necessary to let go of modernist ideals such as control, predictability, and assurance.

Bosch-Rekveldt et al. (2011) noted that when dealing with complexity, managers tend to be flexible and deceptive in their methods, adapting according to the situation, for example by using planned solutions or exploring to cope with the emerging complexities. Individuals and groups' social synergy is exhibited through APM change adaptive behavior when dealing with project complexity. For complex and mega projects, it's difficult to evaluate what will happen, thus instead of making predictions and trying to prevent the changes, the project should embrace them. However, agile in construction project delivery focuses on lowering the negative consequences of project complexity, making projects more predictable, limiting buffers, reducing uncertainties, increasing collaborative planning, developing dependable work plans (Ahn et al., 2017; Maylor et al., 2017). Numerous project management solutions have been presented in an effort to reduce the negative impact of project complexity (Dybå et al., 2014). APM is a useful strategy for dealing with project complexity. It is the goal of agile approaches to increase project success by allowing for more adaptability and response to changing situations (Kaim et al., 2019). Therefore, considering the above discussions, the following hypothesis has been formulated:

H6: Mega project complexity negatively moderates the relationship between mega project governance and agile project management.

2.12.7 Project management office as moderated moderator MPC, MPG and MCPS

An intriguing approach to improving efficiency in a multi-project context is the establishment of a PMO, one of many such ideas that have been offered. The project management office concept was first presented in the mid-1990s (Crawford, 2006), with the primary goal of consolidating all company-wide activity pertaining to project management into a centralized location. Although researchers have more than a decade of experience with PMOs, numerous variations exist, and despite several articles on the subject (Hurt & Thomas, 2009; Darling et al., 2016), many questions remain. Consequently, further investigation is necessary to advance our understanding of how to effectively implement PMOs in practice, ultimately providing a more accurate representation of PMO. Singh et al. (2009) asserts that incorporating a PMO within an organization can enhance project management performance. Other authors (e.g., Liu & Yetton, 2007; Ershadi et al., 2021a) also recognize the significance of PMOs and their role in supporting company operations in multi-project settings. Ward and Daniel (2013) contribute to a better understanding of project management's overall role on organizational performance. Kutsch et al. (2015) offers recommendations for configuring PMOs to better serve organizations. However, Hobbs et al. (2008) argue that PMOs provide limited sustainable value to organizations due to their short lifespans. Aubry et al. (2010) address PMOs' instability and frequent changes. In contrast, Ershadi et al. (2021a) believe PMOs can add genuine value to organizations when they focus on enhancing project management. By examining the startups of three successful and sustainable PMOs, they demonstrate how investing in PMOs can create value for organizations.

Projects might fall off track if contractors aren't held accountable for upholding high standards of performance. Their old methods will no longer suffice in the face of increasing complexity and the resulting uncertainty, and integrated techniques are needed to effectively manage cross-functional interdependence and competing objectives. The complexity of a project may be reduced by the use of effective organizational control systems. As a result of its early acceptance in the construction sector, project management office (PMO) has been transformed from conventional stand-alone approaches to more systematic methodologies (Unger et al., 2012). PMO complexity and the temporality of megaprojects can have a significant impact on the management of such projects and the validity of the results they provide (Cornelio et al., 2021). Significant management issues arise as a result of mega projects' inherent ‘temporariness’ (Toivonen et al., 2014; Karmowska et al., 2017). Because of their short-term nature and the complexity of mega projects, it is necessary to clearly link them as projects in multiple contexts. When it comes to mega project planning and scheduling, there are more factors at play than only intra-organizational or technological limits (Deng et al., 2021). As well as inter-organizational restrictions and facilitators, there are also common constraints from the institutional field, such as the sector and industry. Because of the requirement to connect projects, processes, and portfolios with organizational objectives, the PMO level is becoming more important in the project-based environment. PMOs also strive to establish, develop, and continually enhance project management competencies and thus enhance maturity of project management.

The PMO's primary role is to efficiently coordinate multiple projects within a single organization to achieve operational consistency (Balali et al., 2020). Artto et al. (2011) indicated that management can use the PMO to centrally control all activities crucial for project success. Project managers require PMO involvement in operations to help implement strategic plans and improve performance in quality and resource allocation (Jalal, & Koosha, 2015). Ultimately, the PMO collaborates with top management to create a conducive environment for effectively managing various ongoing project practices. Additionally, the PMO is responsible for identifying appropriate projects to undertake within a specific timeframe. Aubry et al. (2010) outlined the PMO's consultancy functions as follows: (i) project planning and initiation, (ii) scrutinizing and defining project priorities, (iii) project proposal development, (iv) guidance on starting a project, (v) providing a plan for executing project plans, (vi) presenting the project to senior management, (vii) offering mitigation strategies for addressing potential challenges, and (viii) creating opportunities for advancing project management skills.

There are three tiers inside the PMO, and each tier is responsible for a certain role within the PMO (Sergeeva & Ali, 2020). The three tiers are the senior manager, the project manager, and the employees of the company. Technology and design, day-to-day project management, investment and cost control, and overall administration are the four responsibilities. The company's project management practices are continually evolving. There is a relationship between successful PMO performance and project success, indicating those functioning and efficient PMOs that support project governance: where project management techniques, processes, and project goals lead to project success, and the absence of such performance has been identified as a leading cause of project failure. This research investigated how PMO performance effects project success in mega construction projects where workers execute projects and found the contingent link between PMO performance, project governance, and successful project completion. The contingent relationship creates a knowledge gap as to which PMO performance metrics are associated with project success (Anantatmula & Rad, 2018; Barbalho & Silva, 2022). Ershadi et al. (2023) found that managers with the discipline and strategy to apply complete organizational standards, adequate resources, effective planning capacity, and activity monitoring of projects are less likely to have projects failures. It is in the best interest of organizational leaders to build a PMO to reduce the likelihood of project failure as a result of the pressure imposed on managers to embrace new disciplines and strategies to remain competitive and maintain an optimum level of performance. Based on the above literature, the following hypothesis is proposed.

H7: Project management office and mega project complexity jointly moderate the positive relationship between mega project governance and mega construction project success, such that the positive relationship is at highest when project management office is high and mega project complexity is low.

2.12.8 Project management office as moderated moderator MPC, MPG and APM

Successful project management relies on effective PMO that fosters teamwork and inclusivity among team members. According to Ershadi et al. (2023), poor PMO is responsible for 80 percent of project failures. The effective PMO is pivotal in determining the outcome of a project. In the end, the responsibility for the success or failure of a project lies with the project manager. It is the project manager's duty to ensure that the project is completed on time, within budget, and to the satisfaction of all stakeholders (Aubry, 2015; Sergeeva et al., 2020). Support for the project manager and the system's fit inside organizational structures have become more important as the scope and complexity of projects continue to grow, both within companies and, more importantly, in society at large as it projectifies (Irfan et al., 2021). These problems were particularly severe in companies where project management has replaced more traditional organizational structures. As a result of this increasing complexity, attempts to classify PMOs have been made. Because of this, a number of classification methods have been suggested, each one based on a different set of criteria, such as the PMO's position in the organization's structure, the group's stated mission, or the scope of its operations. Nevertheless, no typology has been completely experimentally tested previous to the research study undertaken by Hobbs et al. (2008). Moreover, Müller et al. (2015) concluded that each typology constituted an oversimplification of organizational reality based on the results of their investigation. They stated that modern PMOs are multifaceted organizations with a wide range of responsibilities and a wide variety of organizational structures that are continually adapting to their environments (Aubry et al., 2012).

Mega construction projects are highly visible to the public and typically take more than a year to complete (Ud Din et al., 2020). The successful completion of such projects demands a high degree of collaboration among numerous stakeholders and the APM, such as communication, time management, quality, and human resources, to turn daunting tasks into successful outcomes (Balali et al., 2020). Consequently, having a PMO team or department within an organization can be advantageous. A PMO is a department within an organization that sets standards and procedures during a project's operation. It serves as a central control point for both the project and senior management to adopt professional standards across project management. The PMO enhances critical tasks such as governance, resource planning, project management techniques, and measurement, creating working standards while seeking new ways to work around project activities (Dai & Wells, 2004). The PMO strives to effectively integrate APM techniques, methodologies, principles, and standards focusing on improving project execution and enhancing efficiency (Sandhu et al., 2019).

A PMO, as previously said, guarantees that the project is adaptable and can swiftly adjust to any advantageous changes (Sarkar et al., 2021). As a result, agile does not presume that a company's staff is ready or eager to accept and embrace changes brought about by the PMO, but rather seeks to get everyone on board. Using the initiative, a business's project management needs are met by establishing or creating a successful PMO. When building an agile PMO, there are four critical stages to follow: first step in building an APM to examine the ultimate solution prototype. To guarantee that the

PMO is fully functioning, this stage ensures that all of the client's needs are met. Secondly, in order to maximize cooperation and minimize preparation while striving for the final rewards, it is essential to avoid any complex stages such as analysis and reporting (Dikmen et al., 2021). It is important to remember that with an agile strategy, the client's consent always comes after the benefits have been realized. Third step is to empower the client's team by training and coaching those who will use the new PMO. A PMO support desk is available for any questions that may arise over the course of the project, so that teams may get started right away with their training (Larsson et al., 2020). Lastly, the PMO must be constantly updated to ensure that the customer and their team are fully involved; the PMO's overall effectiveness depends on its ability to accept and implement any helpful adjustments from the customer and the team. An agile PMO that is client-driven, adaptable, and helpful will be developed (Stern, 2020; Masia et al., 2021). To enable effective project governance in the complex mega project environment, an agile PMO is formed through the use of a change-oriented agile strategy (Müller et al., 2015; ul Musawir et al., 2020; Ershadi et al., 2021b).

Standardized agile framework implementations in their pure form are uncommon (Noll & Beecham, 2019). According to a PMI institute report, 23% of 2018 respondents employed a hybrid approach, while 30% claimed to use agile (PMI, 2018). Implementing a new agile project management structure in an established firm often faces resistance (Cooper & Sommer, 2016). Hybrid frameworks might serve as a strategy to minimize this resistance. Some authors argue that agile cannot support multiple projects or large enterprises without incorporating traditional elements (Gill et al., 2018); while others contend that traditional and agile hybrids result from upper management skepticism. Nonetheless, it is not unusual to find large firms with numerous agile teams, traditional project managers, project sponsors, and PMOs.

While resistance to change is a well-documented phenomenon (Armenakis et al., 1993), there is limited literature on the impact of PMOs on agile. Some authors investigate how PMOs can facilitate the transition to agile (Hodgkins & Hohmann, 2007), how PMOs should operate in an agile environment (Elatta, 2012; Pinto & Ribeiro, 2018), and share experience reports of establishing PMOs (Tengshe & Noble, 2007). However, there are few publications that examine existing PMOs in agile settings. The current study aims to explore whether and how the roles of the PMO change when agile is introduced to a mega construction projects. Accenture inspired the choice to analyze the PMO. The company offers a broad range of consulting services, including planning, and executing agile transitions, coaching teams in agile practices, outsourcing project managers, PMOs, scrum masters, and more. Accenture has shown interest in the convergence of PMOs and Agile methodologies, which assist in reducing project complexity and achieving successful completion of mega construction projects. Thus, the current investigation has proposed the following hypothesis:

H8: Project management office and mega project complexity jointly moderate the positive relationship between mega project governance and agile project management, such that the positive relationship is at highest when project management office is high and mega project complexity is low.

2.13 Summary

This chapter has offered a comprehensive overview of the literature most relevant to the study's variables. The current study argues that mega project governance, agile project management, mega project complexity, project management office, mega construction project success can be considered as the valuable resources for the Pakistani construction project employees working in mega projects. Therefore, they are needed to be investigating the phenomenon of mega project governance on MCPS. This chapter not only conducted a thorough review of the existing literature concerning key factors but also pinpointed several research gaps at the conclusion of each primary topic. The literature clearly indicates that MPG has a positive impact on MCPS. Also, the mediator APM positively influences the relationship between MPG and MCPS. MPC moderates the two relationships MPG and MCPS, MPG and APM. Lastly, PMO act as a moderated moderator on the relationship between MPC, MPG and MCPS, also MPC, MPG and APM.

Chapter 3: Research Methodology

3.1 Introduction

An investigation is defined as a process of collecting, analysing, and synthesizing information that is relevant to the study of the subject topic being discussed. Within specified frameworks, the study explains the goal and conveys the results (Singh, 2006). In addition, it helps researchers plan out their research strategy, including how to conduct the study and what reasonable considerations to make. This chapter explains the research philosophies, research design, measures, Pre-test questionnaire, pilot study and data collection. Sections on data collecting and the description of research tools are included in this section. At the conclusion of the chapter, there is also a summary of the content.

3.2 Research Philosophies

In the field of project management, most of the research is positivist in nature. Efforts are made to regulate the context of research in the positivist tradition by isolating the phenomena being studied (Meredith et al., 1989). An apparent trend away from processes and toward behaviours may be seen in recent studies on project management. Managing projects requires a move from the positivist paradigm to an interpretive paradigm that recognizes the project's dynamic character, which is impacted by a variety of external circumstances (Pollack, 2007). An investigation of the nature and evolution of knowledge is the focus of research philosophy. Epistemology and ontology are two of the most common research philosophies in social research (Al-Ababneh, 2020).

3.2.1 Epistemology

Positivism and interpretivism are two of the most common study approaches (Hughes et al., 2016). Smyth et al. (2007) categorized positivist and interpretative data collection methodologies as two major categories. Empirical testing is a key component of positivism. Positivism's primary notion is that researchers may observe social behaviour from an ‘experimental’ perspective, with the possibility of conducting a specific investigation in the process (Bryman, 1984). Experimentation and testing are used to show or disprove conjecture, and then new hypotheses are formed by combining facts to develop laws or standards (Lawson, 2003). In positivism, events are explained by linear thinking in one reality, but in constructivism, understanding via in-depth investigation of the many realities prevails. There are two kinds of systems: those that test hypotheses (or theories) and those that develop them. A demonstrative researcher agrees to experience the world through the eyes of the general public, allowing them several points of view of reality rather than a single reality of trust for them to focus on the (Kulkarni et al., 1988). These approaches should not be considered interchangeable with qualitative (e.g., pre-test, observations) and quantitative data collection methods (Ibert et al., 2001).

The current study aims to contribute to a positivist perspective of epistemological assumption. The positivist concept of research is based on the idea that the best method to learn about reality is through theoretically developing hypotheses (Blumberg et al., 2014).

Mega project governance, agile project management, mega project complexity, and project management office influence on the success of Pakistan's mega construction projects are the primary focus of this research. In addition, the positivist approach means that statistical techniques will be more useful in analysing the data obtained, and the findings will be more dependable and less prone to mistake (Scruggs et al., 1987). Therefore, rather relying on subjective opinions and assumptions the current study interpreting the findings based on the evidence.

3.2.2 Ontology

To understand the nature of reality, ontology relies on a philosophical assumption. Ontology, according to Bell et al. (2021), is the study of ‘the nature of social entities’. Research is guided by the ontological assumption that social entities exist outside of the social actor presence in the actual world. According to a more objective perspective, social actors' perceptions and actions are what make reality (Graue, 2015). An objective perspective is used in this research since the phenomena under consideration are based on existing models and theories, such as the mega project governance, agile project management, mega projects complexity and project management office, a model for mega construction project and a theory for success. No matter how many people participate, these models are not influenced by them. Furthermore, the current study examines the link between five variables (mega project governance, agile project management, mega projects complexity, and project management office and mega construction project success) and so, the objectivist perspective assists the researcher to identify the answer to the research questions.

3.3 Research orientation

Research orientation act as a bridge between the philosophies previously adopted (i.e., Subjectivist Approach) the research approach and research design (Friedman et al., 1997). Holden and Lynch (2004), explains that the choice of an appropriate orientation relies upon the prevalent academic literature, and what is needed to be answered. In addition, it is affected by the philosophy adopted, assumptions of the authors, and their conception of the phenomenon (Eyisi, 2016). Furthermore, an objectivist view drives the research towards a quantitative design while subjectivist view aligns with qualitative design (Antwi & Hamza, 2015). As mentioned earlier, current study used objectivist viewpoint, therefore it was based on quantitative research using deductive reasoning (Proudfoot, 2022). This will further be elaborated in the next section:

3.3.1 Inductive vs. Deductive Approach

There are two major methods to reasoning which represent inductive reasoning and deductive reasoning. The inductive reasoning starts with theory building through observation and generalization concerning a specific incident, while for deductive reasoning is through assessing an existed generalization and investigates it (Haque, 2022). In the deductive approach, the classification process follows a structured framework of themes, often referred to as a "start list," with the anticipation that specific core concepts will be evident in the data (Azungah, 2018). In contrast, the inductive method relies solely on participant experiences as the driving force behind analysis. Morse and Mitcham (2002) explain inductive analysis as a process where concepts and themes are derived primarily through thorough readings of raw data. This involves meticulously examining data line by line, assigning codes to paragraphs or text segments as relevant concepts emerge in response to the research questions. Inductive analysis, employed to identify the most empirically grounded and theoretically interesting factors (Casula et al., 2021), is a recursive process necessitating a continual back-and-forth between data analysis and existing literature to interpret emerging concepts (Azungah, 2018). While researchers may outline evaluation objectives or questions that influence inductive analysis findings, conclusions are exclusively drawn from the examination of unprocessed data and not predetermined notions or models (Pandey, 2019). Therefore, deductive reasoning was used for this research data as it is based on prior knowledge on a phenomenon (Casula et al., 2021). Research in business and management often use surveys to answer questions like ‘how many,’ ‘how much,’ ‘what,’ ‘where,’ and ‘who’ (Proudfoot, 2022).

3.4 Research Design

Developing a research design is the first step while doing research. Myers et al. (2013) define the research design as including the researcher's proposal to identify the approach and procedure for collecting and exploring basic data. Methodological considerations include how to gather and investigates data, where and when it will be done as well as how long it will take and how ethically sound it is to do such a study (Casula et al., 2021). The current study used the quantitative research technique to gather data and establish the variables' relationships (Kehr & Kowatsch, 2015; Sharma, 2017). Data collection for the entire population is impossible because of limited resources and time restrictions. Hence, convenience sampling technique was used to gather and analyse the data (Etikan et al., 2016). It took six months to gather data for both pilot study (15th Jun 2022 till 15th August 2022) and complete data for final analysis (16th August till 16th Dec 2022). It was cross-sectional research because the data was collected at a certain period. The survey approach was used in the current study. It was possible to derive results from this data with regard to existing connections using quantitative analytical method (Gayle & Lambert, 2018). However, in certain circumstances, quantitative approaches are employed to support a notion rather than to prove it (Malterud, 2001; Golafshani, 2003). The primary data is gathered commonly through the questionnaire survey after sampling the entire population during the study.

3.4.1 Participants

In research, the unit of analysis refers to the specific component examined by the scholar, and it is determined by the research's objectives and nature (Levy & Lemeshow, 2013). The unit of analysis can encompass individuals, industries, organizations, countries, groups, or cultures from which data is collected. However, to conduct this research, mega construction project were selected as the unit of analysis. Project managers were required to report on the mega project governance, agile project management, mega projects complexity, and project management office and mega construction project success of their most recent project. Sampling techniques are widely used to collect and analyze data since it is difficult to acquire information from the entire population due to time constraints and resource limitations (Sharma, 2017). The sample is a composition of the population representing the whole population study (Alvi, 2016).

There are two major types of sampling techniques, which are probability and non-probability sampling (Berndt, 2020). Probability sampling is based on probability theory, in which all available samples are sampled randomly from the population (Uprichard, 2013). Because each individual has the same chance of being chosen and there is less risk of bias, quantitative researchers can more easily compare data from a sample to the entire population (Hansen et al., 1983), and the sampling error magnitude can be evaluated, allowing researchers to determine the statistical significance of differences between indicators (Daniel, 2012). The random sampling approach is encouraged as it reflects the study population, but random sampling needs a full list of target population (Haider et al., 2021). Since, the current study consists of mega construction projects; therefore a complete list of mega projects employees was essential for random sampling. Random sampling methods may only be utilized if the whole population has been determined or a list of the complete population has been created (Levy et al., 2013). However, the researcher was unable to find out the entire number of employees working on mega construction projects.

As an alternative, researchers may only use non-probability sampling approaches when there is no data on the complete population or a list of individuals who are eligible to participate (Schreuder et al., 2001; Vehovar et al., 2016). Therefore, current study used a purposive sampling technique for data collection (Alvi, 2016). Moreover, as the data collected was self-reported and the survey was completed within a fixed timeframe, it is critical to determine the degree to which common method variance (CMV) threatens the validity of this research (Tehseen et al., 2017). Instead of the actual hypothesized effect, the significant correlation between two variables might be due to CMV. Chin et al. (2013) recommended two effective statistical methods that were used to reduce CMV (i.e., construct level correction (CLC) and item level correction (ILC). Furthermore, Harman's single factor test and Marker variable will use to control CMV (Podsakoff et al., 2003; Tehseen et al., 2017). As a result, the current study results are considered reliable to draw conclusions and recommendations based on the study's findings because the current study has a 95 percent probability of identifying the true impact within an entire population. As a result of their involvement in the planning, monitoring, and assessment of these public and private mega construction projects in Pakistan, the respondents included project managers, middle management, project engineers, human resources (HR) directors, and chief executive officer (CEOs)/Presidents.

"A good sample should reflect the similarities and differences found in the population so that it is possible to make inferences from the (small) sample about the (large) population," state Hair et al. (2017, p.22). According to Sarstedt et al. (2021), the sample size is determined by the population's size and the variance of the variables being studied. According to Hair et al. (2019), when using multivariate analysis such as PLS-SEM, the technical aspect of sample size becomes more important. To ensure that PLS-SEM findings have sufficient statistical power, a minimum sample size is required (Hair Jr et al., 2020).

According to Hair et al. (2012), PLS-SEM has a higher chance of identifying a significant association when there is a significant one in the population because of its larger statistical power. Consequently, Type II error may occur if the sample size is too small to detect a statistically significant effect on the population (Sarstedt et al., 2021). Also, the generalizability of the model and the robustness of the PLS-SEM findings are dependent on the minimal sample size (Hair et al., 2019). However, PLS-SEM's results could change from one sample to another due to a lack of data (Sarstedt et al., 2021). Therefore, it is essential to determine the right minimum sample size before doing PLS-SEM analysis.

Power analysis or the 10-times rule can be utilized to determine the minimal sample size. According to Hair et al. (2017; p. 24), the 10-times rule suggests that the sample size should be the larger of either 10 times the maximum number of formative indicators used to measure a single construct or 10 times the largest number of structural paths directed at a specific construct in the structural model. However, this rule offers an approximate value for estimating the minimal sample size (Sarstedt et al., 2022). Determining the sample size for PLS-SEM should also consider the model's background and data characteristics (Sarstedt et al., 2021). Hence, Sarstedt et al. (2022) recommend employing power analysis, particularly with the most predictors in the model. A research study's sample size can be determined through power analysis, as defined by Heseler (2017) as the likelihood of detecting an actual effect. Researchers employ this method to ascertain the statistical power of the analysis, determine the appropriate test for data analysis, and establish the required sample size. Ringle et al. (2020) note that power analysis helps decide if a large sample is necessary for accurate statistical estimates. It also assesses how specific statistical estimates may influence the overall impact of a particular sample size on the analysis. Choosing an appropriate sample size is crucial to avoid a lack of accuracy and reliability from a sample that is too small or unnecessary time and cost from an excessively large sample. Sarstedt et al. (2022) emphasize the necessity of conducting a priori power analysis to establish the correct sample size, as it significantly determines the statistical power of PLS.

Sample size holds significant importance in Covariance-based Structural Equation Modelling (CB-SEM), PLS Path Modelling, and PLS Modelling, as highlighted by Hair and Alamer (2022). Despite various considerations, regression remains the most direct method for determining an appropriate sample size. Ordinary Least Squares (OLS), the most common regression estimation technique, doesn't require large samples (Henseler, 2017). In regression analysis, statistical power depends on predictors, significance level, effect size, and sample size. Henseler (2017) offers comprehensive guidelines on using these variables to identify the minimum required sample size for achieving an adequate degree of statistical power. In social sciences, the minimum acceptable power level is typically set at 80% of the overall statistical power, explicitly stated by Sarstedt et al. (2021).

To calculate appropriate power across various scenarios in linear regression, several websites, including www.danielsoper.com, offer tools to determine the minimum sample size (Hair & Alamer, 2022). They highlight that even with a small sample, the PLS estimation approach yields considerable statistical power. As a rule of thumb, the literature generally suggests a minimum sample size ten times larger than the maximum number of predictors for each dependent variable in the model (Hair & Alamer, 2022). However, this recommendation lacks rigorous empirical support (Ringle et al., 2023). Therefore, in line with the recommendations of Faul et al. (2007) and Verma et al. (2020), the present research determined the necessary sample size using G*power software version 3.1.9.7. The study is based on four predictor's project governance, agile project management, project complexity and project management office those have direct or indirect effect on mega construction project success. To analyse the present framework with four predictors, a sample size of 85 is needed, which results in a power of 0.80 for our study model with a medium effect. The Figure 3.1 illustrates the minimal sample size necessary and the power of the acquired sample size, respectively.

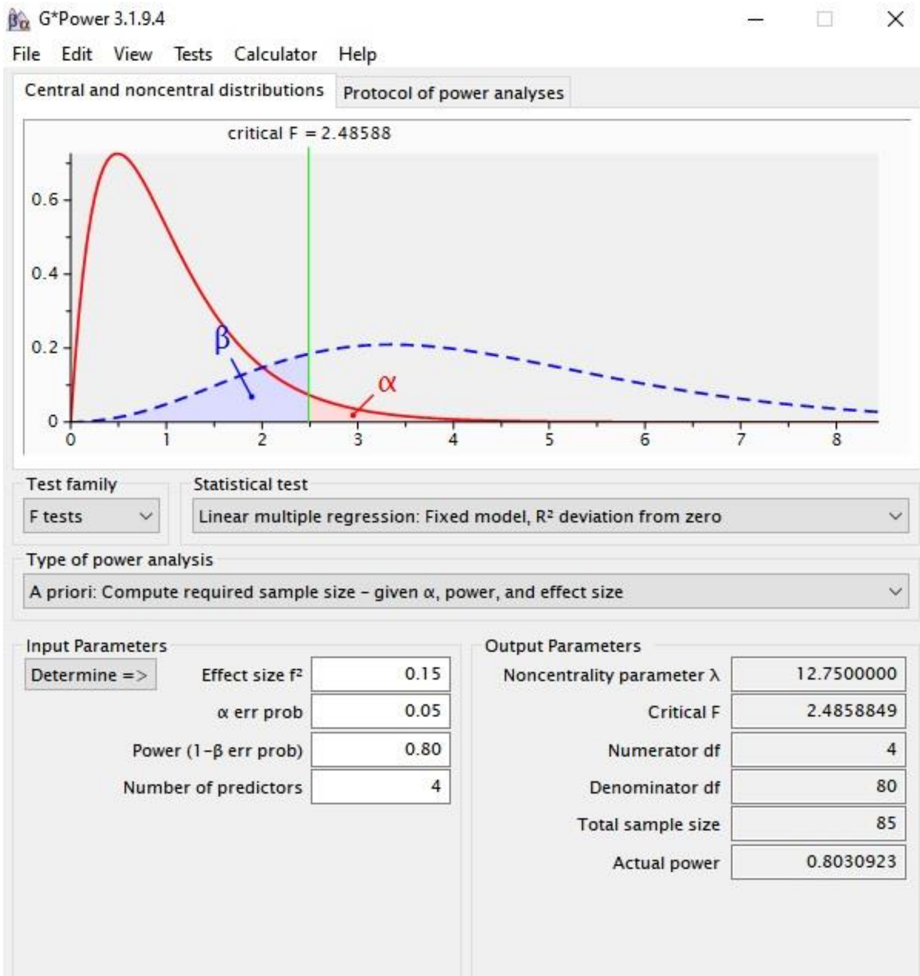

Figure 3. 1 G* Power (power=0.80)

Although a sample size of 85 participants was necessary to obtain a minimum power of 80%, the researcher aimed for a maximum power of 95%, therefore Figure 3.2 presented that a sample size of 129 participants was decided based on G* power analysis for the current study. However, data were collected from 327 individuals, including project managers, middle management personnel, project engineers, HR directors, and CEOs/presidents. This sample size exceeded the minimum requirement, thereby increasing the likelihood of uncovering genuine effects in mega construction projects. Rather than requiring whole population to determine sample size, G* power uses model setup and the maximum number of predictors to use it (Faul et al., 2009). As a result, it is the most appropriate tool to use when the total population of a group is unknown for determining sample size and analysing its power (Ramayah et al., 2017).

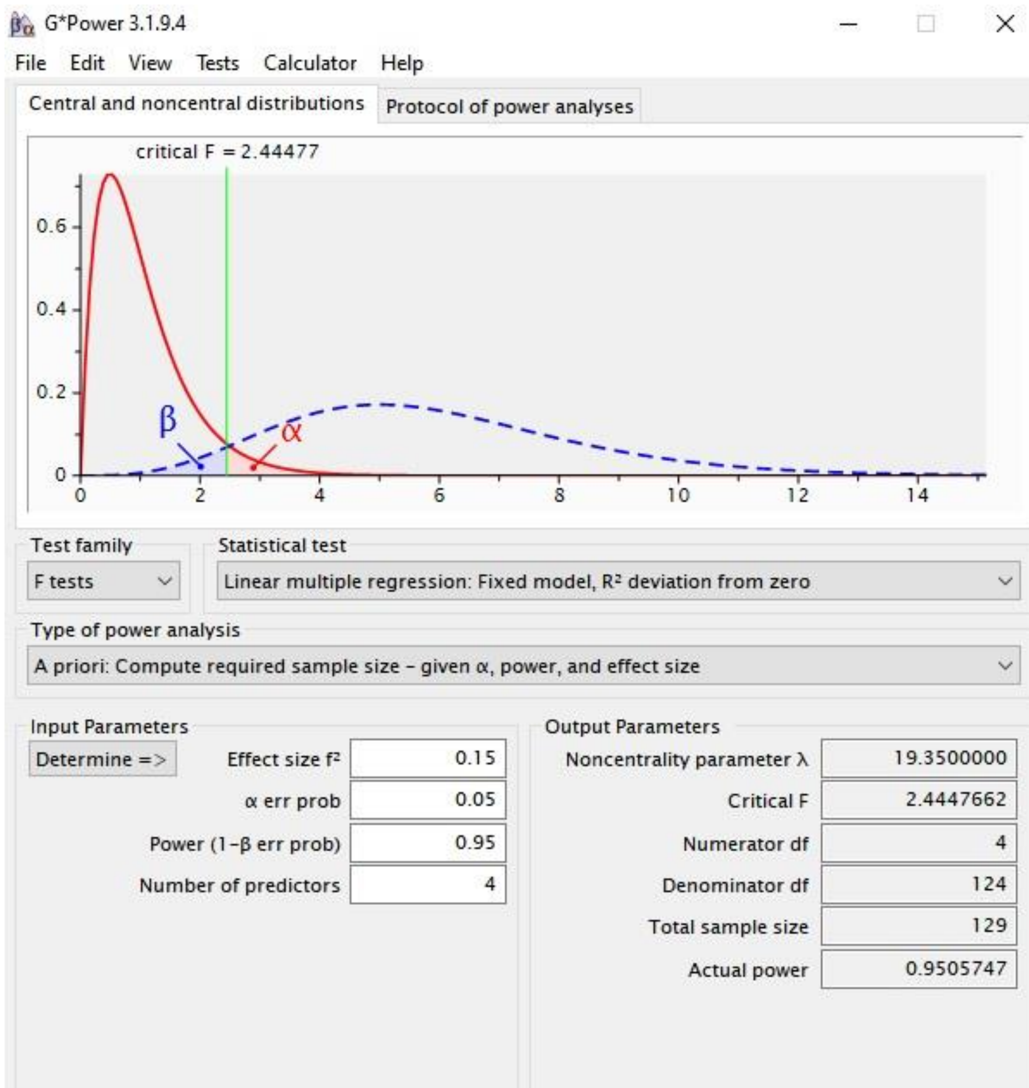

Figure 3. 2 G* Power (power=0.95)

3.5 Measures

The information was gathered through the use of questionnaires, and all variables scale were adopted from previously published studies (Rowley, 2014). To conduct a large-scale investigation, a pilot study was conducted to verify the reliability and validity of the scale. Surveys were written in English language. In Pakistan, students are taught English as a compulsory subject started from high school. Moreover, the majority of respondents were college graduates; it is likely that they had little difficulty with the survey. The first parts include demographic information (gender, age, experience, education level, experience in current organization and position) (Luo et al., 2017). The second part project related information (project type, project size, project duration, position), project management office (age of PMO in the organization, PMOs' staff composition, and the status and authority of the PMO), independent variable (mega project governance), mediating variables (agile project management), dependent variable (mega construction project success), moderator (projects complexity), and moderated moderator (project management office). Closed-ended questionnaires were used to measure all the variables.

The questionnaire has a total of 142 items. The items were rated on a five-point Likert scale: 1 – Strongly Disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, and 5 – Strongly Agree (Allen et al., 2007), was used to measure mega project governance, agile project management and project management office. The independent second order variable mega project governance adopted from Li et al. (2019), based on 15-items scale divided into three categories: governance structure (5-items), governance mechanism (6-items) and external environment (4-items) (see Table 3.1). When it comes to mediator variable the 36-items scale was used to measure agile project management developed by Kumara (2017). The project management office used as moderated moderator, which consist of 12-items scale adopted from Ershadi et al. (2021c). Moreover, second order variable the project complexity consist of 27-items developed by Luo et al. (2017), was used as moderator based on six categories, specifically, information complexity (9-items), task complexity (4-items), technological complexity (4-items), organizational complexity (2-items), environmental complexity (4-items) and goal complexity (4-items). The project complexity scales were measure using five-point Likert scale: 1-simple, 2-mildly complex, 3-moderately complex, 4-highly complex, and 5-extremely complex. Lastly, the 34-items scale was adopted from Joslin et al. (2016), to measure dependent variable mega construction project success. The MCPs items were measure using five-point Likert scale: 1-not successful, 2- slightly successful, 3- moderately successful, 4-highly successful, and 5-very highly successful.

Table 3. 1 Constructs summary

Constructs/sub dimensions	**Items**	**Source**
Agile Project Management	36	Kumara (2017)
Mega construction Project Success	34	Joslin et al. (2016)
Project Management Office	12	Ershadi et al. (2021c).
Mega Project Complexity	27	Luo et al. (2017)
Environmental Complexity	4	
Goal Complexity	4	
Information Complexity	9	
Organizational Complexity	2	
Task Complexity	4	

Technological Complexity	4	
Mega Project Governance	15	Li et al. (2019)
External Environment	4	
Governance Mechanism	6	
Governance Structure	5	

3.5.1 Procedure

A pilot research study was undertaken to assess the reliability of the assessment tool before conducting the full-scale study. In the pilot study, data was collected from 147 participants solely through hard copies. However, for collecting data through hard copies, the author distributed surveys using online platforms such as Email, Facebook, and WhatsApp, in addition to personally visiting construction sites. Participants were assured that any information they provided would be kept confidential to encourage them to provide authentic data related to the topic. They were also informed that all the information being gathered was solely for academic purposes in order to gain insight into the role of mega project governance, agile project management, mega project complexity, project management offices, and mega construction project success.

3.6 Data Analysis Techniques

Analysis of survey results revealed the interrelationships between the various constructs. Data analysis was performed using SPSS version 25 and Smart PLS version 4. Descriptive and inferential statistics were used to summarise the data. Descriptive statistics, which characterise the information or data by frequencies, were generated using SPSS. Parameter estimates for the whole population were calculated using the inferential statistics PLS-SEM method. PLS-SEM allows the researchers to evaluate a group of associated hypotheses by investigating the connections between several exogenous and endogenous constructs in a model (Hair & Alamer, 2022). PLS-SEM has developed as a statistical modeling method; it has been dubbed a ‘silver bullet’ and a ‘fully developed system’ (Ringle et al., 2023).

The present research used partial least square-structural equation modeling (PLS-SEM) analysis due to its efficacy in simulating a full summary of the findings by evaluating the hypotheses about the correlations between observable and latent variables (Sarstedt, Ringle & Hair, 2021). The PLS analysis was used to assess the validity and reliability of the measurement scales, and the hypotheses fit with research constructs (Hair et al., 2019). For the measurement and structural models, the analysis was conducted in two steps (Götz et al., 2009). Began with the validity and reliability of the measurement model, using validity and discriminant validity evaluations (Benitez et al., 2020). Convergent validity is the concurrence between multiple items that measure the same variable. It comprises the analysis of factor loadings, Cronbach's alpha (α), composite reliability (CR), and average variance extracted (AVE) (Henseler, 2017). Cronbach alpha is the metric used to determine the internal consistency of a measured scale when determining the reliability of items (Bonett, & Wright, 2015). In addition to addressing the correlations between variables and their respective items for discriminant validity, this step examines whether they are convergent (Henseler, Ringle & Sinkovics, 2009). It includes correlation studies such as factor loadings, HTMT and Fornell-Larcker criterion and structural equation model (SEM) examination through examining the explained coefficient of determination (R^2) to check the validity of research hypotheses, Q^2 predict to determine if the model is fit or not and effect size (f^2) (Sarstedt et al., 2014). Figure 3.3 demonstrates the dependent, independent, mediator, moderator, and moderated moderator variables before analysis is performed in the current study.

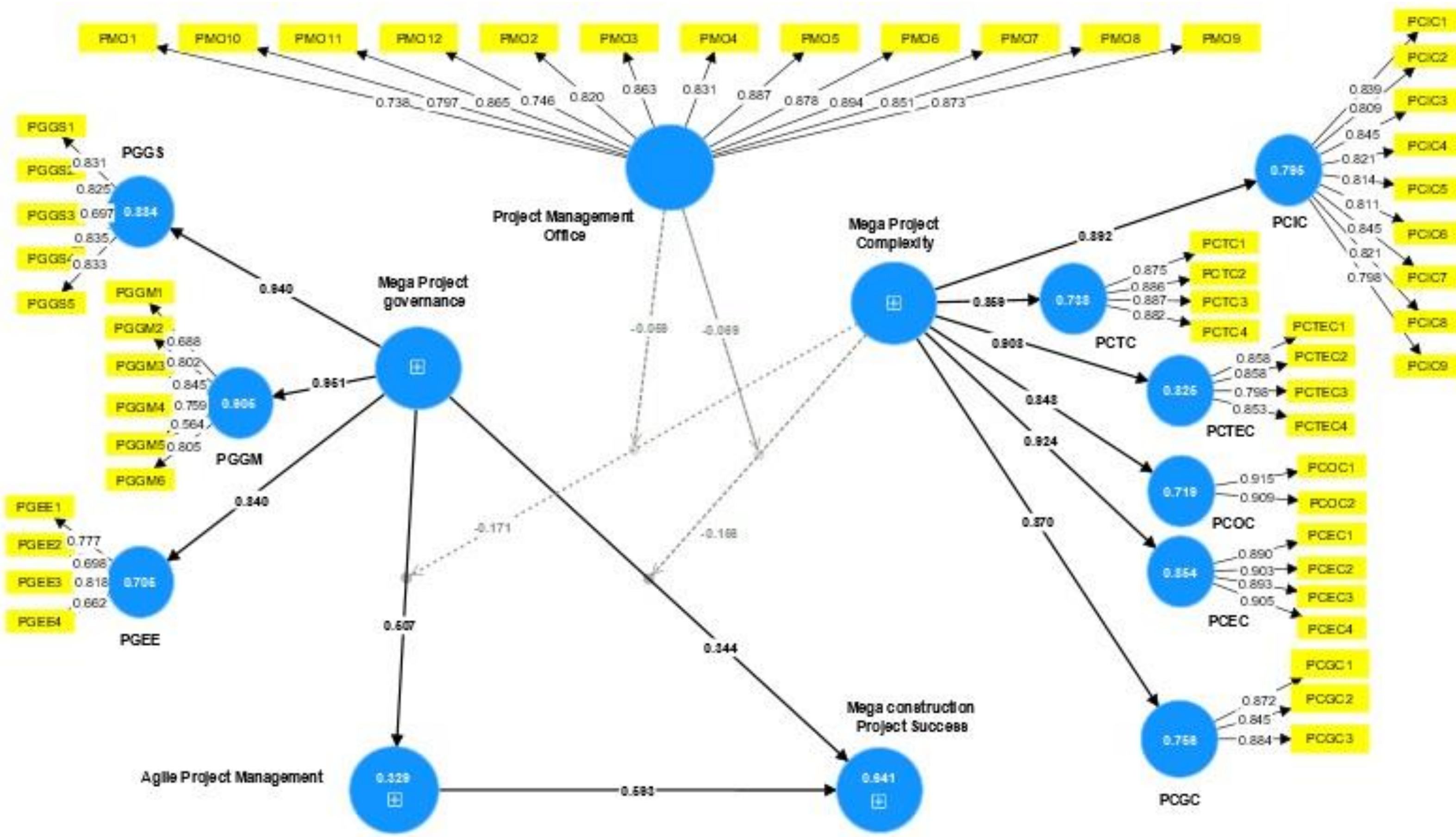

Figure 3.3 Measurement model analysis of second order reflective type Construct (Repeated indicator set up in a two-stage approach)

PLS is the method used by SEM (Hair & Alamer, 2022). In social science, structural equation modeling has shown to be the most effective method of high-level statistical analysis. Also, structural equation modelling (SEM) is a kind of multivariate analysis that integrates features of both factor analysis and regression. This allows researchers to look at the connections between measured variables, latent variables, and the interactions between the latent variables themselves all at once (Hair et al., 2022). Hence, SEM is a hybrid - method approach that incorporates both multiple regressions and factor analysis (Ong & Puteh, 2017). The most popular SEM techniques in the social sciences are Covariance-based SEM (CB-SEM) and variance-based partial least squares (PLS-SEM). Both approaches have their own advantages and disadvantages. For Example: CB-SEM is used to validate or reject existing theories. This is accomplished by using a provided theoretical model to estimate the covariance matrix for a specified collection of sample data (Astrachan et al., 2014). Alternatively, partial least squares structural equation modeling (PLS-SEM), also known as PLS path modeling, is used in exploratory research for theory development by elucidating the sources of variation in the dependant variables (Ringle et al., 2023).

3.6.1 Rule of Thumb for Choosing PLS-SEM and CB-SEM

Using SEM methods, the researcher must make a decision based on the purpose of the study. In addition, data parameters must be evaluated before to using any SEM method (Rigdon et al., 2017). Both PLS-SEM and CB-SEM procedures are distinct from one another and serve different purposes. According to Ringle et al. (2023), the following guidelines must be considered while deciding between PLS-SEM and CB-SEM. It is recommended to utilise PLS-SEM when:

- Key construct prediction or primary construct driver identification is the focus.
- Measured constructs from the formative assessment are included in the PLS path model.
- There is a complex model that makes use of a wide variety of indicators and constructs.
- Non-normal data and a small sample size.

CB-SEM should be utilised when it is intended that the latent variable scores will be employed in the following analyses:

- The hypothesis is to be tested, confirmed, or compared to other hypotheses.
- More detail is required in the definition of error terms like covariation.
- There are circular relationships throughout the model's structure.
- There must be global goodness-of-fit criteria for the current study.

3.6.2 Justification for Using PLS-SEM

According to Ringle et al. (2023), PLS-SEM is adapting to the field of statistical modelling. To ensure that models are applicable in real-world scenarios, PLS-SEM is used (Sarstedt et al., 2022). Hair et al. (2019) states that PLS-SEM is a'regression-based' approach that decreases the residual variances of the endogenous components. To top it all off, PLS-SEM is a more versatile method that can handle both small and big samples, as well as integrate critical and reflective components. Furthermore, guidelines for choosing PLS-SEM have been laid out in detail by Hair et al. (2019). The rules are stated below.

A. Research goals

- If the research goal is to predict key drivers or to identify key target constructs.
- If the research is the extension of an existing structural theory or is an exploratory.

B. Measurement model specification

- If structural model consists of formative measured construct/constructs.

C. Structural model

- If there is a complex structural model (means many constructs and many indicators).

D. Data characteristics and algorithm

- If CB-SEM cannot be met (such as model specification, data distributional assumptions and non-convergence).
- If sample size is small.
- If data is non-normal to some extent.

E. Model evaluation

- If scores of latent variables are used in subsequent analyses.

The advantages of PLS-SEM have also been discussed in recent studies. PLS-SEM, for instance, may be used for both exploratory and predictive purposes, and it can also deal with complex models (Sarstedt et al., 2022). PLS-SEM also reveals novel associations (like moderation) and heterogeneity, and it is employed when researchers upgrade or re-specify existing models by adding or eliminating paths from the original model with theoretical reason (Sarstedt et al., 2022). It has been noted by pioneering researchers that PLS-SEM excels when dealing with complicated models (such as those with a hundred constructs and a hundred indicators) (Hair et al., 2011). Moreover, PLS-SEM has well-established techniques for modeling the relationship between latent constructs (Hair & Alamer, 2022). The current study concludes that PLS-SEM is the best method to analyse the data for our investigation. The aim of current study is to predict the mega construction project success from mega project governance and agile project management, therefore, the current study is prediction oriented. The purpose of this study is to predict the mega construction project success thus it involves observed heterogeneity and moderated moderations analysis to establish the different project related complexities and control through project management office. The current study tends to extend the existing complexity and institutional theories to uncover the new relationships among the latent constructs. This research model involves two reflective second order variables (MPC and MPG). This research conceptual model is complex (5 latent constructs and 124 items). Latent construct scores must be included into further investigation. Latent variable modeling is also a part of this research.

3.6.3 Inferential Analyses of Data

According to Aron and Aron (2002), inferential statistics help generalise what is occurring in the actual world based on a sample of gathered data. PLS-SEM was used for inference-based data analysis (Sarstedt et al., 2022). The suggested research model was examined utilising SMART-two-step PLS's procedure, which included evaluating the measurement model and then assessing the structural model (Ringle et al., 2020). The evaluation of the measurement model and structural model is detailed in depth in Chapter 4. In addition, conditional effect, one of the advanced approaches of PLS-SEM, was used to draw management implications from this research. The following section of this chapter describes the pretesting procedure, techniques for analysing CMV data from the current study, and other assumptions' testing, including Mardia's multivariate skewness and kurtosis.

3.7 Pre-test questionnaire

The questionnaire was pretested among experts and was adapted according to their suggestions. The experts identified the most relevant items to the mega project governance, agile project management, mega project complexity, project management office and mega construction projects. The irrelevant items were dropped from the questionnaire. Thus, for final data collection, the questionnaire was again revised after removing or modifying the items from the original questionnaire. In addition, PLS-SEM is the most suitable technique to apply for this investigation since soft theories (i.e., Institutional theory) are being used. The complete questionnaire for final data collection has been shown in appendix B, C, D, E, F, G, H and I. The structure of questionnaire for final data collection is presented in Table 3.1.

3.7.1 Pre-testing

After the items representing the focus constructs have been discovered from the available literature, their content validity must be determined using a pre-test (Ismail et al., 2018). Despite the fact that the original content validity of items was determined by literature research, the content validity by experts offers more insightful information on the content's representativeness in the measuring instrument (Bowden et al., 2002; Gürbüz, 2017). Prior to the final distribution of the questionnaire, pre-tests expert input on the survey instrument via the use of pre-distribution questionnaires (Van Teijlingen & Hundley, 2010). A pre-test was undertaken with research colleagues, academics, and target respondents (project managers) to evaluate the suitability of the survey questions and to ensure that the questions were clear, concise, jargon-free, and grammatically accurate (Ismail, Kinchin, & Edwards, 2018). Other elements, such as format, length, survey flow, and completion time, were also evaluated. This was an interactive procedure in which constant input was gathered with each adjustment cycle. The pre-test procedure consisted of two significant steps. The first involves collecting and analysing comments from 10 academics, 10 Ph.D. students, and 10 Project managers helped to select the well-established survey instrument by suggesting it be used in this specific context to measure the variable (mega construction project success) and the variable (mega project governance) among Pakistan construction sectors. It also based on previous research to identify mediator (agile project management), moderator (mega project complexity) and moderated moderator (project management office) variables. With the guidance of academics and researchers, the survey instrument was adapted from prior studies and performed a pre-test among 147 professionals (project managers, middle management, project engineers, HR directors, and CEOs/Presidents) in the field. Based on input from industry experts (project managers), it was evident that several areas of the survey need clarification and modification. For example, the survey initially included mixed items for questions related to both aspects of specific dimensions, resulting in a lengthy and repetitive survey. This, in turn, affected respondents' willingness to participate. To address this issue, the current study refined and improved the survey questions based on the feedback from respondents. Also, revised the survey style and certain measures.

Data was collected using purposive and convenience sampling techniques for pilot study. Using the personal and professional networks, the researcher was able to identify and question mega project managers from Pakistan. The card sort technique known as the ‘Q Method,’ which was used (Gauzente & Good, 2019). This technique employs an exploratory approach with an emphasis on explaining the unique interpretation and comprehension of the topics or situations under investigation. It assesses individuals' attitudes, views, and beliefs on certain topic areas. Card sorting has been shown to be a reliable technique for determining people' perspectives of certain situations or ideas, such as competences (Lobinger & Brantner, 2019). This approach consisted of an exercise in which subjects (items) were presented on a card set, and participants were required to identify and arrange the cards according to the particular structures (Gauzente & Good, 2019). This card sorting procedure required three steps. The initial step required the experts to identify the objects and place them in the boxes corresponding to the relevant construct. The researcher then revised and updated the wordings of several items for clarity based on the recommendations of experts. Once the items' wordings were improved, the second stage of this process required the experts to identify the most pertinent items (questions) to mega construct project managers and to select the key items of each of the constructs that could be included in the final survey instrument. The seven items of the mega construction project success scale, three items of project management office and four items of agile project management were also pre-tested and slightly changed based on the recommendations of the experts.

3.7.2 Pilot Study

Pilot testing is always chosen in order to conduct research on a larger scale, and it is believed to be a highly positive and successful technique in order to prevent numerous risks associated with resource and time waste (Wong, 2021). Earlier studies indicated that acceptable sample size for pilot study range from 40-50 participants to verify the validity of the questionnaire (Hertzog, 2008; Bujang et al., 2017). According to Lin et al. (2020), when using PLS-SEM for analysis, the sample size should be at least 10 times larger than the number of indicators of the latent construct with the highest number of indicators in the model. Due to the fact that the current study model includes latent structures with up to four indicators, a sample size of 100 is necessary at the very least (fairly below the actual sample size of 127). So, the small sample size is not a limitation of this research. Therefore, the pilot study was carried out using a sample size of 147 participants. 200 questionnaires were distributed, and 163 respondents returned the questionnaire. After deleting 16 incomplete responses, 147 questionnaires were considered for further analysis, which is the response rate of 73.5%. Out of 147 respondents, 91.8% were male and only 8.2% were females. Table 3.2 shows that the majority of respondents were Master degree holders (52.4%), 20.4% had a Bachelors degree, 19% had completed M.Phil. And 8.2% were PhD holders. Additionally, the Table 3.2 shows the complete demographics of pilot test sample.

Table 3. 2 Descriptive statistics of demographics of pilot test sample

Demographics	Categories	Frequency	Percent
Gender	Male	135	91.8
	Female	12	8.2
Age	21-30	25	17.0
	31-40	75	51.0
	41-50	39	26.5
	>50	8	5.4
Education	Bachelor	30	20.4
	Masters	77	52.4
	M.Phil.	28	19.0
	PhD	12	8.2
Experience in the construction field	Less than 5	60	40.8
	5-10	43	29.3
	11-15	31	21.1
	>15	13	8.8
Experience in Current Organization	Less than 3 years	14	9.5
	3-5	60	40.8
	6-10	46	31.3
	>10 years	27	18.4
Position in Current Organization	Project manager	37	25.2

	Middle management	34	23.1
	Senior managers (vice presidents)	49	33.3
	Project engineer	17	11.6
	CEOs/presidents	10	6.8
Mega Project Governance			
Project Type	Residential project	23	15.6
	Hydroelectric project	70	47.6
	Road and bridge project	18	12.2
	Airport project	36	24.5
Project Size	50–100 million USD	1	.7
	201–300 million USD	80	54.4
	301–400 million USD	66	44.9
Project Duration	4-7 years	103	70.1
	8- 10 years	44	29.9
Stakeholders	Government	16	10.9
	Contractors	73	49.7
	Suppliers	27	18.4
	Supervisors	31	21.1
Project Management Office			
Age of PMO in organization	Under 5 years	15	10.2
	5-10	77	52.4
	>10	55	37.4
PMOs' staff composition	Staff of PMO (other than project/program managers)	42	28.6
	Presence of project managers within the PMO	73	49.7
	Experience of the staff	32	21.8
The status and authority of the PMO	Location of PMO within the organizational hierarchy	32	21.8
	Percentage of projects within the mandate of the PMO	46	31.3
	Decision-making authority of the PMO about projects and project managers	60	40.8
	Amount of supportive role of	9	6.1

	PMO		
Agile Project Management			
Do you know the term Agile Project Management (APM)?	YES	147	100.0
	NO	0	0.00
If 'Yes', how did you get know?	By reading	61	41.5
	By listening to a lecture	61	41.5
	As a partner of an application of APM	25	17.0
Which Industry APM can be applied as you know?	Information Technology	44	29.9
	Manufacturing	66	44.9
	Construction	37	25.2
Do you have any experience of APM application in Pakistani Construction Industry?	YES	109	74.1
	NO	38	25.9
Do you think APM is adapting to Pakistani Construction Industry?	YES	80	54.4
	NO	67	45.6

3.7.3 Measurement Model Analysis (Pilot Study)

To determine the reliability of a construct, Cronbach's alpha (α) was used, which measures the 'internal consistency' (Vaske et al., 2017), which offers an estimate of reliability based on collinearity of the observed indicator variables. However, Cronbach's alpha underestimates the reliability of internal consistency and is also sensitive to the number of items on the scale. Composite reliability (CR) has been proposed as an alternative to Cronbach's alpha as a measure of internal consistency reliability (Raykov et al., 2003).

Composite reliability between 0.60 and 0.70 is acceptable in exploratory research, but values of between 0.70 and 0.90 are acceptable in more advanced research stages. Cronbach's alpha poor reliability levels (Boduszek et al., 2013). Composite reliability, on the other hand, overestimates the internal consistency reliability and results in high reliability estimations (Hair et al., 2011). Between Cronbach's alpha and the composite reliability, the real dependability of a measure may typically be discovered (Ringle et al., 2023). Since Cronbach's alpha and composite reliability are both essential, it is necessary to mention both.

Composite reliability, often represented as the omega coefficient, serves as a measure of the consistency of a composite scale (Hair et al., 2021). This scale comprises multiple items or sub-scales, all designed to assess the same underlying concept. SmartPLS 4 software provides two composite reliability metrics, namely, omega-a (rho a) and omega-c (rho c), to evaluate concept reliability and validity (Hair Jr et al., 2021). Omega-a (rho a) assesses the reliability of the composite scale when all its components are considered together. It is calculated by adding the AVE to the squares of the correlations among the elements. Omega-a is the appropriate choice when there is no presumption that the items measure distinct facets of the construct being examined, and all items aim to gauge the same underlying construct. Omega-c (rho c) evaluates the reliability of the overall scale when the individual components are analyzed separately. This metric is calculated by dividing the sum of the AVEs for all items by the total of the AVEs for all items and their squared correlations with each other. Omega-c is the suitable choice when items are intended to explore different facets of the same underlying concept or when items are not closely interconnected.

A two-step procedure was conducted since the MPG and MPC constructs are a reflective second order constructs, as seen in Figure 3.3. Reflective construct (i.e., first order construct) indicators' outer loadings were initially analysed (Hair & Alamer, 2022). To assess the validity of the reflective construct, scores of latent variables of all lower-order constructs were calculated to produce single items (i.e., second order construct). The initial route model estimate for the outer loadings is shown in Figure 3.3. The outer loadings for each item, Cronbach’s alpha (α), composite reliability, and average variance extracted (AVE) are shown in Table 3.3 and Table 3.4.

Table 3.3 Assessment of Outer Loadings

Constructs	Items	Factor Loading	Items	Factor Loading	Items	Factor Loading
Mega Project Governance	PGGM1	0.688	PGGS1	0.831	PGEE1	0.777
	PGGM2	0.802	PGGS2	0.825	PGEE2	0.698
	PGGM3	0.845	PGGS3	0.697	PGEE3	0.818
	PGGM4	0.759	PGGS4	0.835	PGEE4	0.662
	PGGM5	0.564	PGGS5	0.833		
	PGGM6	0.805				
Mega construction Project Success	MCPS1	0.174 (deleted)				
	MCPS2	0.715	MCPS13	0.639	MCPS24	0.639
	MCPS3	0.058 (deleted)	MCPS14	0.497	MCPS25	0.197 (deleted)
	MCPS4	0.252 (deleted)	MCPS15	0.566	MCPS26	0.536
	MCPS5	0.710	MCPS16	0.842	MCPS27	0.650
	MCPS6	0.734	MCPS17	0.489	MCPS28	0.572

	MCPS7	0.568	MCPS18	0.630	MCPS29	0.640
	MCPS8	0.521	MCPS19	0.443	MCPS30	0.670
	MCPS9	0.595	MCPS20	0.707	MCPS31	0.601
	MCPS10	0.682	MCPS21	0.630	MCPS32	0.571
	MCPS11	0.612	MCPS22	0.674	MCPS33	0.697
	MCPS12	0.638	MCPS23	0.892	MCPS34	0.634
Agile Project Management	APM1	0.615	APM13	0.736	APM26	0.731
	APM2	0.566	APM 14	0.201 (deleted)	APM25	0.773
	APM3	0.518	APM15	0.777	APM27	0.753
	APM4	0.553	APM16	0.725	APM28	0.763
	APM5	0.751	APM17	0.740	APM29	0.747
	APM6	0.768	APM18	0.707	APM30	0.721
	APM7	0.701	APM19	0.733	APM31	0.649
	APM8	0.745	APM20	0.778	APM32	0.740
	APM9	0.716	APM21	0.678	APM33	0.747
	APM10	0.729	APM22	0.752	APM34	0.753
	APM11	0.744	APM23	0.352	APM35	0.656
	APM12	0.716	APM24	0.769	APM36	0.722
Mega Project Complexity	PCIC1	0.839	PCEC1	0.890	PCTC1	0.875
	PCIC2	0.809	PCEC2	0.903	PCTC2	0.886
	PCIC3	0.845	PCEC3	0.893	PCTC3	0.887
	PCIC4	0.821	PCEC4	0.905	PCTC4	0.882
	PCIC5	0.814	PCGC1	0.872	PCTEC1	0.858
	PCIC6	0.811	PCGC2	0.845	PCTEC2	0.858
	PCIC7	0.845	PCGC3	0.884	PCTEC3	0.798
	PCIC8	0.821	PCOC1	0.915	PCTEC4	0.853
	PCIC9	0.798	PCOC2	0.909		
Project Management Office	PMO1	0.738	PMO5	0.887	PMO9	0.873
	PMO2	0.820	PMO6	0.878	PMO10	0.797
	PMO3	0.863	PMO7	0.894	PMO11	0.865
	PMO4	0.831	PMO8	0.851	PMO12	0.746

Abbreviations: PGGS = Governance Structure, PGGM = Governance Mechanism, PGEE = External Environment, PCIC = Information Complexity, PCTC = Task Complexity, PCTEC = Technological Complexity, PCOC = Organizational Complexity, PCEC = Environmental Complexity And PCGC = Goal Complexity.

Convergent validity exists when one item of a construct is connected to other items of a similar construct (dos Santos et al., 2021). It may be evaluated using factor loadings, composite reliability, and AVE). The reliability indicator suggested that each item's loading varied from 0.352 to 0.882 using convergent validity (as presented in Table 3.3). In general, factor loadings should be greater than 0.70. According to Sarstedt et al. (2022), factor loadings between 0.40 and 0.70 should only be eliminated if doing so will increase the AVE. If the AVE was more than 0.5 and the CR was greater than 0.6, Hair et al. (2020) may still accept the convergent validity of the concept. The level of convergent validity refers to how well the construct explains the variation among its items. Convergent validity is measured by calculating the average variance extracted across all items on the construct. The AVE is calculated by mean the squares of the loadings of all indicators for a given construct. An acceptable AVE is 0.50 or more, this indicates that the construct explains at least fifty percent of the variance of its items (Hair et al., 2020). Thus, agile project management item (APM 14) and mega construction project success items (MPCS 1, 3, 4, and 25) were deleted for the increased values of AVE. By removing certain items, factor loadings, CR, and AVE calculations will be greater than the recommended cut-off values. Table 3.4 depicts a measuring model with convergent validity.

Table 3. 4 Assessment of Cronbach's Alpha, Composite Reliability and Average variance extracted

Constructs	α	CR (rho_a)	CR (rho_c)	AVE
Mega Project Governance				

PGEE	0.725	0.732	0.829	0.549
PGGM	0.840	0.854	0.883	0.562
PGGS	0.864	0.865	0.902	0.650
Mega construction Project Success	0.914	0.924	0.925	0.505
Agile Project Management	0.970	0.974	0.972	0.503
Mega Project Complexity				
PCEC	0.920	0.921	0.943	0.806
PCGC	0.835	0.841	0.901	0.752
PCIC	0.940	0.941	0.950	0.677
PCOC	0.798	0.799	0.908	0.832
PCTC	0.905	0.905	0.934	0.779
PCTEC	0.863	0.864	0.907	0.709
Project Management Office	0.961	0.968	0.966	0.703

Abbreviations: PGGS = Governance Structure, PGGM = Governance Mechanism, PGEE = External Environment, PCIC = Information Complexity, PCTC = Task Complexity, PCTEC = Technological Complexity, PCOC = Organizational Complexity, PCEC = Environmental Complexity, PCGC = Goal Complexity, α = Cronbach's alpha, CR = Composite reliability, AVE = Average variance extracted.

3.7.4 Evaluating a Second-Order Constructs

After analysing and confirming the validity of the first order constructs, the second order construct was examined for the multicollinearity of items and assessment of the outer weights along with their significance. Tehseen et al. (2017) propose a two-stage process for evaluating second-order structures. The scores of the latent variables were first computed for the first-order constructs. After obtaining stage one latent constructs scores, the current study applied those scores across all variables as MPG and MPC items. Table 3.5 and Figure 3.4 details the results of an evaluation of the MPG and MPC measurement model based on recommendations from Sarstedt et al. (2019). To investigate collinearity concerns, the current study used external variation inflation factor (VIF) values. When multiple elements of a construct are strongly correlated, the current study state that there is multicollinearity; this is quantified using the VIF. A multicollinearity problem exists if the value is more than 5. Collinearity analysis of the reflecting construct was performed. Thus, it was estimated that the MPG sub dimensions (PGGS, PGGM, and PGEE) and MPC sub dimensions (PCIC, PCTC, PCTEC, PCOC, PCEC and PCGC) can be included as predictors. The VIF values of second order reflective dimensions reported in Table 3.6 illustrate that there were no issues of collinearity.

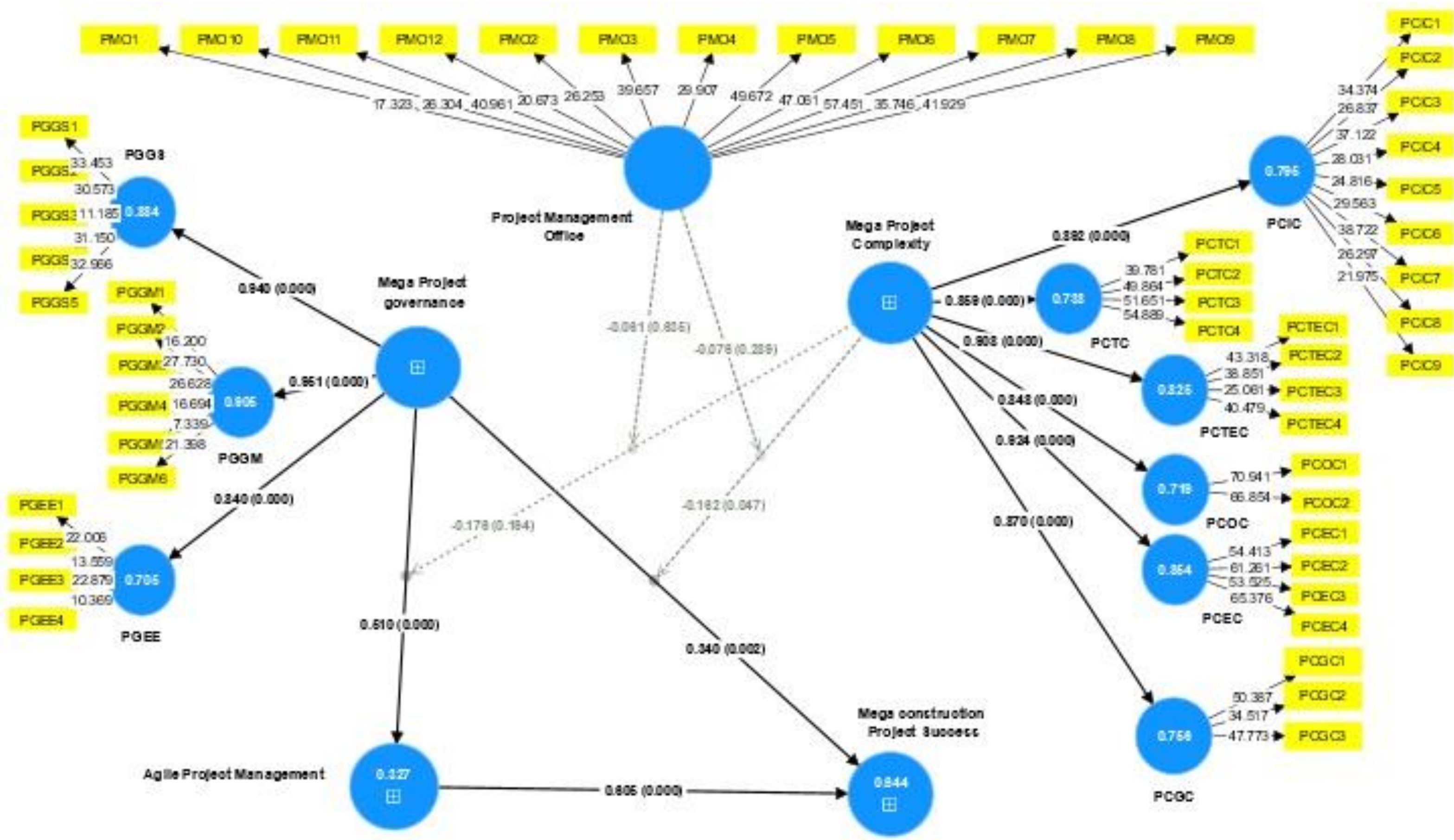

Figure 3.4 PLS-Path Analysis of (n = 5000 bootstrapped samples)

Table 3.5 Regression weights/Beta values for Reflective Indicators

Relationship among constructs	*β*	Sample mean	Standard Deviation	*t* values	*p* values	LLCI 2.5%	ULCI 97.5%
Mega Project Governance -> PGEE	0.840	0.838	0.033	25.206	0.000	0.879	0.935
Mega Project Governance -> PGGM	0.951	0.952	0.010	91.891	0.000	0.276	0.788
Mega Project Governance -> PGGS	0.940	0.941	0.009	101.448	0.000	0.146	0.563
Mega Project Complexity -> PCEC	0.924	0.925	0.010	90.003	0.000	0.470	0.764
Mega Project Complexity -> PCGC	0.870	0.871	0.020	43.165	0.000	-0.323	0.228
Mega Project Complexity -> PCIC	0.892	0.891	0.027	32.441	0.000	-0.222	0.110
Mega Project Complexity -> PCOC	0.848	0.849	0.022	38.174	0.000	0.905	0.945
Mega Project Complexity -> PCTC	0.859	0.861	0.025	34.618	0.000	0.828	0.907
Mega Project Complexity -> PCTEC	0.908	0.909	0.015	62.561	0.000	0.830	0.939

Abbreviations: PGGS = Governance Structure, PGGM = Governance Mechanism, PGEE = External Environment, PCIC = Information Complexity, PCTC = Task Complexity, PCTEC = Technological Complexity, PCOC = Organizational Complexity, PCEC = Environmental Complexity, PCGC = Goal Complexity

Table 3.6 Assessment of VIF for Reflective Indicators

Constructs	Items	VIF	Items	VIF	Items	VIF
Mega Project Governance	PGGM1	2.070	PGGS1	2.182	PGEE1	1.475
	PGGM2	2.484	PGGS2	2.223	PGEE2	1.380
	PGGM3	3.598	PGGS3	1.418	PGEE3	1.712
	PGGM4	1.899	PGGS4	2.210	PGEE4	1.192
	PGGM5	1.323	PGGS5	2.135		
	PGGM6	3.174				
Mega construction Project Success	MCPS2	1.171	MCPS14	2.582	MCPS24	2.756
	MCPS5	1.282	MCPS15	3.821	MCPS26	1.825
	MCPS6	1.402	MCPS16	1.353	MCPS27	2.295
	MCPS7	1.649	MCPS17	1.239	MCPS28	1.103
	MCPS8	1.956	MCPS18	1.562	MCPS29	2.390
	MCPS9	1.809	MCPS19	1.901	MCPS30	2.135
	MCPS10	2.398	MCPS20	1.466	MCPS31	2.330
	MCPS11	1.867	MCPS21	2.317	MCPS32	1.819
	MCPS12	2.256	MCPS22	2.095	MCPS33	3.691
	MCPS13	2.024	MCPS23	3.830	MCPS34	2.196
Agile Project Management	APM1	2.266	APM13	1.484	APM26	2.514
	APM2	1.911	APM15	2.488	APM27	1.475
	APM3	2.059	APM16	2.701	APM28	3.466
	APM4	2.112	APM17	1.753	APM29	2.999
	APM5	2.869	APM18	2.846	APM30	2.769
	APM6	3.196	APM19	2.895	APM31	1.373
	APM7	2.474	APM20	1.641	APM32	1.245
	APM8	2.961	APM21	2.937	APM33	2.974
	APM9	2.965	APM22	3.362	APM34	2.124
	APM10	2.735	APM23	1.578	APM35	2.853
	APM11	2.263	APM24	2.912	APM36	1.439
	APM12	2.105	APM25	3.165		
Mega Project Complexity	PCOC1	1.791	PCIC1	3.032	PCEC1	2.871
	PCOC2	1.791	PCIC2	2.471	PCEC2	2.654
	PCTC1	2.511	PCIC3	3.191	PCEC3	2.907
	PCTC2	2.713	PCIC4	2.692	PCEC4	2.931
	PCTC3	2.731	PCIC5	2.534	PCGC1	1.898

	PCTC4	2.606	PCIC6	2.763	PCGC2	1.880
	PCTEC1	2.224	PCIC7	2.973	PCGC3	2.094
	PCTEC2	2.244	PCIC8	2.769	PCGC4	2.779
	PCTEC3	1.725	PCIC9	2.584		
	PCTEC4	2.135				
Project Management Office	PMO1	2.110	PMO5	2.517	PMO9	1.108
	PMO2	3.646	PMO6	2.343	PMO10	3.050
	PMO3	1.073	PMO7	2.816	PMO11	3.673
	PMO4	1.475	PMO8	2.372	PMO12	2.206

Abbreviations: PGGS = Governance Structure, PGGM = Governance Mechanism, PGEE = External Environment, PCIC = Information Complexity, PCTC = Task Complexity, PCTEC = Technological Complexity, PCOC = Organizational Complexity, PCEC = Environmental Complexity, PCGC = Goal Complexity and VIF = variation inflation factor.

3.8 Study data preparation

Prior to data analysis, the raw data underwent preparation. This step was essential for informed decision-making and drawing accurate conclusions, requiring transformation into an appropriate format. Cleaning and coding the raw data were crucial steps to ensure accuracy in the analysis process. Prior to selecting respondents, the researcher verified their eligibility for participation. The survey questionnaire's components and questions were pre-coded, enabling the utilization of these codes to modify the questionnaire data using SQL. To ensure alignment between the questionnaire and pre-coded data, each item was thoroughly reviewed. Following checks for completeness and missing values, the data was input into SPSS 25. These software programs facilitated both inferential and descriptive analyses, evaluating study hypotheses and the conceptual model. Additionally, the software enabled the examination of assumptions such as outliers, transformations, and normalities.

3.8.1 Assumption Testing

An outlier is an extreme reaction to a specific question or extreme response to all questions, as stated by Sarstedt et al. (2019). Tehseen et al. (2017) argue that the extreme cases should be kept since they are representative of the whole population. Nevertheless, if an outlier is the consequence of a mistake in data collection or input, it must be fixed or removed (Ringle et al., 2023). The Mahalanobis distance test was used in SPSS to check for outliers in the underlying latent variables (Ghorbani, 2019). As shown in the Chi-square test for 124 items, for example, the Mahalanobis distance value should be less than or equal to 140.893 at the 0.001 probability level. Given that the regression model being used in the current study had four predictor variables. Predictor variables, also referred to as independent variables, are termed as such because they are utilized to predict or forecast the values of the dependent variable within the model (Sarstedt et al., 2019). Therefore, current study has for predictor variables (mega project governance, agile project management, mega project complexity and project management office) those have direct or indirect effect on dependent variable (mega construction project success), a Chi-Square value with degree of freedom of four was chosen. Mahalanobis distance in this research ranges from a minimum of 51.451 to a maximum of 114.887 (Ghorbani, 2019). Since the largest Mahalanobis distances are less than the threshold value of 140.893, this demonstrates that there is no outlier in the data.

3.8.2 Common Method Variance (CMV)

When several variables are measured using the same technique, such a survey, this creates a level of spurious correlation known as the common method variance (CMV)

(Tehseen et al., 2017). Inflating or underestimating results might incorrect inferences regarding relations between constructs. Since CMV may falsely inflate or deflate correlations, it focuses specifically on the reliability of conclusions drawn about the strength of the relationship between the constructs (Chang, Van Witteloostuijn, & Eden, 2020). CMV poses a risk to data integrity when respondents complete surveys in one sitting (Fuller et al., 2016). Use of a single responder or rater, item context, item attributes, and the measurement context are all major causes of measurement context bias (Johnson et al., 2011).

CMV must be checked when data is gathered through self-reported surveys, especially when the respondent provides both the predictor and criteria variables (Tehseen et al., 2017). Studies have shown that when self-reported measurements are acquired from the same sample, general method variance or same source bias occurs (Simmering et al., 2015). In addition, Cooper et al. (2020) noted that when data is obtained from the same kind of respondents, CMV reduces the capacity to identify the important consequences of moderations. Recent studies (Simmering et al., 2015; Chang et al., 2020) have also stressed the need of tackling the problem of common technique bias in future research. The survey data was analysed to evaluate the common method bias since the current study utilised a single respondent from each of the responding projects the same survey instrument (questionnaire). In current study cross-sectional research technique was used during randomly data collection it reduces bias and decreases the influence of common method variation (Johnson et al., 2011). Numerous scholars have pointed out two primary techniques to mitigate the effects of bias in research methods. For example, one approach is to account for potential technique biases in the research design, while another is to adjust for them statistically once data collection is complete (Tehseen et al., 2017). The current research used both strategies to mitigate the effects of prevalent approach biases.

3.8.2.1 Techniques to Address the Issue of CMV (Strengthening Research Design)

When data collection starts, it is recommended that measures be taken to reduce the potential for CMV bias by careful study design. Although it was challenging to utilise many sources to obtain information on a single organization, however, following the advice of Tehseen et al. (2017), the current study adopted the following steps to reduce the possibility of CMV bias: (a) protected the participants' privacy and identity. (b) Rearrange the order of the questions in the survey. (c) Clearly and accurately stated scale items less vulnerable to bias. d) Advised participants that there was no correct or incorrect response, and requested their sincere judgement of the survey questions. (e) Avoided survey questions with confusing wording and structures. Before beginning the survey, notified respondents of the projected time needed to complete the questionnaire or the length of the face-to-face session. (f) To minimise misunderstanding, definitions for each of the constructs and explicit directions for completing item evaluations was provided.

3.9 Ethical Considerations

Respondents were ensured that the information they provided would only be used for research thesis purposes and that their responses would be kept completely confidential. No one was forced to provide a response during the data collection process, in accordance with ethical considerations. While conducting this research project, the following ethical considerations were taken:

- Ethical code approval number (PGSUREC2022/011) and obtained from Sunway University Research Ethics Committee.
- Informed Consent is required.
- Protection of respondents' personal information.

Table 3.7 highlights the issues affecting the quality of current research and scholar's efforts to mitigate them.

Table 3. 7 Issues Affecting the Research

Factor	Risk	Mitigation strategy
Reliability of data	The collected information is neither trustworthy or reliable, not able to make theoretical contributions.	• Careful record-keeping. • Open-book policy with respondents. • Guaranteeing anonymity to encourage genuine responses. • Identifying and analysing personal biases.
Transparency	The research approach is unclear and unable to communicate results.	Comprehensive descriptions of the procedures used, clear, extensive data descriptions, and use a reference group to ensure clarity. Attend conferences and seminars to exchange and discuss research results.
Credibility	Results those are not indicative of the object of study.	To ensure clarity, triangulate data and include a reference group.
Confirmability	The results are unduly impacted by the scholars.	Confirm accuracy by using a reference group and triangulating data.
Authenticity	The study's results do not provide a comprehensive view of the topic under investigation.	To ensure clarity, triangulate data and include a reference group.

Transferability	The study's findings are not relevant in other contexts.	Methods are described in detail. Data descriptions those are clear and detailed. Utilize a reference group to ensure clarity.
Dependability	The study's findings are not reproducible.	Collaboration with other researchers and a reference group for an audit of the methodology and results.

3.10 Assumptions

There were a few assumptions and restrictions placed on this non-experimental research. The current study was conducted with the assumption that its subject and conclusions would be of interest to a wide range of stakeholders in the field of mega construction project management, including companies, researchers, and professionals. Identifying assumptions used throughout a study effort revealed a researcher's integrity, level of transparency and ethical care (Slade, & Prinsloo, 2013). The PMI literature, mainly the Project Management Body of Kmowlwdge (PMBOK) Guide, was a fundamental assumption supporting mega construction project, project governance, and PMO activities (PMI, 2017).

3.10.1 Hypothetical assumptions

The current study observed the connections (or correlations) between sets of continuous variables. It was assumed methodologically that the selected statistical model could be used to examine associations between groups of continuous-level independent variables and a single continuous-level dependent variable (Holden, & Lynch, 2004). According to the fundamental ontological assumptions of the research philosophy, investigations like the one being presented are fixed and quantifiable (Bahari, 2010). Each of the mega project governance and mega project complexity factors, project management office, agile project management, has a well-defined, measurable, and observable effect on mega construction project success. The current study epistemological foundations suggest it is authentic, objective, and measurable (Dieronitou, 2014); hence, demonstrating the suitability of institutional theory as a theoretical framework. Research value may be objectively tested through the use of axiological assumptions about the link between mega project governance, mega project complexity factors, project management office, agile project management and project success. The methodology relied on the premise that the determinants of MPG and APM as linked to project success are complex and quantifiable.

3.11 Summary

This chapter provides a summary of the study's methodology. The chapter covers survey research methods by providing the study model, research design, participants, measurements, procedure, pretesting and pilot study, and Smart-PLS software-based data processing.

Chapter 4: Research Findings

4.1 Introduction

Findings from the current study survey are presented in this chapter, which adheres closely to the reporting format suggested by Sarstedt et al. (2019). The Partial Least Squares - structural equation modeling (PLS-SEM) is used to perform the inferential statistics necessary for assessing the proposed conceptual model. Descriptive analysis of the demographic data is first discussed in this chapter. It then explains Sarstedt et al. (2022) suggested two-step procedure for dealing with reflective- reflective second-order constructs through a series of repeated indicators. In order to evaluate the measurement and structural models, PLS path modeling has been used. PLS Predict has also been observed after structural model evaluation.

4.2 One- way ANOVA Test

SPSS Statistic version 25 was used to perform a one-way ANOVA test in order to control variables (González-Rodríguez et al., 2012). This test's primary objective is to determine if the demographic factors have a substantial impact on the dependent variable. Existing research has shown the effect of demographic gender, age, education level, experience, and current organization experience, position have a strong correlation with MCPS (Luo et al., 2017). In prior research, Ma and Fu (2020); Kumara (2017); Ershadi et al. (2021c); Luo et al. (2017) and Li et al. (2019) also employed the project type, project size, project duration, stakeholders, age of PMO in organization, PMOs staff composition, the status and authority of the PMO, do you know the term APM, if yes, then how did you get known, which can industry APM be applied as you known, any experience of APM application in Pakistani construction, and APM is adapting to Pakistani construction industry as a control variable in their analysis. If any demographic variable is discovered to have a substantial effect on the dependent variable, it will be used as a control variable for further analysis. Table 4.1 displays the results of a one-way ANOVA. Table 4.1 shows that there is no statistically significant relationship between any of the demographic variable values and the dependent variable. Hence, there is no need to control any demographic variables as they have no impact on dependent variables.

Table 4. 1 One- way ANOVA

Demographics	Mean Square	F	Sig.
Gender	.026	.639	.962
Age	.469	.854	.729
Education	.893	1.171	.226
Experience	.759	.908	.639
Experience in Current Organization	.903	1.126	.283
Position	1.938	1.053	.389
Project Type	1.887	.938	.585
Project Size	.366	1.050	.394
Project Duration	.707	.896	.660
Stakeholders	.713	.768	.852
Age of PMO inorganization	.468	1.080	.348
PMOs staff composition	.463	.988	.498
The status and authority of the PMO	.701	.922	.613
If yes, then how did you get known	.451	.843	.746
Which can Industry APM be applied as you known	.818	1.108	.713
Any experience of APM application in Pakistani	.291	1.087	.315

Construction APM is adapting to Pakistani Construction Industry	.202	.798	.813

4.3 Preliminary Examination of Data

In quantitative studies, such analysis is essential (Sarstedt et al., 2014). According to Tehseen et al. (2017), it's important to clean and filter acquired data for missing responses and inaccuracies. Even if corrective measures aren't always called for, it's crucial to check the outputs of statistical analyses to make sure they're accurate (Ringle et al., 2020). The obtained data should be reviewed for problems such as missing data, unusual answer patterns, disinterested respondents, outliers, and uneven distribution, as emphasised by Sarstedt et al. (2022). As a result, SmartPLS 4 will be used in the next steps to investigate these fundamental data-related concerns.

4.3.1 Incomplete Data

Studies in behavioural, marketing (Sarstedt et al., 2014), and social sciences often struggle with the issue of missing data (Ringle et al., 2023). It's an issue when respondents don't fill out the whole questionnaire (Sekaran et al., 2016). Because of this issue, less data that is useful for analysis are collected, which might lead to biased conclusions (Ong & Puteh, 2017). The descriptive statistics for all items in the research, proving that current study doesn’t contain any missing data for this analysis.

4.3.2 Outliers

Outliers are replies that are considerably different from the norm and serve as a prime illustration of the kind of irrational answers that might be obtained (Sekaran et al., 2016). Cases with unusual values (either too low or too high) are easily distinguished from other cases according to the definition provided by Ringle et al. (2023). Data validity, data distribution, and statistical test bias are all impacted by these factors (Hair & Alamer, 2022). The normality of data distribution is affected by outliers; hence, it was necessary to check for the presence of outliers in the dataset before moving on to parametric analysis. Hence, it's crucial to identify and properly deal with outliers. Those examples with abnormally low or high values of a single variable are singled out during multivariate outlier detection (Sarstedt et al., 2014). Minimum and maximum values are useful for identifying these kinds of outliers (Sekaran et al., 2016). As demonstrated in Table 4.2, there are no outliers detected in the study data set.

4.4 Data normality Test

The sample size, multivariate normality, non-response bias (NRB), and common method bias (CMB) were all examined before the PLS-SEM analysis was performed (Tehseen et al., 2017). In line with Ali et al. (2018) recommendation, a normality test has been carried out before examining the measurement model.

4.4.1 Multivariate skewness and kurtosis

As suggested by Hair et al. (2022) the current study performed a test of multivariate normality. Multivariate skewness and kurtosis were calculated for all major latent variables. WebPower's statistical power analysis was used to calculated Mardia's multivariate skewness and kurtosis values of skewness and kurtosis should range from −1 to +1 and −20 to +20, respectively (Cain, Zhang, & Yuan, 2017). The results indicated that our data are not normal Mardia's multivariate skewness ($\beta = 5.45$, $p < .001$) and Mardia's multivariate kurtosis ($\beta = 35.01$, $p > .001$). When there are noticeable differences between respondents and non-respondents (NRB), which is common in survey research, it might compromise the reliability of the data (Cain et al., 2017). This indicates the non-normality encompassed within the data including its significant application for regression analysis through SmartPLS 4.

Using WebPower's statistical power analysis, the value of $b_{1,2} = 5.458194$ and $b_{2,2} = 35.012343$. Stated in Mardia's table (Qu, Liu, & Zhang, 2020), the current study have these critical values; $b_{1,2,0.05,148} = 0.4$, lower $b_{2,2,0.05,148} = 6.858$, and upper $b_{2,2,0.05,148} = 9.3$. For skewness, the sample is from multivariate normal distribution if the statistic value is less than critical value, while for kurtosis; the sample is from normal distribution if the statistic value is between lower critical value and upper critical value (see Table 4.2). Because the value of skewness is greater than 0.4 and kurtosis value is not in range [6.858, 9.3], residuals in our case do not follow multivariate normal distribution.

Table 4. 2 Mardia's multivariate skewness and kurtosis

	Skewness	SE_skew	Z_skew	Kurtosis	SE_kurt	Z_kurt
Sample size: 327						
Number of variables: 5						
Univariate Skewness and Kurtosis						
Agile Project Management	-0.608	0.135	-4.513	-0.502	0.269	-1.867
Mega Project Complexity	-0.312	0.135	-2.312	-1.115	0.269	-4.149
Mega Project Governance	-1.047	0.135	-7.761	0.449	0.269	1.672
Mega Construction Project Success	0.298	0.135	2.210	-0.646	0.269	-2.402
Project Management Office	-1.091	0.135	-8.092	-0.211	0.269	-0.787
Mardia's Multivariate Skewness and Kurtosis						
	B	Z		p-value		
Skewness	5.458194	297.47156993		0.0000000		
Kurtosis	35.012343	0.01333828		0.9893579		

4.4.2 Statistical Measures to Detect and Reduce the Bias Caused by CMV

The correlation matrix methodology and Harman single factor test has been used in the analysis of CMV bias, and thus briefly explain below:

4.4.2.1 Correlation Matrix Approach

The correlation among latent variables is another way to determine the CMV (Tehseen et al., 2017). The current study also adopted the correlation matrix approach to identifying CMV. Usually, correlation analysis is carried out in order to define the association among variables selected for the study. In the current study, correlation analysis was used to validate the proposed hypothesis by discovering the relationship between MPG, MCPS, APM, PMO, and MPC also the sub dimensions of MPG (PGGS, PGGM, and PGEE) and MPC (PCEC, PCGC, PCIC, PCOC, PCTC and PCTEC) to test the proposed hypotheses valid as presented in Table 4.3. Moreover, the common method bias is evident when substantially large (*r* > 0.9) correlation exists among principal constructs. Thus, by looking at principal constructs' inter-correlations in the correlation matrix, the correlation among the principal constructs was not found to be more than 0.9 in the data set. This shows the lack of common method bias.

Table 4. 3 Correlation Analysis

No.	Relationship among constructs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	APM	1.000													
2.	MPC	-0.319	1.000												
3.	MPG	0.262	-0.272	1.000											
4.	MCPS	0.472	-0.174	0.337	1.000										
5.	PCEC	-0.361	0.227	-0.227	-0.149	1.000									
6.	PCGC	-0.362	0.844	-0.174	-0.179	0.773	1.000								
7.	PCIC	0.067	0.508	-0.157	-0.104	0.294	0.271	1.000							
8.	PCOC	-0.309	0.833	-0.240	-0.136	0.775	0.612	0.245	1.000						
9.	PCTC	-0.234	0.780	-0.284	-0.073	0.696	0.583	0.178	0.720	1.000					
10.	PCTEC	-0.228	0.736	-0.251	-0.064	0.641	0.565	0.239	0.723	0.849	1.000				
11.	PGEE	0.193	-0.258	0.845	0.245	-0.192	-0.156	-0.232	-0.209	-0.239	-0.204	1.000			
12.	PGGM	0.209	-0.221	0.242	0.298	-0.166	-0.129	-0.164	-0.174	-0.247	-0.191	0.801	1.000		
13.	PGGS	0.303	-0.278	0.218	0.361	-0.253	-0.194	-0.097	-0.269	-0.287	-0.271	0.682	0.756	1.000	
14.	PMO	0.331	-0.448	0.380	0.204	-0.433	-0.337	-0.262	-0.371	-0.318	-0.287	0.350	0.340	0.355	1.000

Abbreviations: PGGS = Governance Structure, PGGM = Governance Mechanism, PGEE = External Environment, PCIC = Information Complexity, PCTC = Task Complexity, PCTEC = Technological Complexity, PCOC = Organizational Complexity, PCEC = Environmental Complexity, PCGC = Goal Complexity, PMO= Project Management Office, MPC = Mega Project Complexity, MPG = Mega project governance, APM = Agile project management, MCPS = Mega construction Project Success.

4.4.2.2 Harman single factor test

In this analysis, single-source data collection involving both dependent and independent variables from the same source raises concerns about Common Method Variance (CMV). To address this potential issue, a statistical approach was employed. Chang et al. (2020) indicate that CMV becomes problematic if a predominant portion of explained variation lies within a single latent factor. Similarly, Fuller et al. (2016) suggest that CMV raises concerns if over 50% of the total variance is attributed to the first factor. To assess the extent of bias, the study conducted the Harman single factor test, following Hair et al. (2017) recommendation. The analysis, detailed in (Appendix J), revealed that only 21.889% of the variance was accounted for by the first factor in the unrelated factor analysis. Consequently, the study concludes that CMV is not a significant issue, validating the suitability of the data for PLS-SEM analysis.

4.5 Descriptive Analysis of the Demographic Data

Frequency and percentage are used to describe respondent's profile as presented in Table 4.4. Further, data screening was conducted by checking the accuracy of the data input. Sekaran et al. (2016) specified that prior to data analysis, steps, including data screening, coding, and selecting suitable strategy for data analyses, must be completed. Raw data must be coded properly and consistently to assist statistical analysis. In addition, data screening was conducted to ensure detection of any data entry related error. The method used for screening data is done by performing descriptive statistics of the variables. The study involved 327 participants who responded to the research survey. The majority of participants were males representing 314 (96%), while female participants were 13 (4%). Pakistan Labour Force Survey (2021) report indicated that the ratio of male was more than 20 times than female participation rate in construction section. According to the Pakistan Bureau of Statistics (PBS) (2018, p.11) the Pakistan's construction industry comprises 7.61% of the total industry division, with a significant disparity in employment between males (7.56%) and females (0.05%). Prior studies also get less number of female employees while collecting data (Afza et al., 2022; Haq et al., 2023).

Moreover, Table 4.4 shows that 45 respondents (13.8%) aged 20 to 30, followed by 167 respondents (51.1%) aged 31 to 40 years, then 103 participants (31.5%) aged 41 to 50, and lastly 12 respondents (3.7%) aged greater than 50. Furthermore, Table 4.4 represents that most participants are holding master's degree holders which represent 157 (48%) participants, followed by 72 (22%) respondents holding M.Phil., followed by 64 (19.6%) participants holding Bachelor's degree, and 34 (10.4%) participants holding PhD. Additionally, majority of respondents job titles are of 106 (32.4%) of Senior managers (vice presidents), followed by project manager representing 81 (24.8%) participants, then middle management representing 73 (23.9%) participants, followed by project engineer representing 38 (11.6%) participants. Lastly, CEOs/presidents representing 24 (7.3%) of participants.

Table 4.4 Demographic Profile of Respondents, Projects and Organization

Demographics	**Categories**	**Frequency**	**Percent**
Gender	Male	314	96.0
	Female	13	4.0
Age	21-30	45	13.8

	31-40	167	51.1
	41-50	103	31.5
	>50	12	3.7
Education	Bachelor	64	19.6
	Masters	157	48.0
	M.Phil.	72	22.0
	PhD	34	10.4
Experience	Less than 5	68	20.8
	5-10	135	41.3
	11-15	90	27.5
	>15	34	10.4
Experience in Current Organization	Less than 3 years	31	9.5
	3-5	129	39.4
	6-10	104	31.8
	>10 years	63	19.3
Position in Current Organization	Project manager	81	24.8
	Middle management	78	23.9
	Senior managers (vice presidents)	106	32.4
	Project engineer	38	11.6
	CEOs/presidents	24	7.3
Mega Project Governance			
Project Type	Residential project	49	15.0
	Hydroelectric project	156	47.7
	Road and bridge project	41	12.5
	Airport project	81	24.8
Project Size	50–100 million USD	6	1.8
	201–300 million USD	179	54.7
	301–400 million USD	142	43.4
Project Duration	1-3 years	17	5.2
	4-7 years	184	56.3
	8- 10 years	79	24.2
	10-15 years	36	11.0
	>15 years	11	3.4
Stakeholders	Government	33	10.1
	Contractors	158	48.3
	Suppliers	63	19.3
	Supervisors	73	22.3
Project Management Office			
Age of PMO in organization	Under 5 years	43	13.1

	5-10	168	51.4
	>10	116	35.5
PMOs' staff composition	Staff of PMO (other than project/program managers)	83	25.4
	Presence of project managers within the PMO	174	53.2
	Experience of the staff	70	21.4
The status and authority of the PMO	Location of PMO within the organizational hierarchy	61	18.7
	Percentage of projects within the mandate of the PMO	103	31.5
	Decision-making authority of the PMO about projects and project managers	140	42.8
	Amount of supportive role of PMO	23	7.0
Agile Project Management Do you know the term Agile Project Management (APM)?	YES	327	100.0
	NO	0	0.00
If 'Yes', how did you get know?	By reading	133	40.7
	By listening to a lecture	138	42.2
	As a partner of an application of APM	56	17.1
Which Industry APM can be applied as you know?	Information Technology	98	30.0
	Manufacturing	147	45.0
	Construction	82	25.1
Do you have any experience of APM application in Pakistani Construction Industry?	YES	239	73.1
	NO	88	26.9
Do you think APM is adapting to Pakistani Construction Industry?	YES	184	56.3
	NO	143	43.7

4.6 Inferential Statistical Analysis

The connections between the variables in the hypothesised conceptual model have been evaluated using the Partial Least Squares method of Structural Equation Modeling in this research. Assessing the structural model findings is the next step after ensuring the constructs are being measured in a valid and reliable manner. The structural model evaluation process is shown in Figure 4.1 (Hair et al., 2021). The first thing to do is to check whether there are any collinearity problems in the structural model (Kock & Lynn, 2012). This is because ordinary least squares (OLS) regressions of each endogenous construct on its associated predictor construct are used in structural model estimation of path coefficients (Farahani et al., 2010). Like ordinary least squares regression, if there is significant collinearity across the predictor constructs, the estimated path coefficients may be biased. After checking that collinearity isn't an issue, researcher assesses the importance and relevance of the structural model's connections (i.e., the path coefficients). Examination of the model's explanatory and predictive abilities constitutes Steps 3 and 4 of the method. Furthermore, certain research scenarios need the calculation and comparison of alternative models, which may originate from other ideas or settings. PLS- SEM makes it easy to compare different models by using well-known standards from the regression research. Since Step 5 is discretionary, depending on the context, it may not be necessary to compare models in every PLS-SEM study.

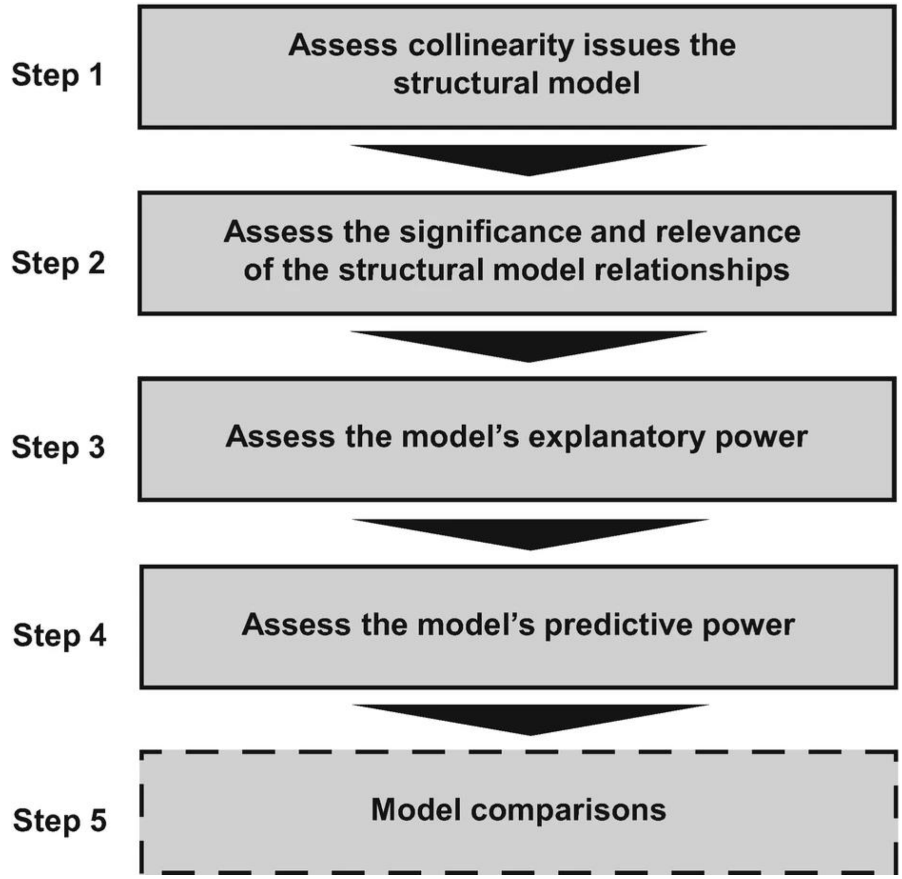

Figure 4. 1 Structural model assessment procedure. (Source: Hair et al., 2021)

4.6.1 The Measurement Model: Evaluation of Latent Constructs and Items

The measurement model, also called the outer model, explains the measurement characteristics of the unobserved latent variables of the hypothesised conceptual model and connects the measured and observed items to them. Using a Likert-type scale from 1 to 5, the measurement model consists of 119-items. All the indicators were put into the appropriate concepts. Construct and item validity was evaluated using CFA, AVE, CR, Cronbach Alpha, discriminant validity, and model coefficients. Furthermore, confirmatory factor analysis (CFA) was utilised in place of exploratory factor analysis (EFA) since all the items being examined were adopted from another source (Brown & Moore, 2012). Studies have shown that EFA is only used when a factor structure does not exist or is poorly understood, whereas CFA is used when a priori factor structure is available. More recent research has also placed a focus on CFA's use for these established indicators (Ramayah et al., 2016). Confirmatory factor analysis (CFA) is used to assess the outer measurement model by determining the strength of the correlations between latent variables and their corresponding items.

4.6.2 Estimation of Hierarchical Component Models in PLS-SEM

Figure 4.2 illustrates the four hierarchical component models proposed by Becker et al. (2012). In the reflective-reflective or Type I paradigm, first-order latent constructs are reflectively assessed, showing a robust interconnection between these concepts while maintaining their distinctiveness. Moving to the reflective-formative or Type II paradigm, the first-order latent constructs are still assessed reflectively. However, these constructs serve as a comprehensive concept mediating the impact on second-order latent constructs without sharing a common cause. In the formative-reflective or Type III paradigm, the second-order latent constructs are a broader representation of the first-order formative latent constructs. Finally, the formative-formative or Type IV paradigm involves first-order latent constructs assessed formatively, presenting a more abstract overarching concept. Although the MPG and MPC dimensions, as first-order latent constructs, embody separate and unrelated ideas without a common causal factor, the overall model in this research aligns with the reflective-reflective or Type I second-order model.

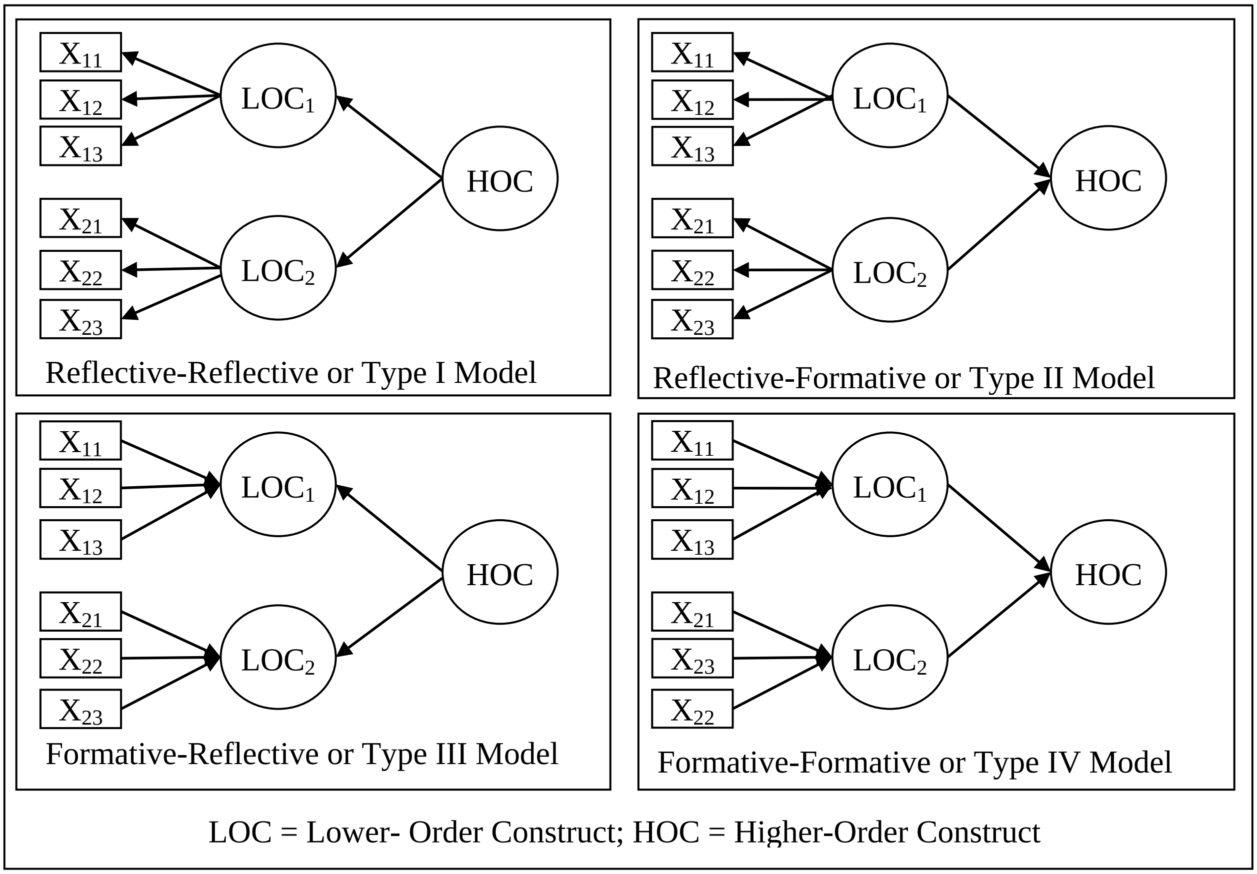

Figure 4. 2 Hierarchical component model types (Source: Ali et al., 2021).

In PLS-SEM, the path model is estimated using the construct scores of the latent constructs. Due to the lack of indications for higher-order latent structures, Becker et al. (2012) proposed three primary strategies for modeling these concepts. These strategies are represented in Figure 4.3. Under the framework of the repeated indicators method, higher-order latent constructs draw upon all of the indicators of their constituent lower-order latent constructs. Scores on latent variables representing lower-order constructs serve as indications of higher-order constructs in a two-stage procedure. In a hybrid strategy, the lower-order latent constructs employ half of the indicators of the higher-order latent constructs, while the higher-order latent constructs use the other half. There are benefits and drawbacks to each method that must be considered (Sarstedt et al., 2022). This research, however, followed the two-step procedure proposed by Hair et al. (2017).

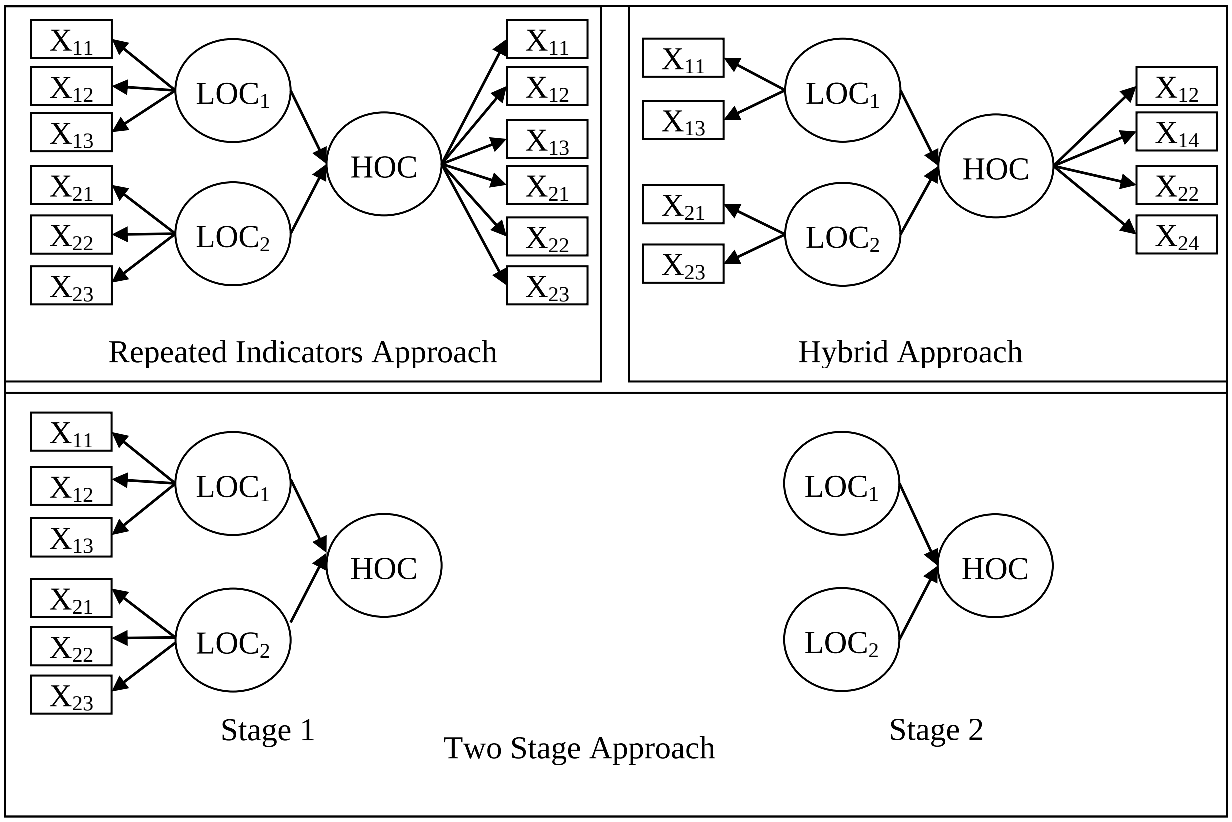

Figure 4. 3 Primary modelling strategies for higher-order construct (Source: Ali et al., 2021)

4.6.3 Assessment of the Measurement Model of Higher Order Reflective Latent Constructs

The current study used a two-stage method recommended by Hair et al. (2017) to evaluate the measurement model validity of the second-order latent constructs MPG and MPC since they are reflective constructs and the criteria to assess reflective constructs are different from those of formative constructs. In this method, second-order constructs are evaluated based on first-order construct scores. This means that the first-order construct are now the markers of the second-order ones. In the first step, a variance inflation factor (VIF) was used to assess the degree of collinearity between the predictors of the second-order formative constructs (first-order constructs). Secondly, PLS bootstrapping was used to estimate the outer weights and significance (*t*-value) from 5,000 sub samples. Table 4.5 displays the findings. According to the data, the predictors of MPG and MPC had VIF values between 1.236 and 1.992, which is within the range of 0.2 to 5.0 suggested by Ringle et al. (2012). That there is no collinearity problem. The data also show that the outer weights are significantly larger than 2.576 ($t > 2.576$ at the .01% level), falling between 0.383 and 0.475. This gives substantial support for conceptualizing reflective constructs as formative. Figure 4.4 illustrates the conceptual model and PLS-SEM outcomes.

Table 4.5 Outer Weights and T-Values of Reflecitve Indicators

Relationship among constructs	β	Sample mean	S.D.	T values	P values	LLCI 2.5%	ULCI 97.5%
MPC -> PCEC	0.927	0.927	0.009	101.363	0.000	0.908	0.944
MPC -> PCGC	0.844	0.844	0.020	42.562	0.000	0.802	0.879
MPC -> PCIC	0.508	0.507	0.070	7.225	0.000	0.357	0.630
MPC -> PCOC	0.834	0.834	0.017	50.071	0.000	0.799	0.865
MPC -> PCTC	0.780	0.781	0.022	35.684	0.000	0.736	0.822
MPC -> PCTEC	0.736	0.737	0.023	32.252	0.000	0.690	0.781
MPC -> PGEE	0.845	0.846	0.017	48.620	0.000	0.808	0.877
MPC -> PGGM	0.942	0.942	0.008	111.157	0.000	0.924	0.957
MPC -> PGGS	0.918	0.918	0.010	96.237	0.000	0.898	0.936

Abbreviations: PGGS = Governance Structure, PGGM = Governance Mechanism, PGEE = External Environment, PCIC = Information Complexity, PCTC = Task Complexity, PCTEC = Technological

Complexity, PCOC = Organizational Complexity, PCEC = Environmental Complexity and PCGC = Goal Complexity, Standard Deviation (S.D.).

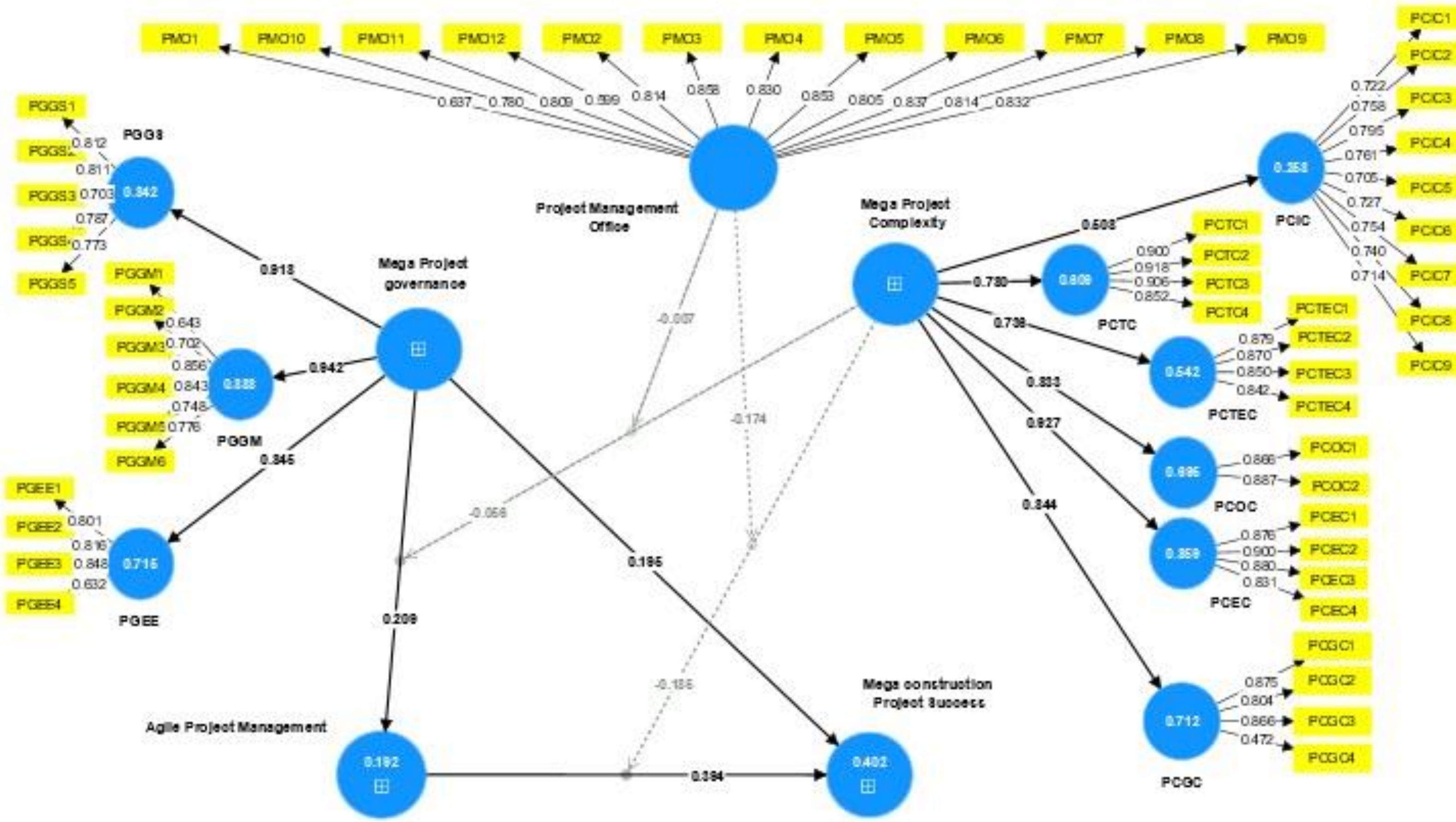

Figure 4. 4 PLS Algorithm at Second Stage (Reflective-Reflective Indicators)

The higher-order structures make the models efficient and facilitate more theoretical simplicity (Hair et al., 2017). A complex model is also defined as having more than 57 items and 5 constructs (Hair et al., 2014). As a result, our model is rather involved, consisting of 119 items and 12 constructs. There are also two distinct kinds of higher-order models: reflecting and formative. Formative types collect individual beliefs into a summary representation, whereas reflective types show the overall attitude in which every dimension reflects the different attitudinal aspects (Hair et al., 2022). According to Nitti and Ciavolino (2014), the conceptual meaning of the construct in the reflective model is unaffected by the addition or removal of any of the elements since they all share the common theme. Second-order constructs in the current study were made up of latent variables, such as MPG and MPC. PLS-SEM allows for the modeling of higher-level structures using a number of different methods, including I the repeated indicator approach, (ii) the two-stage approach, and (iii) the hybrid approach (Becker et al., 2012).

In this investigation, the reflective-reflective type I latent constructs of MPG and MPC have been used (Figure 4.2). Furthermore, the context-specific conceptual implications of MPG and MPC may change if any of the reflective indicators are removed, as is permitted by the features of reflective assessments (Rahman, 2015; Jarvis et al., 2003). Dropping any of the first order constructs leads to changes in the meaning of the second order constructs, since the Lower- Order Constructs (LOCs) of the Higher-Order Constructs (HOCs), in this case, MPG and MPC, do not have a similar theme. As a result, in the current study, reflective-reflective relationships were made. The low correlations between these second-order latent variables' first-order constructs are another factor in deciding to develop the reflective-reflective second-order constructs.

Similarly, the correlations between LOCs and MPG vary from 0.845 to 0.942 and MPC from 0.508 to 0.927 as presented in Table 4.5. Because reflective higher order constructs would exhibit the strong correlation among its first order constructs (0.8), the results of the current study lend credence to the view that MPG and MPC are reflective-reflective type I second order constructs, rather than formative ones. This work follows Fawad (2021) two-stage technique, which is based on Becker et al. (2012) two-stage approach, by using a repeated indicator set up to build reflective-reflective higher-order constructs (Nitti & Ciavolino, 2014). The first step included saving the scores of latent variables representing MPG and MPC; the second stage involved using these values as indicators for reflective-reflective Hierarchical Component Models (HCMs). By fusing the repeated indicator technique with the two-stage strategy proposed by Becker et al. (2012), the current study find that Fawad method is the most appropriate. First, in Fawad method, the scores of the second order construct are saved at the first stage and used as a single indicator of the second order construct in the second stage, whereas in Becker et al. (2012) method, the scores of LOCs are saved at the first stage and used as indicators for the second order construct in the second stage. The second key distinction is that the Fawad approach uses a repeated indicator approach to obtain scores of second order constructs at the outset, whereas in the Becker et al. (2012) procedure, the LOCs are constructed independently of HOCs at the outset, with the latter's scores subsequently serving as indicators of the former. Although both methods make our PLS model more parsimonious, Gaskin's approach is the simplest since it does not need the measurement model analysis of the second-order reflective constructs at the second stage (Lowry & Gaskin, 2014).

In addition, the method proposed by Becker et al. (2012) is inappropriate for this investigation since it describes for two stages of work: first, developing all LOCs without HOCs; second, using the scores of LOCs from HOCs; and third, repeating the measurement model analysis for all LOCs and HOCs. Due to the fact that our model has 12 LOCs and 119 items, this is a very lengthy process. While the current study constructs all LOCs independently in the first stage only to gather scores and then combine those in the second, our model will be more complicated. It would take more time to analyse data to perform the measurement model analysis again at the second stage for HOCs for 327 samples. Our findings suggest that the two-stage procedure proposed by Becker et al. (2012) is best suited to empirical models and research with a more homogeneous population. Therefore, Gaskin's methodology provides the best method due to its simplicity and suitability to our PLS complex models (Lowry & Gaskin, 2014). Also, the single item reflects the scores of latent variables (LOCs) as derived from the multi-item survey in Stage 1, hence the problems highlighted when utilising single items are not an issue here (Ringle et al., 2023). Fawad (2021) indicated, the current study may utilise single item as indicators of reflective second-order constructs in stage two. Reflective-reflective type I constructs, such as MPG and MPC, have been built utilising a repeated indicator technique, as shown in Figures 4.4, with scores from the second order constructs utilised as a single item to represent the constructs. All LOCs and HOCs have had their measurement models evaluated in stage 1 using Fawad (2021) method, however only LOCs have had their measurement models analysed in stage 2 as presented in Figure 4.4.

A conceptual framework was created based on the theoretical foundation and hypotheses, and it is shown in Figure 4.4. The conceptual model is a second-order model with a hierarchical structure consisting of first- and second-order variables. A higher order model, also called a hierarchical component model, is one that seeks to evaluate a more sophisticated, higher-level construct, such a second-order model (Hair et al., 2017). These models have the ability to help in a wide range of situations, such as simplifying the model, enhancing its reliability and validity, decreasing the bias caused by collinearity, and solving discriminant validity issues (Ringle et al., 2023).

Given the broad and intricate nature of mega project governance and mega project complexity, these constructs were modeled as second-order constructs. It's essential to note that higher-order constructs, in this case, are comprehensive concepts that rely on their underlying lower-order constructs. These constructs are represented reflectively or constituted formatively from their foundational lower-order constructs, as indicated by Becker et al. (2012) and Tehseen et al. (2020). Thus, MPG was constituted from its three underlying first-order constructs, that is, governance structure (PGGS), governance mechanism (PGGM) and external environment (PGEE). Similarly, MPC was constituted from its six underlying first-order constructs, that is, information complexity (PCIC), task complexity (PCTC), technological complexity (PCTEC), organizational complexity (PCOC), environmental complexity (PCEC) and goal complexity (PCGC). However, the underlying indicators represented the first-order constructs of both MPG and MPC. In essence, MPG and MPC were considered reflective-reflective constructs, while AMP, PMO, and MCPS were viewed as first-order reflective constructs. It's important to highlight that the relationship between higher (second) and lower (first) order constructs doesn't imply causality; instead, it signifies the inherent nature of these constructs, as outlined by Becker et al. (2012).

4.7 Evaluation of Measurement Model of LOCs at First Stage

Indicator-construct connections are analysed as part of the measurement model evaluation (Hair et al., 2017). Each LOC's measurement model was examined to see whether it accurately reflected the LOC. The following procedures were used to investigate LOC measurement models.

- Reliability analysis using tools like Cronbach's alpha and composite reliability.
- Second, an evaluation of the validity, through convergent validity evaluation Using AVE.
- Evaluating discriminant validity using the Fornell-Larcker criterion, the HTMT criterion, and cross-loading.

The current study employed outer loadings, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) to evaluate the model's first-order latent reflective constructs, as proposed by Hair et al. (2017). Table 4.6 presented the outcomes of a PLS algorithm with a maximum of 5,000 iterations. (Ringle et al., 2023).

Table 4. 6 Assessment of Outer Loadings

Constructs	Items	Factor Loadings	Items	Factor Loadings	Items	Factor Loadings
Mega Project						
Governance	PGGM1	0.643	PGGS1	0.812	PGEE1	0.801
	PGGM2	0.702	PGGS2	0.811	PGEE2	0.816
	PGGM3	0.856	PGGS3	0.703	PGEE3	0.848
	PGGM4	0.843	PGGS4	0.787	PGEE4	0.632
	PGGM5	0.748	PGGS5	0.773		
	PGGM6	0.776				
Mega construction	MCPS2	0.735	MCPS14	0.680	MCPS26	0.735
Project Success	MCPS5	0.732	MCPS15	0.714	MCPS27	0.499
	MCPS6	0.752	MCPS17	0.472	MCPS28	0.516
	MCPS7	0.452	MCPS18	0.506	MCPS29	0.539
	MCPS8	0.645	MCPS19	0.452	MCPS30	0.581
	MCPS9	0.694	MCPS20	0.700	MCPS31	0.501
	MCPS10	0.548	MCPS21	0.530	MCPS32	0.523
	MCPS11	0.548	MCPS22	0.615	MCPS33	0.522
	MCPS12	0.508	MCPS23	0.466	MCPS34	0.565
	MCPS13	0.780	MCPS24	0.543		
Agile Project	APM1	0.635	APM13	0.698	APM26	0.663
Management	APM2	0.618	APM15	0.700	APM27	0.692
	APM3	0.596	APM16	0.717	APM28	0.685
	APM4	0.514	APM17	0.715	APM29	0.549
	APM5	0.605	APM18	0.714	APM32	0.493
	APM6	0.583	APM19	0.715	APM33	0.521
	APM7	0.574	APM20	0.739	APM34	0.551
	APM8	0.666	APM21	0.677	APM35	0.485
	APM9	0.646	APM22	0.684	APM36	0.533
	APM10	0.572	APM24	0.721		
	APM11	0.746	APM25	0.690		
	APM12	0.693				
Mega Project	PCOC1	0.866	PCIC1	0.722	PCEC1	0.876
Complexity	PCOC2	0.887	PCIC2	0.758	PCEC2	0.900
	PCTC1	0.900	PCIC3	0.795	PCEC3	0.880
	PCTC2	0.918	PCIC4	0.761	PCEC4	0.831

	PCTC3	0.906	PCIC5	0.705	PCGC1	0.875
	PCTC4	0.852	PCIC6	0.727	PCGC2	0.804
	PCTEC1	0.879	PCIC7	0.754	PCGC3	0.866
	PCTEC2	0.870	PCIC8	0.740	PCGC4	0.472
	PCTEC3	0.850	PCIC9	0.714		
	PCTEC4	0.842				
Project Management Office	PMO1	0.637	PMO5	0.853	PMO9	0.832
	PMO2	0.814	PMO6	0.805	PMO10	0.780
	PMO3	0.858	PMO7	0.837	PMO11	0.809
	PMO4	0.830	PMO8	0.814	PMO12	0.599

Abbreviations: PGGS = Governance Structure, PGGM = Governance Mechanism, PGEE = External Environment, PCIC = Information Complexity, PCTC = Task Complexity, PCTEC = Technological Complexity, PCOC = Organizational Complexity, PCEC = Environmental Complexity and PCGC = Goal Complexity.

4.8 Reliability (Outer Loadings, Cronbach's Alpha, and Composite Reliability)

Reliability is a statistical measure of how consistent a measurement is with its intended theoretical construct and how well it predicts constructs and item performance (Sarstedt et al., 2022). One of the first criteria to be examined is the extent to which the estimates are consistent among themselves. Conventionally, the reliability estimate based on the intercorrelations of the observed indicator variables has been calculated using Cronbach's alpha, an internal consistency criterion. Moreover, Cronbach's alpha is sensitive to the total number of items on the scale, and therefore tends to overestimate the reliability of internal consistency (Ringle et al., 2023). In light of the restrictions imposed by Cronbach's alpha, an alternative measure of internal consistency reliability called composite reliability has been proposed (Hair et al., 2019). Values of composite reliability between 0.60 and 0.70 are considered acceptable in exploratory research by Hair et al. (2019), whereas values between

0.70 and 0.90 are considered appropriate in more advanced research phases. Low values of Cronbach's alpha indicate poor levels of reliability. Composite reliability, on the other hand, leads to inflated reliability estimations since it overestimates the internal consistency reliability. Cronbach's alpha and composite reliability should thus be considered and reported. Specifically, the true reliability of measurements is often found between the Cronbach's alpha and the composite reliability (Ringle et al., 2023). Table 4.7 presented that all variables Cronbach's alpha were greater than the required threshold values.

Table 4. 7 Assessment of Cronbach's Alpha

Constructs	Sub-Dimensions	Cronbach's alpha
Mega Project Governance		
	PGEE	0.777
	PGGM	0.855
	PGGS	0.836
Mega construction Project Success		0.877
Agile Project Management		0.955
Mega Project Complexity		
	PCEC	0.895
	PCGC	0.756
	PCIC	0.898
	PCOC	0.699
	PCTC	0.917
	PCTEC	0.883
Project Management Office		0.946

Abbreviations: PGGS = Governance Structure, PGGM = Governance Mechanism, PGEE = External Environment, PCIC = Information Complexity, PCTC = Task Complexity, PCTEC = Technological Complexity, PCOC = Organizational Complexity, PCEC = Environmental Complexity and PCGC = Goal Complexity.

By evaluating the measures' internal consistency reliability, the current study presented both reliabilities (along with the new criteria of reliability, rho A, also known as true reliability). Reliability above or equal to the 0.70 threshold indicates that items in capturing a given latent variable; although, this value is flexible, as shown by the results in the Hair et al. (2019). In order to establish the reliability of the measurement models in LOCs, the current study examined at the outer loadings of items, the composite reliability, and the Cronbach's alpha, all of which are recommended by Hair et al. (2017). Examination of item loadings on their respective constructs across the 327 sample data sets allowed for assessment of the 119 items' outer loadings. As can be seen in Table 4.6, with the exception of a small number of items, loadings on their corresponding LOCs were 0.452 to 0.918. According to the criterion established by Hair et al. (2014), items with outer loadings between 0.40 and 0.70 were either maintained or eliminated. Hence, the current study concluded that keeping the few items with outer loadings below 0.4 and above 0.7 in each sample data set would not result in AVE and CR values below their threshold level for any construct. Consequently, these items were kept on their respective constructs in all data sets. Similarly, for every construct that was studied, the CR value was more than 0.70. Table 4.8 also displays the true construct reliability, rho A, which lies between the CR and Cronbach alpha values (Ringle et al., 2023), and it varies from 0.631 to 0.961 for all the LOCs.

Table 4. 8 Assessment of Composite Reliability, rho_A

Constructs	Sub dimensions	Composite reliability (rho_a)	Composite reliability (rho_c)
Mega Project Governance			
	PGEE	0.779	0.859
	PGGM	0.858	0.893

	PGGS	0.838	0.885
Mega construction Project Success		0.886	0.892
Agile Project Management		0.958	0.958
Mega Project Complexity			
	PCEC	0.895	0.927
	PCGC	0.810	0.849
	PCIC	0.902	0.917
	PCOC	0.703	0.869
	PCTC	0.919	0.941
	PCTEC	0.883	0.919
Project Management Office		0.955	0.953

Abbreviations: PGGS = Governance Structure, PGGM = Governance Mechanism, PGEE = External Environment, PCIC = Information Complexity, PCTC = Task Complexity, PCTEC = Technological Complexity, PCOC = Organizational Complexity, PCEC = Environmental Complexity and PCGC = Goal Complexity.

4.9 Assessment of Validity

Indicating whether the instrument or scale really measures what it claims to measure is what the current study means by 'validity' (Hair et al., 2022). Convergent validity considers how well the items within a given construct fit together in terms of measurement, while discriminant validity examines whether one construct's measurement can be clearly distinguished from the measurements of all other constructs (Ringle et al., 2020). How these two kinds of validity are evaluated is explained in the following sections:

4.9.1 Composite Reliability

The internal consistency of the reflective structures may be evaluated using the method of composite reliability (Hair et al., 2021). While calculating composite reliability in Partial

Least Square (PLS), it is important to account for how various items' outer loadings affect the final score. Cronbach's alpha is often used as a criterion for evaluating internal consistency, presupposes that no two items have different degrees of reliability (or equal outer loadings for all items on a construct). Nevertheless, this statistic tends to underestimate the internal consistency reliability and is sensitive to the amount of items on the scale. Hence, composite reliability, where the value ranges from 0 to 1, is suggested in many modern tests for internal consistency, with larger values indicating better degree of dependability (Hair et al., 2021). If, however, the composite reliability is more than 0.95, then it may be concluded that all items are really measuring the same phenomena of the construct in question. Consequently, it is very improbable that these items serve as a reliable indicator of the construct. Table 4.8 indicates that all CR values are considered excellent.

4.9.2 Convergent Validity

When evaluating a measure's convergent validity, it is important to consider how well it corresponds with other measures that assess the same concept. It is desirable for items belonging to the same construct to converge or share a large amount of variation. Examining the items' outer loadings and the average variance recovered will be done to establish convergent validity. The higher the exterior loadings on a build, the more similar the elements that make up the construct are. This set of features is also known as indicator reliability. Indicator reliability is obtained from outer loadings (Hair et al., 2019). Outer loading for indicator reliability should be higher than 0.71. If loadings are between 0.40 and

0.70, such items should be considered for removal only if deletion leads to an increase in composite reliability. In addition, any indicator reliability loading between 0.40 and 0.70 with AVE that is less than 0.50, will also be considered for removal. An AVE usually has at least 0.50 or higher, which means that the construct explains more than 50% the variance of its items (Hair et al., 2017).

In testing, convergent validity is defined as the extent to which multiple items reliably gauge the same concept (Hair & Alamer, 2022). To assess the convergent validity of reflective constructs, one might employ the Average Variance Extracted (AVE) and the outer loadings of the indicators (Ringle et al., 2023). A commonly used method to ascertain convergent validity at the concept level is through the AVE measure. The AVE is derived by summing the squared overall indicator loadings for the construct. An AVE value of 0.50 or higher indicates that the construct explains over 50% of the variance across the studied indicators. Conversely, as per Ringle et al. (2023), an AVE value less than 0.50 suggest inadequate explanation of variation by the concept, signifying greater variations in the items' errors. Therefore, in current study the mediating variable APM items (APM23, APM30, and APM31), and dependent variable MCPs items (MCPS2, MCPS4, MCPS16, and MCPS25) were deleted to increase the value of AVE. Hence, after deleting these items all AVE values were greater than the threshold values, ranging from 0.513 to 0.800, as shown in Table 4.9.

Table 4. 9 Assessment of Average variance extracted Values

Constructs	Average variance extracted
Mega Project Governance	

PGEE	0.606
PGGM	0.585
PGGS	0.606
Mega construction Project Success	0.526
Agile Project Management	0.513
Mega Project Complexity	
PCEC	0.761
PCGC	0.596
PCIC	0.551
PCOC	0.769
PCTC	0.800
PCTEC	0.740
Project Management Office	0.629

Abbreviations: PGGS = Governance Structure, PGGM = Governance Mechanism, PGEE = External Environment, PCIC = Information Complexity, PCTC = Task Complexity, PCTEC = Technological Complexity, PCOC = Organizational Complexity, PCEC = Environmental Complexity and PCGC = Goal Complexity.

4.10 Assessment of Significance and Relevance of Indicator's Weights

Using the bootstrapping method, the significance and relevance of the indicator weights were evaluated in Smart PLS version 4. Bootstrapping (with 5000 resamples) was performed to determine whether the weights were statistically significant (Ramayah et al., 2017). In addition, the weights of the second-order reflective construct were evaluated using bootstrapping with 5000 resamples. Indicator weights should ideally be more than 0.1 (Ringle, Da Silva, & Bido, 2015). The data demonstrates that the item weights are higher than the optimal value of 0.1. Also, an indicator's connection to the formative index building is shown at a significance level of at least 0.05 (Ramayah et al., 2018). Figure 4.5 illustrates that the indicator weights, representing the first-order constructs, exhibited statistically significant values. Additionally, Table 4.10 provides the confidence intervals and *t*-values for the sample, further supporting the significance of the *t*-values, as evidenced by the absence of zero within the confidence intervals between the lower and upper values.

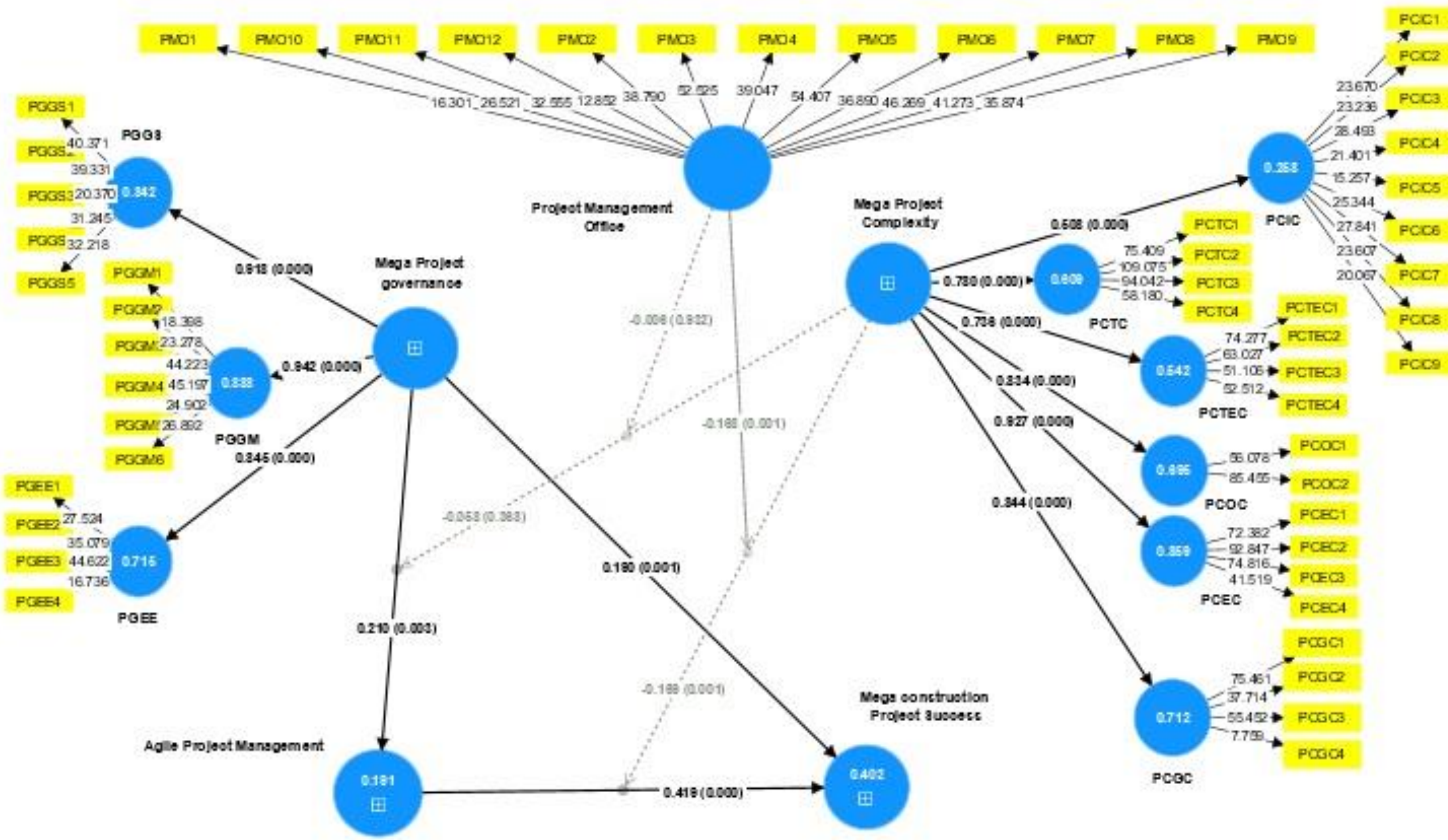

Figure 4. 5 Second Order Reflective- Reflecitve Type Construct (Two-Stage Approach)

4.11 Assessment of Indicator’s Collinearity through Variance Inflation Factor

Each reflective indicator's variance inflation factor (VIF) was also examined across 12 variables. If VIF is less than 5, it is considered to be below the threshold (Ringle et al., 2023). Table 4.10 demonstrates that VIF values for all the reflective indicators were below 5, there are no issues of collinearity. Therefore, it was estimated that the collinearity of all constructs APM, MPC, PMO, MPG (including sub-dimensions: PGGS, PGGM, PGEE) and MPC (including sub-dimensions: PCIC, PCTC, PCTEC, PCOC, PCEC and PCGC) were significant.

Table 4.10 Assessment of VIF for Reflective Indicators

Constructs	Items	VIF	Items	VIF	Items	VIF
Mega Project	PGGM1	1.658	PGGS1	2.041	PGEE1	1.873
Governance	PGGM2	1.786	PGGS2	2.153	PGEE2	1.944
	PGGM3	2.933	PGGS3	1.554	PGEE3	1.963
	PGGM4	2.670	PGGS4	1.817	PGEE4	1.179
	PGGM5	1.941	PGGS5	1.802	PGEE4	1.689
	PGGM6	2.129				
Mega construction	MCPS2	1.306	MCPS15	1.498	MCPS28	1.631
Project Success	MCPS5	1.316	MCPS17	1.578	MCPS29	1.748
	MCPS6	1.423	MCPS18	1.653	MCPS30	1.664
	MCPS7	1.476	MCPS19	1.465	MCPS31	1.664
	MCPS8	1.445	MCPS20	1.273	MCPS32	1.486
	MCPS9	1.575	MCPS21	1.706	MCPS33	1.625
	MCPS10	1.680	MCPS22	1.866	MCPS34	1.880
	MCPS11	1.556	MCPS23	1.700		
	MCPS12	1.518	MCPS24	1.954		
	MCPS13	1.494	MCPS26	1.388		
Agile Project	APM1	2.300	APM13	2.796	APM26	2.977
Management	APM2	2.196	APM15	2.746	APM27	3.109

	APM4	1.841	APM16	2.729	APM28	2.467
	APM5	1.986	APM17	2.472	APM29	2.113
	APM6	1.880	APM18	2.536	APM3	2.317
	APM7	1.811	APM19	2.889	APM32	1.922
	APM8	2.359	APM20	3.160	APM33	1.876
	APM9	2.184	APM21	2.304	APM34	2.036
	APM10	2.047	APM22	2.521	APM35	1.803
	APM11	3.104	APM24	3.015	APM36	1.917
	APM12	2.412	APM25	2.392		
	MCPS1	1.366	MCPS14	1.392	MCPS27	1.457
Mega Project Complexity	PCOC2	1.407	PCIC2	2.565	PCEC2	2.980
	PCTC1	3.121	PCIC3	3.050	PCEC3	2.743
	PCTC2	3.334	PCIC4	2.822	PCEC4	1.996
	PCTC3	3.294	PCIC5	2.203	PCGC1	2.168
	PCTC4	2.297	PCIC6	2.158	PCGC2	1.688
	PCTEC1	2.626	PCIC7	2.669	PCGC3	2.177
	PCTEC2	2.486	PCIC8	2.532	PCGC4	1.093
	PCTEC3	2.131	PCIC9	2.460		
	PCTEC4	2.028				
Project Management Office	PMO1	1.559	PMO5	3.187	PMO9	3.296
	PMO2	3.133	PMO6	2.784	PMO10	3.566
	PMO3	2.111	PMO7	2.644	PMO11	3.291
	PMO4	3.434	PMO8	2.811	PMO12	1.626
	PCOC1	1.407	PCIC1	2.043	PCEC1	2.554

Abbreviations: PGGS = Governance Structure, PGGM = Governance Mechanism, PGEE = External Environment, PCIC = Information Complexity, PCTC = Task Complexity, PCTEC = Technological Complexity, PCOC = Organizational Complexity, PCEC = Environmental Complexity And PCGC = Goal Complexity.

4.12 Fornell-Larcker Criterion, the HTMT Criteria, and Cross-Loadings Are Used To Evaluate Discriminant Validity

Discriminant validity refers to how well individual items capture unique concepts or set apart between various types of constructs. Researchers have often relied on only two methods of discriminant validity in the past. One method for determining whether or not an indicator is discriminant is to look at its cross-loadings. Indicators should have higher outer loadings on their target constructs than cross-loadings on other constructs (Ringle et al., 2023). The results showed that outer loading was higher on the targeted construct than cross-loadings (see Table 4.11). A Fornell-Larcker criterion is the second method used to evaluate discriminant validity. In this method, the correlations of the latent variable are compared to the square root of the AVE values. Each construct's AVE square root should exceed its correlation with all other constructs. The idea behind this technique is that there will be greater correlation between a construct and its indicators than between the construct and any other construct (Ringle et al., 2023). Using this method to evaluate discriminant validity, the current study discovered that the square root of AVE for each construct greater than its association with the other constructs. Cross-loadings and the Fornell-Larcker criteria are often used to evaluate discriminant validity.

Table 4. 11 Discriminant Validity Through Fornell-Larcker Criteria

No.	Constructs	1	2	3	4	5
1.	Agile Project Management	**0.643**				
2.	Mega Project Complexity	-0.361	**0.799**			
3.	Mega Project governance	0.269	-0.184	**0.907**		
4.	Mega construction Project Success	0.466	-0.134	0.338	**0.479**	
5.	Project Management Office	0.331	-0.406	0.214	0.189	**0.793**

Note: The diagonal values represent the square root of the average variance extracted (AVE).

However, recent studies have shown that they are unreliable in identifying problems with discriminant validity (Voorhees et al., 2016; Henseler, Ringle & Sarstedt, 2015). The traditional metric was established by Fornell and Larcker (1981), who proposed for comparing the AVE of each construct to the squared inter-construct correlation (as a measure of shared variance) of that construct and all other reflectively assessed constructs in the structural model. All model constructs should have a variance that is less than or equal to their AVEs (see Table 4.9). A new study indicates, however, that this measure is not adequate for testing discriminant validity. The Fornell- Larcker criteria, as shown by Henseler et al. (2015), do not fare well, especially when indicator loadings on a construct change just marginally (e.g., all the indicator loadings are between 0.65 and 0.85). Henseler et al. (2015) suggested the heterotrait-monotrait (HTMT) ratio of correlations as a substitute (Voorhees et al., 2016). When comparing items measuring the same construct to those measuring different constructs, the HTMT is the geometric mean of the average correlations between the two sets of items.

Hence, Henseler et al. (2015) suggest evaluating the discriminant validity by calculating the heterotrait-monotrait ratio (HTMT) of the correlations. Mean correlations between indicators of distinct constructs (heterotrait-heteromethod correlations) compared to the average correlations between indicators of the same construct (geometric mean) constitutes "HTMT" (Ringle et al., 2023). The actual correlation between two properly measured constructs is estimated using the HTMT method. The term "disattenuated correlation" is also used to describe this true correlation. A lack of discriminant validity is shown if the disattenuated correlation between two constructs is near to 1. Some researchers have recommended a cutoff value of 0.85 (Voorhees et al., 2016), while others have offered a cutoff value of 0.90 (Ab Hamid et al., 2017). Discriminant validity was also evaluated and verified by evaluating the confidence interval for HTMT values less than one. If the value 1 is removed from the interval range, it indicates that the variables are empirically distinct. The HTMT values for all constructs are less than 0.85, as shown in Table 4.12. Thus, this demonstrates that discriminating validity has been recognized in this investigation.

Table 4. 12 Discriminant Validity Through Heterotrait-Monotrait Ratio (HTMT)

No.	Constructs	1	2	3	4	5
1.	APM					
2.	MPC	0.355				
3.	MPG	0.277	0.225			
4.	MCPs	0.475	0.196	0.346		
5.	PMO	0.330	0.453	0.224	0.233	

It is crucial to note that the aforementioned measurement models for current study data sets were first assessed using the PLS technique. In the first phase, the whole model was executed to determine quality evaluation criteria, including reliabilities and validity. The first stage models are shown in Figures 4.4 and 4.5. Considering the cross-loadings test, Table 4.6 demonstrates that each item's loading is larger than the sum of its cross-loadings. In addition, the loadings for each item that were more than 60% were acceptable and met the above-mentioned cut-off for factor loadings.

4.13 Statistical significance is evaluated using Bootstrapping.

Bootstrapping is a nonparametric approach that evaluates the accuracy of a parameter without resorting to parametric assumptions by instead assessing the distribution of the estimates by resampling from the available sample data (Ramayah et al., 2017). For this purpose, bootstrapping creates several replacement-based random subsamples of the original data set. While doing statistical inference, these subsamples' model estimations are put to use (i.e., calculating confidence intervals or p-values). In the mega construction projects, bootstrapping is often used for a variety of assessment criteria, including the heterotrait-monotrait ratio of correlations criterion (Henseler et al., 2015). Bootstrapping is widely used by construction sector researchers, although it is not without its share of practical issues. Henseler et al. (2015) indicated that researchers should pay close attention to the following criteria: the kind of bootstrap confidence intervals utilized; the sample size per bootstrap subsample; the number of bootstrap samples; and the significance level. In the case of a 5% significance threshold, this technique utilizes the bootstrap estimates to determine the 2.5 and 97.5 percentiles of the distribution of a parameter value. Both the minimum and maximum points of the confidence interval are determined by these percentiles. Researchers should use the bootstrap strategy, which corrects the percentile method for skewness, if the distribution of their parameters is very asymmetric (Hayes and Scharkow, 2013). There is no objective criterion for what constitutes a ‘very asymmetric’ distribution. Upon reviewing the histogram, however, if significant deviations of symmetry are found (such as a multimodal distribution), these should be viewed as obvious evidence in support of the bootstrap method. Hence, the current research used the bootstrap technique (5,000 subsamples) was used on the 327 respondents to examine the significance level for factor loading, path coefficients and weights as shown in Figure 4.6.

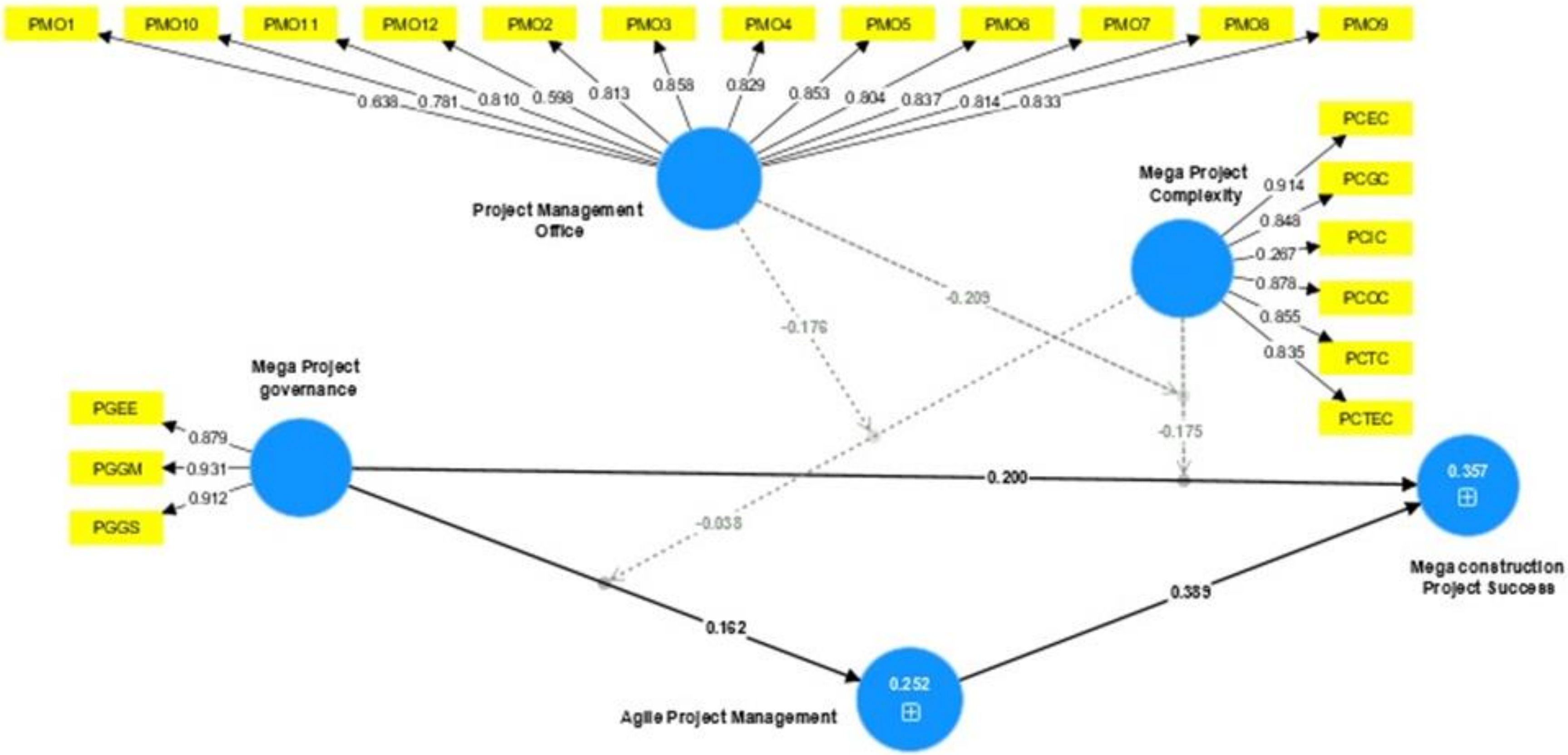

Figure 4. 6 PLS path analysis of (5000 bootstrapped samples)

4.14 Assessment of Structures equation modeling

Results from the structural models were evaluated once the measurement models' analysis had established the constructs' reliability and validity. The model's prediction abilities and inter-construct relationships were assessed (Ringle et al., 2023). Key criteria for evaluating the structural model in PLS-SEM (see Table 4.13), as outlined by Hair et al. (2017), are as follows:

- First, an analysis of the structural model's collinearity problems.
- Evaluation of the structural model's significance and relevance.
- Evaluation of the coefficient of determination (R^2) value.
- Evaluation of the effect size (f^2) value.
- Evaluation of PLS predict value.

Table 4.13 Guidelines for Evaluating Structural Models

Key criteria	
Collinearity	If VIF is more than or equal to 5, critical collinearity problems are probable to arise. In most cases, collinearity problems are not severe when VIF is between 3 and 4. If the VIF is less than 3, collinearity is not considered to be problematic.
Significance and relevance of the path coefficients	Apply bootstrapping to assess the significance of the path coefficients on the ground of *t*-values or confidence intervals. Assess the magnitude of path coefficients. Assess the f^2 values for each path and check that they follow the same rank order as the path coefficient magnitude.
R^2 value	R^2 values of 0.75, 0.50, and 0.25 are considered substantial, moderate, and weak. However, R^2 values have to be interpreted in the context of the model and its complexity. Excessive R^2 values

	indicate that the model overfits the data.'
PLS predict	Focus on one key target construct in the analysis. Set k = 10, assuming each subgroup meets the minimum required sample size Use ten repetitions. Compare the RMSE or MAE values generated by Partial Least Squares Structural Equation Modeling (PLS-SEM) against those produced by Linear Modeling (LM) for each indicator. Assess whether the PLS-SEM analysis, in comparison to LM, results in lower prediction errors. Determine if PLS-SEM exhibits higher predictive power, as indicated by lower RMSE (or MAE) values, for all indicators (high predictive power), the majority or an equal number of indicators (medium predictive power), a smaller number of indicators (low predictive power), or none of the indicators (no predictive power). Utilize the Data Augmentation (DA) approach to generate predictions in mediation models.

Abbreviations: RMSE = Root-mean-squared error, MAE= Mean absolute error

4.14.1 Analysis of Collinearity Problems

To evaluate the collinearity issues in the theoretical model, several different Variance Inflation Factor (VIF) values were tested. Table 4.14 displays the VIF values for all possible pairings of external constructs (predictors) and endogenous constructs (explanatory variables).

Table 4.14 Inner VIF Values for Samples

Constructs	Agile Project Management	Mega construction Project Success
Mega Project governance	1.315	1.350
Agile Project Management		1.337
Mega Project Complexity	1.519	1.598
Project Management Office	1.908	1.955

4.14.2 Coefficient of Determination (R^2)

Table 4.15 indicates the R^2 value of the endogenous constructs. R^2 measures the model's explanatory capacity (Hair et al., 2022), also known as its in-sample predictive power, by indicating the proportion of variation in each endogenous component that is accounted for by the model (Sarstedt et al., 2022). The R^2 scales from 0 to 1, with higher values suggesting more explanatory strength. In several areas of the social sciences, R^2 values of 0.75, 0.50, and 0.25 are regarded as large, moderate, and weak, respectively (Ringle et al., 2020). Yet acceptable R^2 levels depend on the study setting and in certain fields a R^2 value as low as 0.10 is regarded good, for as in predicting market returns (e.g., Sarstedt et al., 2022). The larger the number of predictor constructs, the higher the R^2 as suggested by Hair et al. (2017). The R^2 value should always be viewed in the context of comparable research and models of a similar level of complexity. In cases when the model overfits the data, R^2 values might be very high. When a (partial regression) model is overfit, it conforms too closely to the data in the sample rather than to the population as a whole because of the model's complexity. The likelihood that the same model would work on a different sample from the same population is low (Hair et al., 2019). R^2 values of (up to) 0.90 may be reasonable for evaluating concepts like physical processes, which have an innate predictability. However, if the model is intended to predict human emotions, thoughts, and actions, then a R^2 value around or at 0.90 would certainly imply model overfit (Hair et al., 2019). As additional variables are added to a model in an attempt to explain the data, the R^2 value tends to rise. The modified R^2 metric takes this into account by reducing the R^2 value according to the number of explanatory factors relative to the quantity of the data and is thus a more cautious estimate of R^2 (Hair et al., 2019). Nevertheless, the adjusted R^2 is not a perfect indicator of the explained variance of an endogenous construct because of the correction factor included to account for data and model size (Sarstedt et al., 2022).

Table 4.15 Coefficient of Determination (R^2)

Constructs	R^2	R^2 adjusted
Agile Project Management	0.252	0.236
Mega construction Project Success	0.357	0.341

4.14.3 Evaluation of the f^2 effect size

The R^2 value of an endogenous construct may also be evaluated when a researcher eliminates a chosen predictive construct. The f^2 effect size is a measure that corresponds closely to the magnitude of the path coefficients (Hair et al., 2017). Comparing the size of the path coefficients and the f^2 effect sizes often yields the same ranking of the predictor construct's importance in explaining a dependent construct in the structural model. According to Hair et al. (2019) the researcher may provide the f^2 effect size to provide a different viewpoint on the findings (i.e., if the rank order of constructs' relevance to clarifying a dependent construct in the structural model changes when comparing the size of the path coefficients and the f^2 effect sizes). Effect sizes are often required in several research contexts, such as moderation analysis (Ringle et al., 2023).

While evaluating a structural model, it is essential to consider the established criteria. Specifically, the f^2 impact size of the interaction effect is of interest in the context of moderation (Hair et al., 2022; Ringle et al., 2023). Using this criterion, one may determine how much the R^2 value changes when an exogenous component is removed from the model, as described in Table 4.16. The f^2 effect size for the interaction effect shows how much the moderating impact helps to explain the endogenous construct. Whether the interaction term of the moderator model is included or removed from the PLS path model, R^2_{included} and R^2_{excluded} represent the R^2 values of the endogenous construct, respectively. Hence, the importance of the moderating influence may be evaluated. It is often accepted that f^2 values of 0.02, 0.15, and 0.35 indicate modest, medium, and high impact sizes, respectively, when evaluating studies (Hair et al., 2022). Tests of moderation often yield a small effect size, however, as shown by Aguinis et al. (2005). In light of this, Kenny and Judd (2019) suggest that 0.005, 0.01, and 0.025 represent more realistic criteria for small, medium, and large impact sizes of moderation, but emphasizes that even these values are optimistic.

Table 4.16 Assessment of the f^2 effect size

Constructs	Agile Project Management	Mega construction Project Success
Agile Project Management		0.176
Mega Project Complexity	0.052	
Mega Project governance	0.027	0.046
Project Management Office	0.025	0.013
Mega Project Complexity x Mega Project governance	0.001	0.031
Project Management Office x Mega Project Complexity	0.001	0.039
Project Management Office x Mega Project Complexity x Mega Project governance	0.018	0.029
Project Management Office x Mega Project governance	0.045	

4.15 Evaluation of Structural Model Path Coefficients

The structural model, also called the internal model, is connected to the route model by its hypothesized relationships between the constructs, which reveal the strength and nature of those relationships. Finally, the model shows how much variation in the endogenous constructs can be accounted for and how much remains unexplained. The study consisted of five constructs in the internal structure models. Through a bootstrapping process including five thousand subsamples, the study was able to determine the parameters of the internal structural models. The path coefficients between the endogenous components (specifically MPG, MPC, PMO, APM and MCPs) were used to estimate the internal structural models in a current study sample. Figure 4.7 show the results of bootstrapping for the current research PLS model.

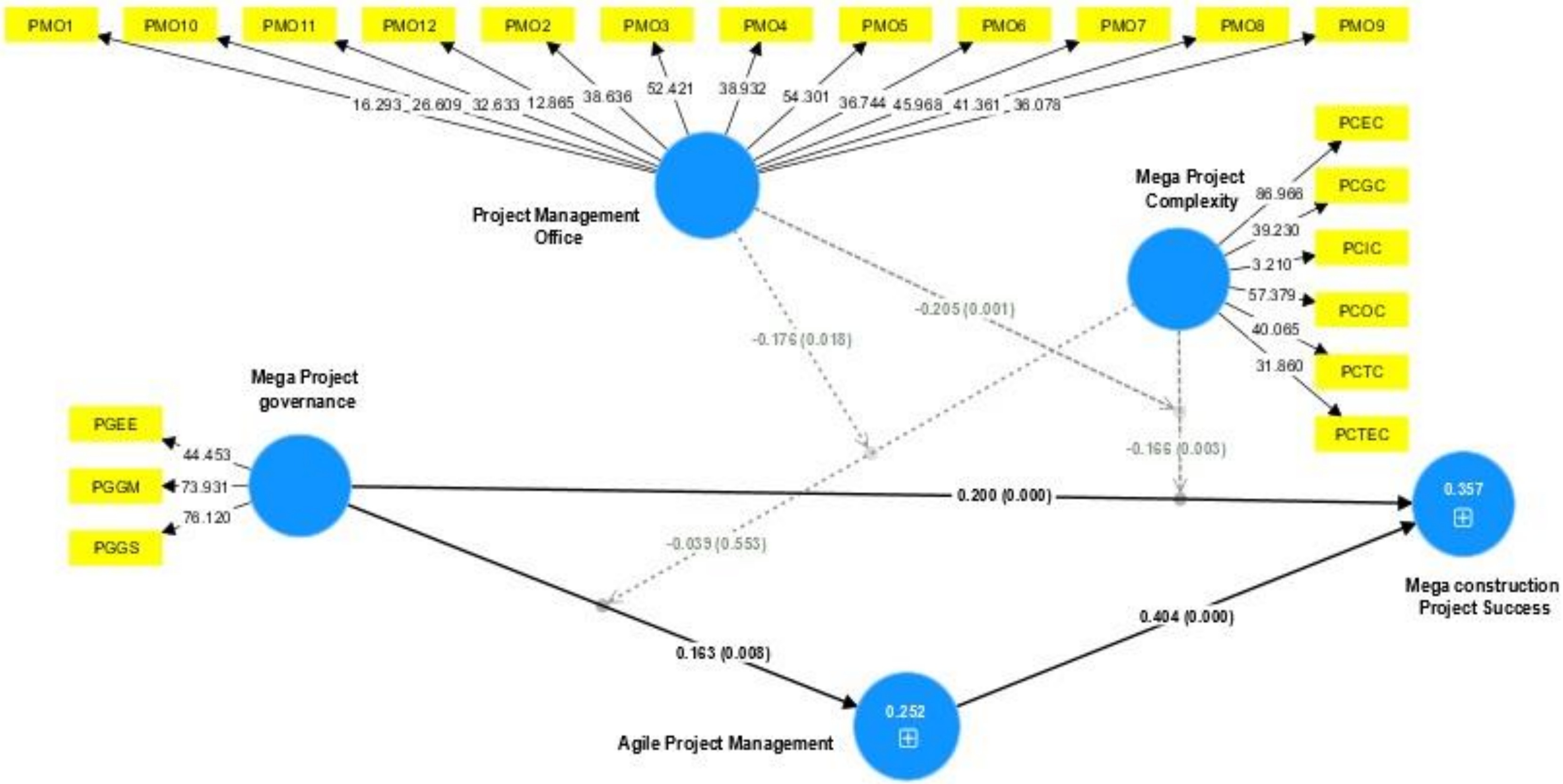

Figure 4. 7 Structural equations model

4.15.1 Testing of Direct Hypotheses

The hypothesized model H1, H3 and H3 were connected to the direct effects of latent constructs on endogenous constructs. The outcomes of these hypotheses are displayed in the explanation below. Table 4.17 showed that there is a positive and significant relationship between MPG and MCPS. The path coefficient (β=0.200, t=3.494, p<0.001) show that a one unit-change in MPG leads to a 20% change in MCPS. The bootstrapping method yielded lower limit confidence intervals (LLCI) of 0.091 and upper limit confidence intervals (ULCI) 0.319, indicating that 'zero' does not lie between the two intervals. Hypothesis 1 was supported, demonstrating the impact of MPG on MCPS, consistent with prior research (Joslin & Müller, 2016; Ul Musawir et al., 2017). Despite challenges posed by cultural factors in developing countries like Pakistan, MPG still influences project success. However, the study reveals that culture may hinder the full benefits of MPG on MCPS. Strengthening participants' understanding of MPG implementation is crucial. This research contributes to understanding MPG's role in developing countries and fills a gap in existing literature (Khattak & Mustafa, 2019; Eyiah-Botwe et al., 2016; Banihashemi et al., 2017; Ali et al., 2021).

Furthermore, hypothesis 2 the direct effect of MPG on APM is positive and significant (β=0.163, t=2.643, p=0.008). The one- unit change in MPG indicates a 16.3% change in APM. Therefore, hypothesis 2 was supported, highlighting the importance of balancing governance structure with the flexibility of agile project management. MPG plays a crucial role in establishing clear objectives and priorities, benefiting APM by providing a solid foundation for decision-making and task prioritization. Additionally, a robust governance framework helps manage project risks effectively, ensuring proactive resolution of potential issues and enabling agile teams to stay focused on delivering value throughout the project lifecycle. These findings are consistent with previous research and emphasize the complementary relationship between MPG and agile project management (ul Musawir et al., 2020; Zhai et al., 2020; Albuquerque et al., 2020; Derakhshan et al., 2019; Deng et al., 2021; Arefazar et al., 2022; Verma, 2022).

Lastly, the hypothesis H3, APM on MCPs (β=0.404, t=7.580, p<0.001) is also positive and significant. The result revealed that 40.4% change occurs in MCPS due to APM. The study confirms a positive and significant impact of agile project management on mega construction project success, supporting Hypothesis 3. This aligns with previous research emphasizing APM's flexibility, collaboration, and continuous improvement principles (Manurung & Kurniawan, 2021). APM prioritizes stakeholder needs, encourages flexibility in response to evolving requirements, and promotes incremental value delivery (Kaim et al., 2019; Gomes Silva et al., 2022; Hutter et al., 2023; Olszewski, 2023). These findings underscore the importance of adopting agile approaches in mega construction projects to enhance success. Moreover, Figure 4.7 indicated connection between factors, if the value of t is within range of –1.96 and þ1.96, the connection between factors insignificant at the confidence level of 95% and if t < –1.96 and >+1.96, the connection between factors will be significant at the confidence level of 95%. Figure 4.7 shows connections between all factors are significant. Hence, all direct hypotheses H1, H2 and H3 were supported.

Table 4. 17 Testing of Hypotheses (Direct Effect)

Hypothesis	Relationship among constructs	*β*	M	S.D.	*t* Values	*p* values	LLCI 2.5%	ULCI 97.5%	Remarks
H1	MPG -> MCPS	0.200	0.206	0.057	3.494	0.000	0.091	0.319	Supported
H2	MPG -> APM	0.163	0.165	0.062	2.643	0.008	0.046	0.292	Supported
H3	APM -> MCPS	0.404	0.420	0.053	7.580	0.000	0.312	0.518	Supported

4.15.2 Mediation Analysis

In mediation, one construct (the mediator constructs) mediates a connection between two other constructs. In the PLS path model, changes in the exogenous construct led to modifications in the mediator construct, which in turn lead to modifications in the endogenous construct. If theoretically valid and methodologically acceptable, mediation may be a valuable statistical study when such an effect is observed. The direct and indirect effects of a mediator are shown in Figure 4.8. In structural models, indirect effects are the results of a sequence of interactions separated by an intervening construct. Because of this, numerous arrows are used to visually represent an indirect impact, which is the result of a sequence involving two or more direct effects.

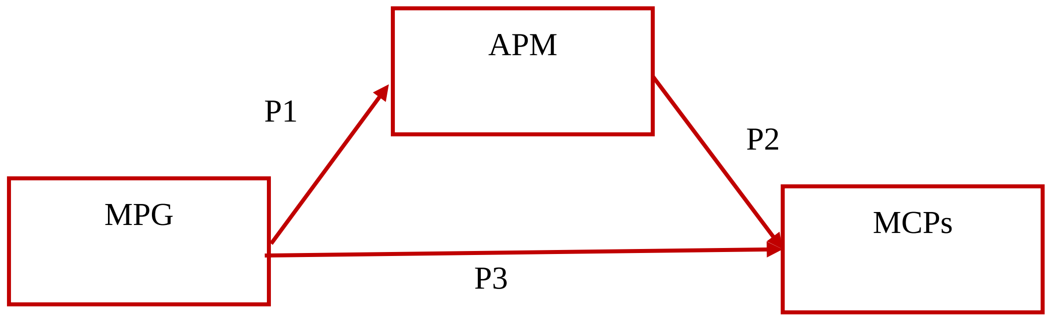

Figure 4. 8 Mediation Analysis

There is a direct influence of MPG to MCPS, and an indirect influence of MPG on MCPS, both of which are shown in Figure 4.8. The indirect impact is the result of APM mediating role in the connection between MPG and MCPS. Lastly, the combined effect (i.e., P1 + P2 + P3 in Figure. 4.8) is known as the total effect. Many PLS path models include mediation effects, although they are not always explicitly theorized and evaluated (Hair et al., 2022). In order to have a complete and accurate understanding of the nature of the cause-effect connection, it is necessary to theoretically analyze the possibility of mediation and also conduct empirical testing (Cheah et al., 2018). Baron and Kenny (1986) introduced a causal step technique to mediation analysis that is being used by many scholars presently (Rasoolimanesh et al., 2021). Nevertheless, more subsequent studies have shown that Baron and Kenny (1986) methodology have conceptual and methodological issues (e.g., Hayes, 2018). Zhao et al. (2010) provide a summary of previous research on mediation analysis and associated directions for future study (see Figure 4.9).

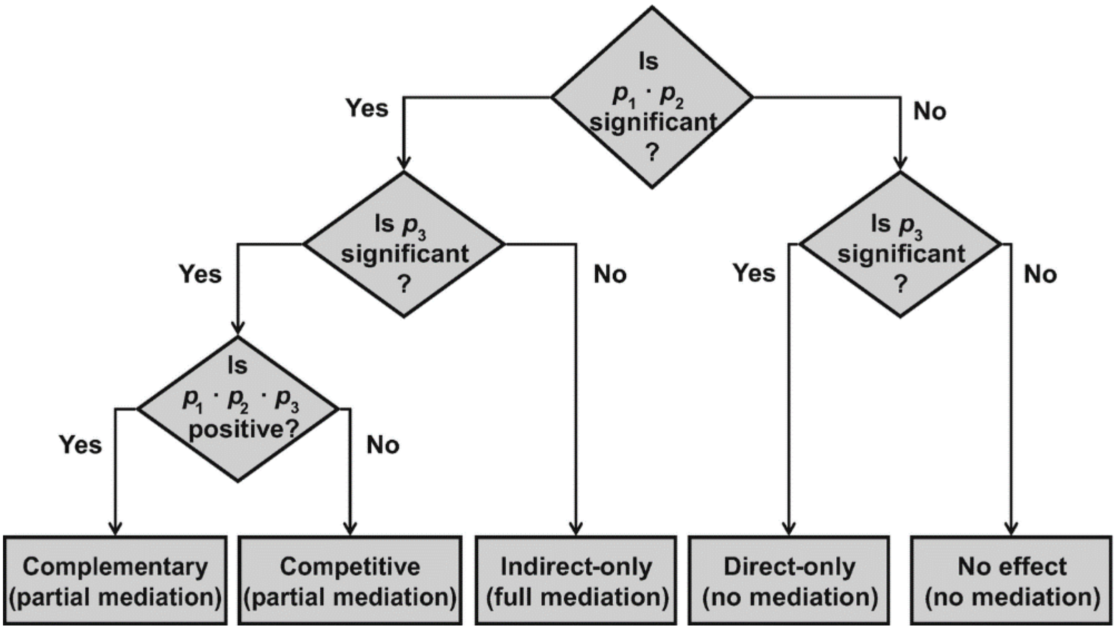

Figure 4. 9 Mediation analysis procedure (Source: Zhao et al., 2010)

Seen in this perspective, the procedure described by Zhao et al. (2010) is very coherent with the partial mediation (i.e., complementary mediation), suppressor effect (i.e., competitive mediation), and full mediation (i.e., indirect-only mediation) ideas proposed by Baron and Kenny (1986). As process evolution is the primary focus of mediation, explanation is the primary goal of the study in mediation analysis (Henseler *et al.*, 2016). Nonetheless, it's possible that mediation analysis will be crucial in forecasting. This approach was summarized by Preacher and Hayes (2008) as follows (see Figure 4.10 and Figure 4.11): Variable M is a mediator if X significantly accounts for variability in M, X significantly accounts for variability in Y, M significantly accounts for variability in Y when controlling for X, and the effect of X on Y significantly decreases when M is entered simultaneously with X as a predictor of Y. Baron and Kenny (1986) technique assumes that assessing the difference between c and c' is equivalent to checking if the strength of the indirect path a x b differs considerably from zero; this is the primary criteria for determining mediation (Henseler et al., 2016).

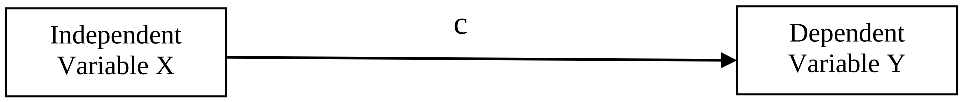

Figure 4. 10 Simple cause effect Relationship Model

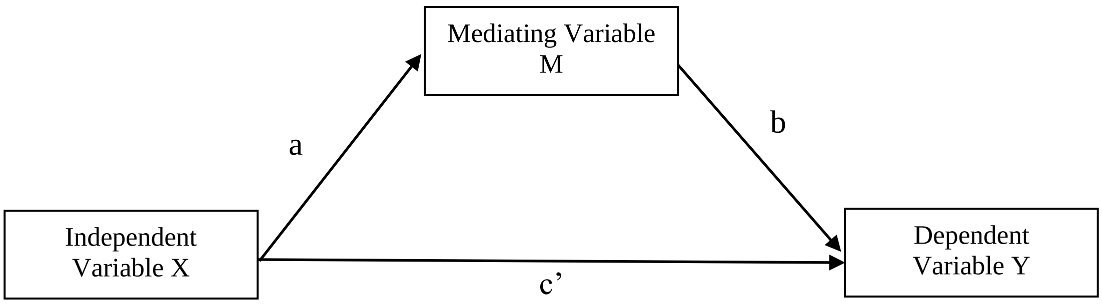

Figure 4. 11 General Mediation Model

In recent years, several scholars, including Preacher and Hayes (2004), Preacher and Hayes (2008), Zhao et al. (2010), Henseler et al. (2016) have advocated for a reevaluation of Baron and Kenny's (1986) technique and recommended the use of new approaches to assess mediating effects. Shrout and Bolger (2002) proposed that the first criterion for mediation outlined by Baron and Kenny (1986), who suggests that X must exhibit a substantial influence (c) on Y in the initial step, may not be necessary to establish the presence of mediation. This implies that the existence of an effect (c) should not be a prerequisite to consider the possibility of mediation. As shown in Figure 4.11, PLS researchers must begin investigating mediating effects by examining the indirect impact (a x b). The indirect impact can alternatively be expressed as the difference between the total effect and the direct effect:

Indirect effect (a x b) = total effect (c)- direct effect (c') ……….. Formula (1)

Thus, in Formula (1), c does not stand for the mediated impact but rather for the total effect. Because of this, it is no longer essential to test a separate model to derive the total effect c in a PLS model (Figure 4.11) since c does not restrict the size of a and b or their product (Hayes, 2018). Therefore, it is recommended that the direct impact c′ be included in PLS analyses on a regular basis so that researchers may monitor and identify the type of mediating effect. A decision tree depicting several approaches to classifying mediation analyses is shown in Figure 4.12. It has two stages that reflect the above-mentioned guidelines for mediation analysis. Therefore, current study follows the new guidelines of Hayes (2018) to perform mediation analysis.

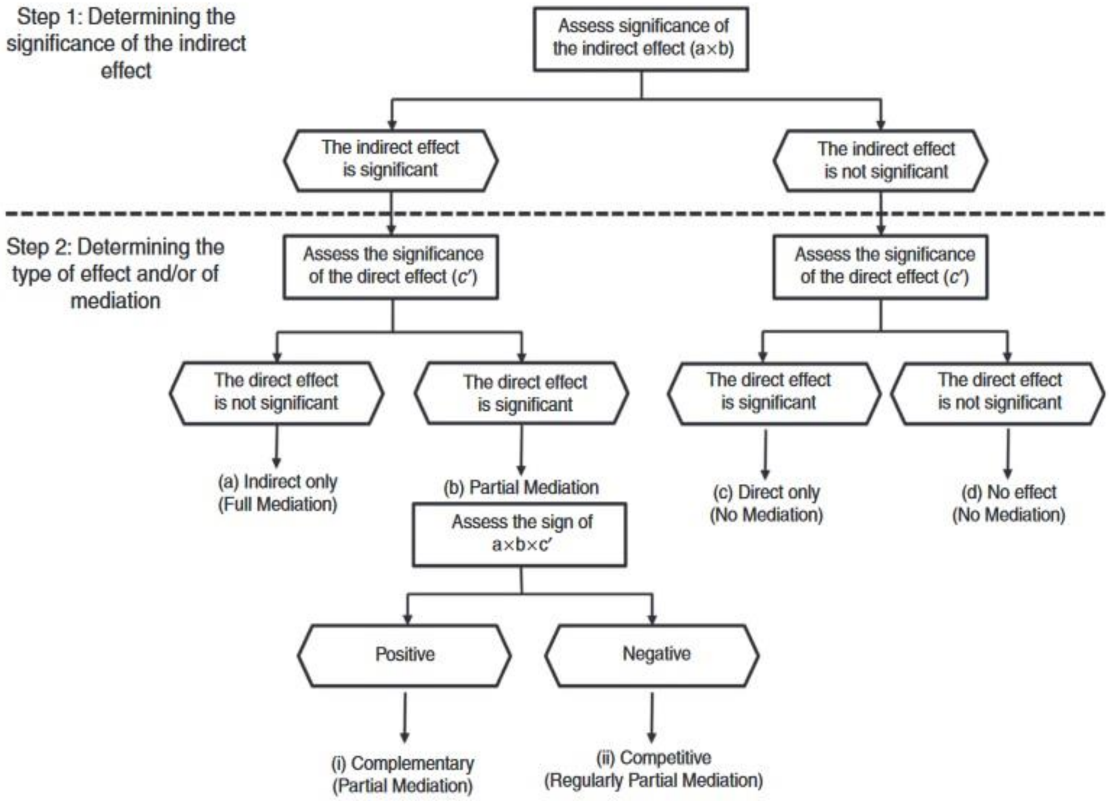

Figure 4. 12 Mediation Procedure for Mediation Analysis in PLS (Source: Zhao et al., 2010)

Table 4.18 indicates that the indirect effect of MPG on MCPS is positive and significant through mediator APM (β=0.066, *t* value=7.322, *p*=0.020). Additionally, using bootstrapping, the lower limit confidence intervals is 0.018 and upper limit confidence intervals is 0.129, respectively, which shows that ‘zero’ does not exist between both confidence intervals. Hence, the study result confirms that agile project management positively and significantly mediates the relationship between mega project governance and mega construction project success, supporting Hypothesis 4. These findings align with previous research highlighting the benefits of integrating MPG and APM to mitigate conflicts and achieve project success (Lappi et al., 2018; Mohammed &

Chambrelin, 2020; Nowotarski et al., 2015; Albuquerque et al., 2020; ul Musawir et al., 2020). The study extends prior work by showing that while both MPG and APM contribute to MCPS; the direct effect of MPG on MCPS is greater than its indirect effect through APM. Continuous improvement in business processes, facilitated by modern agile methodologies, holds promise for enhancing the efficiency of the construction industry (Bergmann et al., 2018; Sohi et al., 2016).

Table 4. 18 Testing of Hypotheses (Indirect Effect: Mediation Analysis)

Hypothesis	Relationship among constructs	*β*	M	S.D.	*t* values	*p* values	LLCI 2.5%	ULCI 97.5%	Remarks
	MPG -> APM	0.163**	0.165	0.062	2.643	0.008	0.046	0.292	
	APM -> MCPS	0.404***	0.420	0.053	7.580	0.000	0.312	0.518	
H4	MPG -> APM -> MCPS	0.163 x 0.404 = 0.066*	0.070	0.028	2.322	0.020	0.018	0.129	Supported

Abbreviations: MPG = Mega project governance, APM = Agile project management, MCPS = Mega construction Project Success, *p<0.05, **p<0.01, *** p<0.001.

4.15.3 Moderation Analysis

When the strength of an association between two concepts changes depending on the values of a third variable (the moderator variable), the current study indicate that the strength of the association is moderated. Depending on the value of the moderator variable (or construct), the direction and/or magnitude of an existing association between two model constructs may be altered. Figure 4.13 has shown that MPC has two moderating impacts: First, it moderates the relationship between MPG and MCPS. Second, MPC acts as a moderator on MPG and APM. The higher the MPC, the weaker the correlation between MPG and APM, and MPG and MCPS.

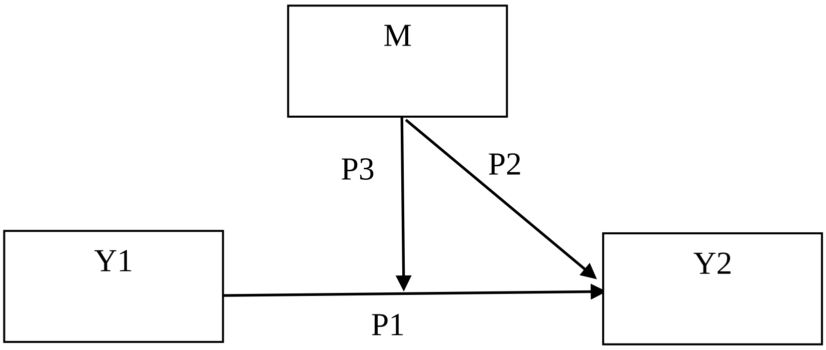

Figure 4. 13 Moderation Model Example

The moderating effect (P3) is shown by an arrow pointing towards the impact P1 that connects Y1 and Y2. In addition, when the moderating effect is included into a PLS path model, there is a direct association (P2) between the moderator and the endogenous construct. This second approach is crucial (and a common source of error) since it controls for the direct influence of the moderator on the endogenous construct. If the route P2 were eliminated, the influence of M on the connection between Y1 and Y2 (i.e., P3) would be exaggerated. Moderation resembles mediation in that a third variable (i.e., a mediator or moderator variable) influences the strength of the link between two latent variables. The key contrast between the two notions is that the moderator variable is independent of the exogenous concept. Mediation produces a direct relationship between the exogenous and mediator constructs (Memon et al., 2018). Figure 4.13 shows a path model with a moderating impact; this model can be described mathematically as follows:

$$Y_2 = (p_1 + p_3 \cdot M) \cdot Y_1 + p_2 \cdot M.$$

In addition to the intensity of the simple impact p1, the product of p3 and M also determines the extent to which Y1 affects Y2. Rewriting the equation as follows clarifies how a moderator variable may be included into a route model.

$$Y_2 = p_1 \cdot Y_1 + p_2 \cdot M + p_3 \cdot (Y_1 \cdot M).$$

This equation demonstrates that specifying the influence of the exogenous construct (i.e., p1.Y1), the effect of the moderator variable (i.e., p2. M), and the product term p3 (Y1.M), which is also known as the interaction term, is necessary for incorporating a moderator effect. The coefficient p3 therefore represents the degree to which the impact p1 shifts when the moderator variable M is altered by a single standard deviation. Interaction terms are shown in Figure 4.13. The model's interaction term is a latent variable that accounts for the multiplication of Y1 (the external construct) and M (the moderator). Researchers often model moderator variables with reference to interaction effects because of this phrase.

The two-stage method proposed by Hair et al. (2017) has been demonstrated to perform very well in simulation experiments in terms of parameter recovery and statistical power. Moreover, this method provides a great deal of adaptability since it is the only method that can be used when the exogenous construct (Y1) or the moderator (M) is specified formatively. According to Ringle et al. (2020) the two-stage method is employed most often for generating the interaction term. The origin of the two-stage method is in its use of PLS-strength SEM in estimating latent variable scores. These two steps are as follows: First, the scores for the latent variables are calculated using the main effect model (i.e., without the interaction term). At Stage 1, latent variables are scored, and those values are used as single items to represent all other latent variables. This data is stored for use in Stage 2 analysis. The second stage involves multiplying the scores of the latent variables representing the exogenous construct and the moderator variable from the first stage into a single item to assess the interaction term.

Table 4. 19 Testing of Hypotheses (Interaction Effect Moderation Analysis)

Hypothesis	**Relationship among constructs**	***β***	**M**	**S.D.**	***t* values**	***p* values**	**LLCI 2.5%**	**ULCI 97.5%**	**Remarks**
H5	MPC x MPG -> MCPS	-0.166	-0.165	0.055	3.023	0.003	-0.269	-0.058	Supported
H6	MPC x MPG -> APM	-0.039	-0.041	0.066	0.593	0.553	-0.170	0.086	Not Supported

Abbreviations: MPC = Mega Project Complexity, MPG = Mega project governance, APM = Agile project management, MCPS = Mega construction Project Success, *p<0.05, **p<0.01, *** p<0.001.

The interaction term results from multiplying the mean-centered independent variable (IV) by the moderator. When the value of the interaction is higher, there is a greater deviation from the parallel lines representing the IV and dependent variable (DV) at various levels of the moderator. This divergence serves as an indicator of the impact of moderation. The study has two moderating hypotheses H5 and H6 as shown in Table 4.19. The H5 is related to the moderating influence of mega project complexity on the relationship between mega project governance and mega construction project success. The result indicates that mega project complexity negatively and significantly moderates the relationship between mega project governance and mega construction project success (β= -0.166, *t* value=3.023, *p*=0.003), the interaction term is significant at less than 5% level of significance. A one unit-change in MPC leads to a -16.6% change in the relationship between MPG and MCPs. Also, the bootstrapping method yielded lower limit confidence intervals (LLCI) of -0.269 and upper limit confidence intervals (ULCI) -0.058, indicating that ‘zero’ does not lie between the two intervals. Therefore hypothesis 5 was supported as presented in Figure 4.14 also indicated the different regression coefficients at three level of moderation effect of as low, medium, and high. These findings are consistent with previous research highlighting the adverse impact of project complexity on project performance (Lebcir et al., 2011; Jarkas, 2017; Bosch-Rekveldt et al., 2011; Floricel et al., 2016; Luo et al., 2017). To address project complexity, organizations can adopt a program management approach to simplify complexities and maintain control over project execution (Ahn et al., 2017). It is crucial for organizations to foster a workplace culture conducive to employee well-being, as dissatisfied employees can hinder project progress. Balancing work-life culture within project teams is essential for optimizing project longevity. In poorly managed settings, unchecked requirements, issues, and defects accumulate, leading to resource strain and confusion during the planning phase. Task division into multiple iterations and stages becomes necessary to meet all criteria effectively.

The conditional effect stable and Figure 4.14 have shown that at a high level (+1 SD) of MPC, the relationship between MPG and MCPS was negative and significant. However, the sixth hypothesis that the mega project complexity negatively moderates the relationship between mega project governance and agile project management is not significant (β= -0.039, t value=0.593, p= 0.553) the p value is greater than 0.05, hence hypothesis 6 was not supported. While agile methodologies prioritize collaboration and customer engagement, challenges in implementing agile approaches persist in the construction industry, including organizational cultural constraints, inadequate education and training, and lack of clear implementation guidelines (Owen et al., 2006; Dikert et al., 2016; Conboy et al., 2019; Raharjo, 2023). Agile methodologies aim to reduce organizational complexity by breaking down large problems into manageable tasks and promoting decentralization and team autonomy (Hidalgo, 2019; Chan & Thong, 2009; Meredith et al., 2017). To address project complexity, project management teams should focus on enhancing their adaptability to internal changes and improving communication among team members to overcome skill disparities and ensure timely task completion (Serrador & Pinto, 2015; Zhai et al., 2020). Figure 4.15 indicated that the conditional effect of MPC on the relationship between MPG and APM was not significant at all three levels (low, medium, and high).

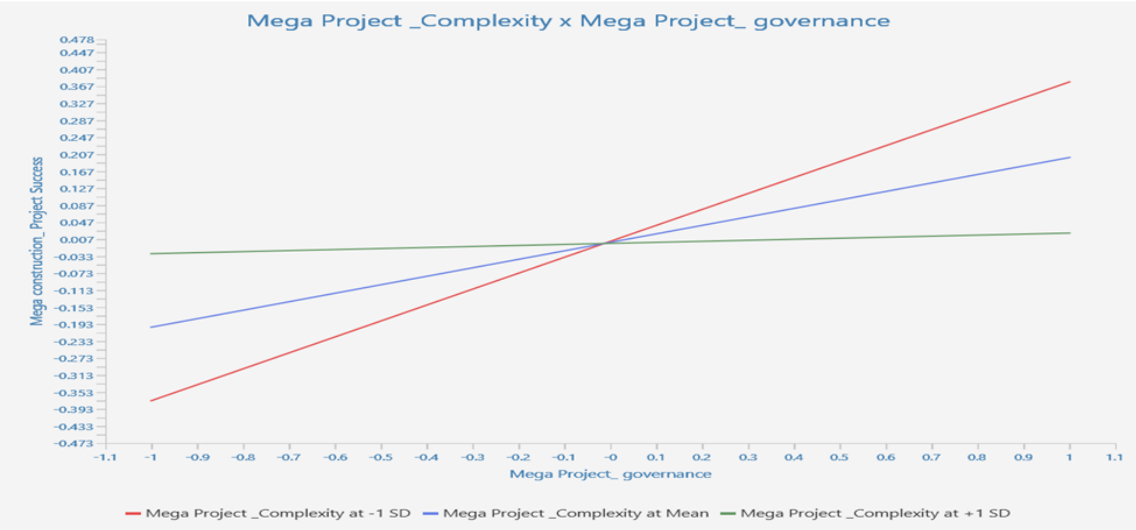

Figure 4. 14 MPC as Moderator on MPG and MCPs (High, Medium, and Low Complexity)

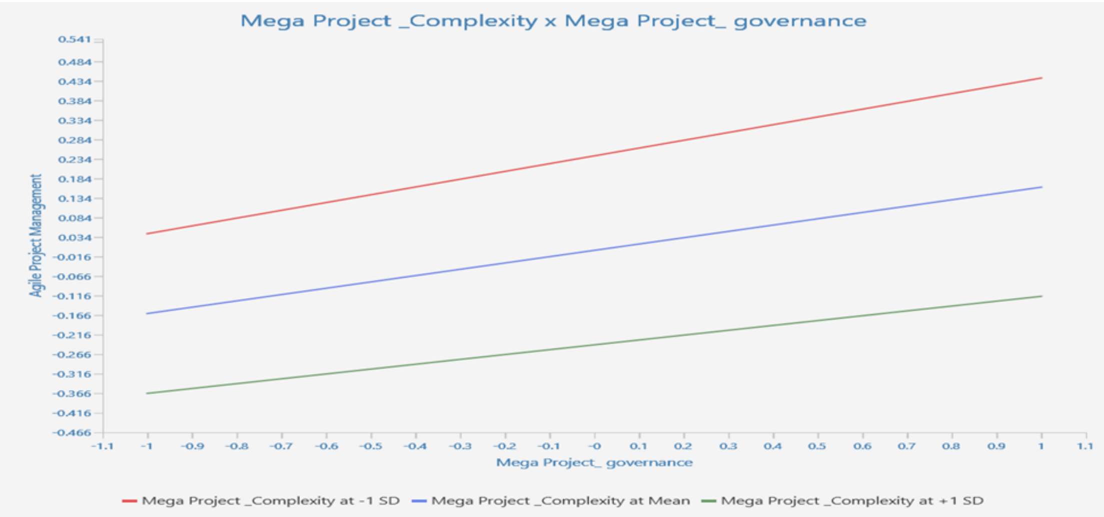

Figure 4. 15 MPC as Moderator on MPG and APM

4.15.4 Moderated Moderation Analysis

In the models considered so far, moderating impact of one moderator on the indirect effect of X on Y through M is assumed to be fixed and independent of the second moderator. Initially, current study discusses moderated moderated mediation models, in which the moderating impact of one variable depends on the second moderator. This is possible in models where X or M interacts with two moderators, W and Z, in a three-way approach. Later, the current study demonstrates that when one variable moderates the X-M path and another variable moderates the M-Y path, moderated moderated mediation has occurred. Consider the model of moderated moderated mediation shown in Figure 4.16. There are two equations that describe this model:

$$\hat{M} = i_M + a_1X + a_2W + a_3Z + a_4XW + a_5XZ + a_6WZ + a_7XWZ \ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

$$\hat{Y} = i_Y + c'X + bM \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

From Equation (1), the effect of X on M is: $^{\theta}X\text{->}M = a_1 + a_4W + a_5Z + a_7WZ$, (see Hayes, 2018), whereas the impact of M on Y is b (derived from Equation (2). Figure 4.16 illustrates how these equations may be modified by including additional variables as covariates and by allowing the direct impact to be moderated by W, Z, or both. This does not affect the logical conclusions drawn below. The indirect impact of X on Y through M is calculated by multiplying the impact of X on M by the impact of M on Y.

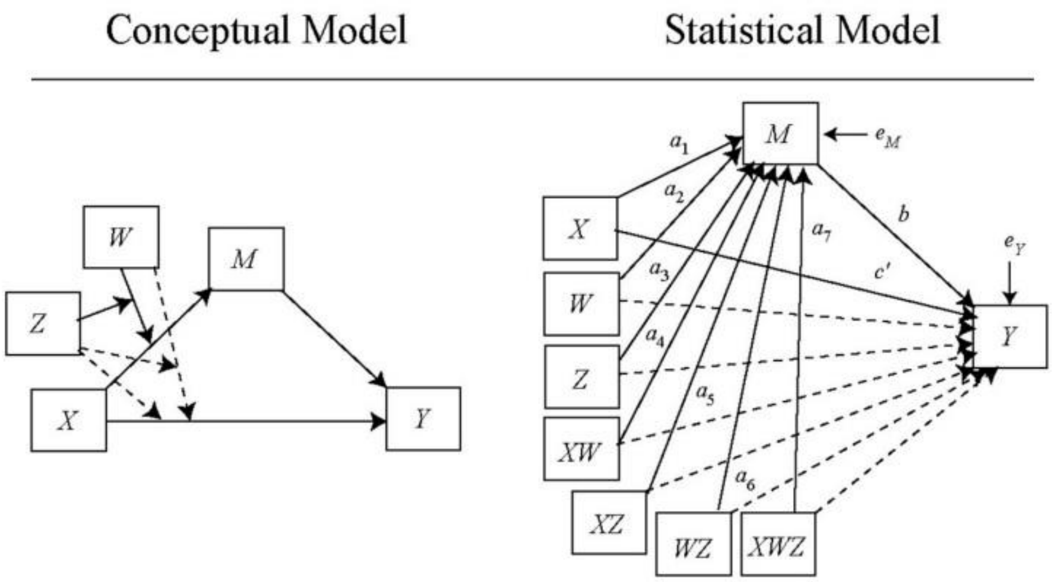

Figure 4. 16 Moderated mediation models in conceptual and statistical (path diagram) form Source: Hayes (2018)

$$^{\Theta}X\text{-}>M^{b} = (a_1 + a_4W + a_5Z + a_7WZ)\, b = a_1b + a_4bW + a_5bZ + a_7bWZ \ldots\ldots\ldots\ldots\ldots \quad (3)$$

Its value is determined by W, Z, and their product. Plugging values of W and Z into Equation (3) yields the indirect influence of X on Y under the conditions of those W and Z values. The link between the indirect impact of X and the moderators W and Z may be shown visually by putting estimates of a1, a4, a5, a7, and b into Equation 3 and plotting the resultant values for different values of W and Z within the data range. Some mathematics demonstrates that Equation (3) may also be written as

$$^{\Theta}X\text{-}>M^{b} = a_1b + (a_4b + a_7bZ)\, W + a_5bZ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

The link between W and the indirect impact of X is thus a linear function of Z: $a_4b + a_7bZ$. If one were to plot the connection between W and the indirect impact of X in two-dimensional space, with W on the horizontal axis, one would have a series of lines for various values of Z, with the slope of the line linking W to the indirect effect of X when Z = z being $a_4b + a_7bz$. Thus, $a_4b + a_7bZ$ in Equation (4) quantifies the rate of change of the indirect influence of X on Y as W varies, given a certain value of Z. In other words, it measures the moderating influence of W on the indirect effect of X for a given value of Z. The index of conditional regulated mediation by W is therefore defined as a4b + a7bZ.

The magnitude of the indirect impact of X is moderated by W if and only if the index of conditional moderated mediation by W for a certain value of Z is significantly different from zero. The index of conditional moderated mediation by W measures the dissimilarity between the conditional indirect impact of X for the two groups for a given value of Z, assuming that W is dichotomous and that the groups are coded by values that vary by one unit. If Z is dichotomous, with groups coded with a difference of one unit, then the index of conditional moderated mediation by W measures the disparity in the direction of the line connecting W and the indirect impact of X for the two Z groups. No prior assumptions regarding the form of the sample distribution of the index of conditional moderated mediation by W are needed in order to employ a bootstrap CI for inference.

The current study has two moderated moderation hypotheses H7 and H8. Table 4.20 indicates that PMO is negative and significantly moderate the relation between MPC, MPG and MCPS (β=-0.205, t=3.205, p=0.001). A one unit-change in PMO leads to a -20.5% change in the relationship between MPC, MPG and MCPS. Furthermore, the bootstrapping method yielded lower limit confidence intervals (LLCI) of -0.327 and upper limit confidence intervals (ULCI) of -0.327, indicating that 'zero' does not lie between the two intervals. The study reveals a negative and significant moderating effect of Project Management Offices on the relationship between Mega Project Complexity, Mega Project Governance, and Mega Construction Project Success, supporting Hypothesis 7. PMOs play a critical role in addressing project management complexities in mega construction projects by providing risk management, mentoring, and performance monitoring services. PMOs help clarify overlapping responsibilities and prevent conflicts among project teams, resulting in improved processes, decisions, coordination, alignment, oversight, and minimized risks and uncertainties (Ershadi et al., 2021a; Müller et al., 2011; Aubry et al., 2012; Sandhu et al., 2019; Steyn et al., 2020). Strengthening PMOs' knowledge management roles and fostering collaboration among stakeholders are essential to integrating extensive knowledge generated during construction processes and ensuring compliance with safety and environmental standards (Tshuma et al., 2018; Steyn et al., 2020).

Furthermore, the moderating effect of PMO on MPC, MPG and APM is also negative and significant (*β*= -0.176, *t*=2.371, *p*=0.018). Thus, a one- unit change in PMO indicates a -17.6% change on MPC, MPG and APM relation. The bootstrapping method yielded lower limit confidence intervals (LLCI) of -0.312 and upper limit confidence intervals (ULCI) of -0.017, indicating that ‘zero’ does not lie between the two intervals. The study result reveals a negative and significant moderating effect of project management offices on the relationship between mega project complexity, mega project governance, and agile project management, supporting Hypothesis 8. PMOs facilitate internal communications between departments regarding project matters, addressing the fragmented nature of projects and inadequate integration with functional departments, ultimately improving project outcomes (Steyn et al., 2020; Açıkgöz et al., 2016; Bakhshi et al., 2016; Naveed et al., 2021; Sergeeva et al., 2020). Therefore, hypothesis H7 and H8 were supported.

Table 4. 20 Testing of Hypotheses (Interaction Effect: Moderated Moderation Analysis)

Hypothesis	Relationship among constructs	*β*	M	S.D.	*t* values	*p* values	LLCI 2.5%	ULCI 97.5%	Remarks
H7	PMO x MPC x MPG -> MCPS	-0.205	-0.200	0.064	3.205	0.001	-0.327	-0.077	Supported
H8	PMO x MPC x	-0.176	-0.169	0.074	2.371	0.018	-	-0.017	Supported

MPG -> APM	0.312

Abbreviations: PMO= Project Management Office, MPC = Mega Project Complexity, MPG = Mega project governance, APM = Agile project management, MCPS = Mega construction Project Success, *p<0.05, **p<0.01, *** p<0.001.

Table 4.21 presents the conditional effects of MPG on MCPS and MPG on APM, considering the moderated moderation impact of PMO and the moderator MPC at different levels. These three levels were determined based on the mean and ±1 standard deviation (SD) of PMO and MPC. They were label as low, medium, and high, as indicated in Table 4.21. In the current study, both moderated moderator (PMO) and the moderator (MPC) were treated as latent constructs with potential quantitative composite scores used in structural equation modeling (SEM). Literature recommends that when examining moderated moderation impact, the quantitative moderator should be divided into three levels based on the mean and ±1 SD. The mean, mean -1 SD, and mean +1 SD represent the average (medium), low, and high levels of the moderator, respectively. Furthermore, the interaction term and conditional effects were computed using these same levels, following the approach described by Hayes (2018). The conditional effect stable and Table 4.21 have shown that at a high level (+1 SD) of PMO and low level (-1 SD) of MPC, the relationship between MPG and MCPS was positive and significant (β=0.561, t=5.292, p<0.001). The result revealed that a one unit-change in PMO and MPC leads to a 56.1% change in the relationship between MPG and MCPS. Furthermore, Table 4.21 indicated that the conditional effect at a high level (+1 SD) of PMO and low level (-1 SD) of MPC, the relationship between MPG and MCPS was positive and significant (β=0.610, t=5.730, p<0.001). The result revealed that a one unit-change in PMO and MPC leads to a 61% change in the relationship between MPG and MCPS.

Table 4. 21 Moderation Analysis Conditional Process result

Hypothesis	Relationship Among Constructs	MPC	PMO	*β*	M	Standard Deviation	*t* values	*p* values	LLCI 5.0%	ULCI 95.0%
H7	MPG->MCPS	Mean	-1 SD	0.179	0.181	0.076	2.358	0.009	0.056	0.307
	MPG->MCPS	+1 SD	-1 SD	0.235	0.239	0.063	3.703	0.000	0.135	0.344
	MPG->MCPS	+1 SD	+1 SD	-0.191	-0.189	0.113	1.690	0.046	-0.372	0.003
	MPG->MCPS	Mean	+1 SD	0.185	0.189	0.082	2.263	0.012	0.056	0.324
	MPG->MCPS	Mean	Mean	0.182	0.185	0.054	3.354	0.000	0.094	0.275
	MPG->MCPS	-1 SD	-1 SD	0.123	0.122	0.142	0.871	0.192	-0.110	0.360
	MPG->MCPS	+1 SD	Mean	0.022	0.025	0.071	0.308	0.379	-0.088	0.142
	MPG->MCPS	-1 SD	Mean	0.342	0.345	0.080	4.289	0.000	0.214	0.477
	MPG->MCPS	-1 SD	+1 SD	0.561	0.567	0.106	5.292	0.000	0.395	0.742
H8	MPG->APM	Mean	-1 SD	-0.091	-0.091	0.098	0.925	0.178	-0.257	0.072
	MPG->APM	+1 SD	-1 SD	0.043	0.036	0.093	0.457	0.324	-0.120	0.186
	MPG->APM	+1 SD	+1 SD	0.198	0.199	0.106	1.870	0.031	0.025	0.371
	MPG->APM	Mean	+1 SD	0.404	0.402	0.077	5.217	0.000	0.273	0.527
	MPG->APM	Mean	Mean	0.157	0.155	0.062	2.519	0.006	0.053	0.257
	MPG->APM	-1 SD	-1 SD	-0.225	-0.218	0.174	1.290	0.098	-0.510	0.063
	MPG->APM	+1 SD	Mean	0.120	0.117	0.074	1.618	0.053	-0.010	0.238
	MPG->APM	-1 SD	Mean	0.193	0.193	0.097	1.989	0.023	0.031	0.352
	MPG->APM	-1 SD	+1 SD	0.610	0.605	0.106	5.730	0.000	0.427	0.781

Abbreviations: MPG = Mega project governance, APM = Agile project management, MCPS = Mega construction Project Success, *p<0.05, **p<0.01, *** p<0.001.

4.15.5 Evaluation of PLS Predict

The R^2 statistic is often used by researchers to assess the prediction power of their models (Sarstedt et al., 2022). Nevertheless, this is only partially correct, since R^2 only reveals the model's in-sample explanatory power (Hair et al., 2023). Predictive power, also known as out-of-sample explanatory accuracy, demonstrates a model's capacity to predict new or future data. To deal with this issue, Shmueli et al. (2016) developed a method called PLS predict for making predictions outside of the training data set. The process of performing PLS predict includes estimating a model using a training sample and then testing its predicting powers using a separate, ‘holdout,’ sample (Shmueli et al., 2016). Hair et al. (2021) stated that information that was not utilized to estimate the model is included in the holdout sample since it was removed from the total sample before the training sample data was analyzed.

For k-fold cross-validation, PLS predict is used. Folds are subsets of the whole sample, and k is the total number of folds. That is, the whole dataset randomly divided into k subsets of data of the same size. With k = 5 folds of cross-validation, for instance, the sample is divided into five groups of data with the same size (i.e., groups of data). To forecast the last subset, PLS predict merges the first k-1 subsets (four groups of data) into a single training sample. During the first cross-validation test, the fifth subgroup serves as the ‘holdout’ group. Each of the five subsets is used once as the holdout sample and the remaining instances are incorporated into the training sample, and this cross-validation procedure is done k times (five times). So, the estimated predicted value for each case in each holdout sample is based on the training sample that did not include that instance. In leave-one-out cross-validation (LOOCV), just one observation is included in the holdout sample, unlike in k-fold cross-validation. An example of cross-validation is shown in Figure 4.17. The minimal sample size recommended by Shmueli et al. (2016) is 10, although researchers should double-check that their training samples for each fold are large enough (e.g., by following the inverse square root method).

As the k-subsets are generated at random, there is a chance that they will be partitioned extremely, which might lead to unexpected outcomes. Researchers should run PLS predict numerous times to reduce the likelihood of getting unpredictable results. In most cases, Shmueli et al. (2016) advise doing the process 10 times. PLS predict should be conducted just once when simulating the future usage of the PLS model to predict a new observation using a single model (calculated from the full dataset) (i.e., without repetitions). Researchers may use several prediction statistics that measure the degree of prediction error in the indicators of a certain endogenous construct to evaluate the predictive power of a model. Prediction errors should be for the indicator of the model's most important endogenous construct, rather than looking at the prediction errors for all endogenous constructs. The root-mean-square error (RMSE) is the standard for measuring the precision of a forecast.

Fold 1	Fold 2	Fold 3	Fold 4	Fold 5
Holdout 1	Training	Training	Training	Training
Training	Holdout 2	Training	Training	Training
Training	Training	Holdout 3	Training	Training
Training	Training	Training	Holdout 4	Training
Training	Training	Training	Training	Holdout 5

Figure 4.1: k-fold cross- validation method (Source: Hair et al. 2021)

To calculate this measure, the current study uses the square root of the sum of all squared deviations between forecasts and actual observations. As the RMSE squares the errors before averaging, the statistics give more weight to larger errors, which is helpful when large errors are undesired, as is often the case in predictive analysis. Mean absolute error (MAE) is another widely used measure. Without considering the trend of the errors, this metric calculates an average magnitude of the errors made in a given set of forecasts (over- or underestimation). Hence, the MAE is the weighted sum of all of the absolute variances between the forecasts and the actual observations. Most of the time, the root-mean-squared error (RMSE) is the best metric to employ when evaluating a model's prediction power. Nevertheless, the MAE is the better prediction statistic if the distribution of prediction errors is very nonsymmetric, as seen by a large left or right tail (Danks & Ray, 2018). The predictive power of these statistics is scale-dependent; hence, the absolute magnitude of the raw numbers is inadequate. Researchers need to compare the RMSE (or MAE) values for each indicator to a naive linear regression model (LM) benchmark to make sense of these measures. In the PLS path model, the LM reference values are derived using a linear regression of the indicators of the dependent construct on the indicators of the exogenous constructs (Danks & Ray, 2018).

The following rules apply when comparing the RMSE (or MAE) values to the LM values (Shmueli et al., 2016): The predictive power of a PLS-SEM model is strong only if (1) all indicators in the study have reduced RMSE (or MAE) values compared to the naive LM benchmark. PLS-SEM analysis with medium predictive power is indicated when the majority of indicators (or the same number of indicators) provide smaller prediction errors compared to the LM. The model's lack of predictive power is shown if just a small subset of indicators for the dependent construct results in less PLS-SEM prediction errors compared to the naive LM benchmark. Fourth, a lack of predictive power is shown if the PLS-SEM analysis (in comparison to the LM) does not result in smaller RMSE (or MAE) prediction errors for any of the indicators (Hair Jr et al., 2021). All PLS items based on endogenous variables had a Q^2 value above 0 and better predictive power than the naive linear regression (LM) benchmark, as shown in Table 4.22. In addition, a model is considered to have good predictive potential if its MAE (or RMSE) values for all indicators in the PLS-SEM study are less than those of the naive LM benchmark. A lower MAE value is being shown by all indicators in PLS as compared to LM. The high predictive power of the model leads to the inference that it may be used to address new cases.

Table 4.22 Indicators Prediction Summary

Items	Q^2predict	PLS		LM		PLS-LM	
		RMSE	MAE	RMSE	MAE	RMSE	MAE
APM1	0.041	0.995	0.822	0.986	0.794	0.009	0.028
APM2	0.033	1.037	0.858	1.044	0.839	-0.007	0.019
APM3	0.081	0.960	0.786	0.985	0.789	-0.025	-0.003
APM4	0.044	0.980	0.788	1.021	0.828	-0.041	-0.04
APM5	0.061	0.928	0.745	0.975	0.770	-0.047	-0.025
APM6	0.097	0.930	0.742	0.954	0.746	-0.024	-0.004
APM7	0.077	0.907	0.726	0.950	0.742	-0.043	-0.016
APM8	0.134	0.983	0.781	1.014	0.811	-0.031	-0.03
APM9	0.116	0.997	0.794	1.034	0.829	-0.037	-0.035
APM10	0.070	1.002	0.802	1.023	0.826	-0.021	-0.024
APM11	0.132	0.893	0.704	0.892	0.685	0.001	0.019
APM12	0.148	0.909	0.733	0.933	0.738	-0.024	-0.005
APM13	0.145	0.876	0.704	0.872	0.686	0.004	0.018
APM15	0.129	0.868	0.696	0.853	0.667	0.015	0.029
APM16	0.126	0.929	0.750	0.905	0.723	0.024	0.027
APM17	0.135	0.955	0.775	0.905	0.725	0.05	0.05

APM18	0.092	0.915	0.733	0.902	0.704	0.013	0.029
APM19	0.076	0.965	0.798	0.958	0.792	0.007	0.006
APM20	0.081	0.915	0.758	0.911	0.753	0.004	0.005
APM21	0.141	0.964	0.781	0.955	0.764	0.009	0.017
APM22	0.104	0.895	0.720	0.892	0.715	0.003	0.005
APM24	0.095	0.969	0.769	0.967	0.751	0.002	0.018
APM25	0.114	0.881	0.700	0.892	0.711	-0.011	-0.011
APM26	0.059	0.963	0.756	0.960	0.759	0.003	-0.003
APM27	0.072	1.004	0.798	0.994	0.783	0.01	0.015
APM28	0.094	0.893	0.715	0.909	0.722	-0.016	-0.007
APM29	0.036	0.899	0.706	0.923	0.714	-0.024	-0.008
APM32	0.060	0.846	0.671	0.848	0.674	-0.002	-0.003
APM33	0.038	0.900	0.686	0.943	0.717	-0.043	-0.031
APM34	0.062	0.916	0.716	0.945	0.739	-0.029	-0.023
APM35	0.021	0.886	0.666	0.904	0.692	-0.018	-0.026
APM36	0.047	0.860	0.668	0.901	0.703	-0.041	-0.035
MCPS2	0.012	0.672	0.518	0.681	0.545	-0.009	-0.027
MCPS5	0.024	0.694	0.526	0.737	0.573	-0.007	0.019
MCPS6	0.029	0.676	0.495	0.693	0.545	0.004	0.005
MCPS7	0.033	0.624	0.442	0.634	0.486	0.009	0.017
MCPS8	0.051	0.650	0.482	0.677	0.529	0.003	0.005
MCPS9	0.051	0.667	0.516	0.704	0.557	0.002	0.018
MCPS10	0.093	0.650	0.485	0.691	0.546	-0.041	-0.061
MCPS11	0.085	0.640	0.470	0.671	0.524	-0.031	-0.054
MCPS12	0.053	0.663	0.493	0.683	0.538	-0.02	-0.045
MCPS13	0.075	0.603	0.421	0.627	0.477	-0.024	-0.056
MCPS14	0.018	0.630	0.446	0.663	0.484	-0.033	-0.038
MCPS15	0.037	0.667	0.506	0.702	0.549	-0.035	-0.043
MCPS17	0.022	0.658	0.506	0.668	0.524	-0.01	-0.018
MCPS18	0.025	0.688	0.532	0.703	0.557	-0.015	-0.025
MCPS19	0.037	0.661	0.494	0.685	0.536	-0.024	-0.042
MCPS21	0.077	0.645	0.478	0.672	0.531	-0.027	-0.053
MCPS22	0.053	0.705	0.555	0.730	0.602	-0.025	-0.047
MCPS23	0.046	0.688	0.523	0.697	0.571	-0.009	-0.048
MCPS24	0.070	0.705	0.556	0.728	0.599	0.009	0.028
MCPS26	-0.020	0.703	0.547	0.726	0.570	-0.021	-0.024
MCPS27	0.064	0.650	0.479	0.670	0.526	0.001	0.019
MCPS28	0.053	0.688	0.534	0.727	0.582	-0.024	-0.005
MCPS29	0.035	0.704	0.539	0.719	0.587	0.004	0.018
MCPS30	0.073	0.670	0.510	0.693	0.558	0.015	0.029
MCPS31	0.032	0.709	0.546	0.740	0.595	0.024	0.027
MCPS32	0.065	0.645	0.494	0.665	0.517	0.05	0.05
MCPS33	0.037	0.700	0.545	0.699	0.568	0.013	0.029
MCPS34	0.041	0.702	0.561	0.728	0.594	0.007	0.006

4.16 Summary

In this chapter, the current study used a measurement model to verify the PLS model's reliability and validity. Since the MPG and MPC constructs are a second-order, reflective-reflective construct, the present research used a two-stage process. The outer loadings of the first order (reflective) construct were first studied. Only items that met the criteria established were retained. Additionally, the following two techniques have been demonstrated to possess discriminant validity: a. Fornell-Larcker criteria and b. HTMT ratios of the correlations. The structural model, also known as the internal model, is assessed after the measurement model is examined. Coefficient of determination (R^2), effect size (f^2), and Q^2 predict are used to assess the structural model's significance. All direct hypotheses were validated, as was shown by the results. For mediation and moderation, a subsample of 5000 was chosen for bootstrapping. According to the results, hypotheses H1, H2 and H3 for direct effect, hypotheses H4 for mediation, H5 for moderation, H7 and H8 for moderated moderation were supported; however H6 for moderated mediation was not supported.

Chapter 5: Discussion

5.1 Introduction

This chapter focuses on the outcomes of the study and the analysis that has been discussed in the previous chapter. It provides a more detailed analysis that is summarized and compared with previous studies to explain the significance of the study. The chapter also delves into a thorough summary of the impact of the various variables selected for the current study and suggests potential directions for future studies involving these variables.

Current study addressed seven eight research questions: RQ1: What is the impact of megaproject governance on mega construction project success? RQ2: What is the impact of megaproject governance on agile project management? RQ3: What is the impact of agile project management on mega construction project success? RQ4: Does agile project management mediate the relationship between megaproject governance and mega construction project success? RQ5: Does mega project complexity moderate the relationship between megaproject governance and mega construction project success? RQ6: Does mega project complexity moderate the relationship between mega project governance and agile project management? RQ7: How Project management office and mega project complexity jointly moderate the positive relationship between mega project governance and mega construction project success, such that the positive relationship is at highest when project management office is high and mega project complexity is low? RQ8: How Project management office and mega project complexity jointly moderate the positive relationship between mega project governance and agile project management, such that the positive relationship is at highest when project management office is high and mega project complexity is low? In order to answer these questions, the current study tested eight hypotheses to determine whether MPG, APM, MPC and PMO were significant predictors of mega construction project success.

5.2 Mega project governance and mega construction project success

Current study result indicates a positive and significant relationship between mega project governance and mega construction project success. Hypothesis 1 was accepted. This empirically tests the role of MPG on MCPS in the Pakistan culture. A positive relationship between MPG and MCPS was identified, which endorses the results of previous studies (Joslin & Müller, 2016; Ul Musawir et al., 2017). Moreover, it has been shown that, in a developing country such as Pakistan, MPG has an influence on project success. People in general dislike being told what to do, especially if they are working in a remote location where they cannot completely follow management directions (Khattak & Mustafa, 2019). Project teams must make decisions that are favorable to the project's success based on ground facts. The results show that MPG has a 20% effect on MCPS. This suggests that, in developing countries, culture is a barrier to fully reaping the advantages of MPG on MCPS (Eyiah-Botwe et al., 2016; Banihashemi et al., 2017). There is a need to strengthen project participants' comprehension and expertise of the MPG system's implementation in the organization. This research is a first step in understanding the function of MPG in developing countries. Additionally, the findings of the current study addressed the gap identified by previous researchers (Ali et al., 2021).

Stafford and Stapleton (2017) contends that decentralized decision-making within interconnected networks is a major driver of the various forms of governance in the provision of public services. Too et al. (2014) and Song et al. (2022) asserts that the primary focus of governance should revolve around the methodologies employed to guide state activities concerning service delivery. To ensure alignment among stakeholders, the presence of well-defined governance structures and processes is of paramount importance (ul Musawir et al., 2020). Furthermore, von Danwitz (2018) have emphasized that governance gives rise to concerns related to economic and social responsibility and fosters collaborative actions for power sharing among interconnected institutions. For international comparative purposes, ‘governance’ refers to the mechanisms through which a nation's legal government manages its social and economic resources to promote growth (Aguilera & Jackson, 2010).

Contemporary project management literature often addresses governance as a proven approach to assist organizations in achieving their objectives (Xie et al., 2019). While organizations initiate projects with the best intentions, many projects end in failure for various reasons. Traditionally, project success was assessed based on its adherence to scope, deadlines, budget, and quality standards (PMI, 2017). However, project assessments increasingly incorporate governance to measure a project's potential to fulfill long-term strategic goals (Young et al., 2019). Effective project governance is characterized by the ability to navigate projects through various uncertainties and unforeseen challenges (Abednego et al., 2006; Joslin et al., 2016; Kakar et al., 2018). As emphasized by Khan et al. (2021), strong governance relies on the commitment of project stakeholders to the project's objectives. In the context of long-term construction development projects, Mok et al. (2015) examine the ownership and dedication of the project sponsor.

In the realm of public-private construction development projects, good governance is of paramount importance (Pratap & Chakrabarti, 2017). The expected delays in the execution of construction projects are mostly attributed to poor corporate governance (Hoechle et al., 2012). Failures in projects sometimes emerge from governance-related problems, such as poor budget management on the construction site, delayed decision making, improper handling of stakeholders, and even fraudulent activities and bribes (Locatelli et al., 2017; Damoah et al., 2020). The timely completion of construction projects with no variances between actual and projected costs may result from fair and transparent governance, which supports projects in lowering their vulnerability to expensive financial crises and cutting down on transaction and capital expenses.

Prior research has underscored the absence of a project governance framework in mega construction projects and the necessity of addressing this matter. The literature review reveals that the existing body of knowledge primarily focuses on two forms of governance mechanisms: contractual and relational (Wang et al., 2019). Nevertheless, in the context of Pakistan mega construction projects, the government assumes a pivotal role in regulating inter-organizational relationships through administrative guidance as a distinct construction entity. Government oversight simplifies the promotion of the project and the management of competing public interests. The failures of substantial capital projects have shed light on the consequences of ineffective governance (Young et al., 2019). Furthermore, Danner-Schröder and Ostermann (2020) have observed that construction projects frequently encounter complexity and uncertainties, with each project's distinct social and environmental requirements contributing to its uniqueness. Proper construction project governance is a vital necessity for advancing an economy. An essential requirement and a significant challenge that will ultimately determine the success of construction development projects is effective project governance. In essence, governance entails the responsibility of planning an organization's future actions, monitoring its progress towards its objectives, approving or rejecting specific initiatives, and evaluating their outcomes.

5.3 Mega project governance and agile project management

Current study result shows a positive and significant relationship between mega project governance and agile project management. Therefore, Hypothesis 2 was supported. The findings have uncovered that achieving the right equilibrium between the structure and control offered by governance and the inherent flexibility and adaptability of agile project management is crucial. The findings were similar to previous studies. Mega project governance plays a pivotal role in setting clear objectives and priorities (ul Musawir et al., 2020; Zhai et al., 2020). This, in turn, can prove advantageous for agile project management by furnishing a robust groundwork for decision-making and task prioritization. This clarity can enable agile teams to better align their work with the overall project goals and make more informed choices when adapting to changes (Albuquerque et al., 2020; Verma, 2022). Mega projects often involve significant risks that need to be managed effectively. A robust governance framework can help identify, assess, and mitigate risks throughout the project lifecycle (Derakhshan et al., 2019; Deng et al., 2021). Agile project management can benefit from this MPG, as it ensures that potential issues are addressed proactively, allowing teams to maintain their focus on delivering value (Arefazar et al., 2022).

Mega project governance emphasizes the importance of stakeholder engagement, ensuring that all parties involved in the project are informed and their concerns are addressed. This focus on stakeholder engagement can be beneficial for agile project management, as it fosters better communication, collaboration, and trust among project participants, which are crucial for agile teams to succeed (Bergmann, & Karwowski, 2018). Mega project governance provides a structure for efficient resource allocation and utilization. According to Brandl et al. (2021), agile project management can benefit from this structure, as it ensures that resources are allocated appropriately to support the iterative and incremental delivery of value. This can help optimize the use of resources, such as personnel, time, and budget, while maintaining agility in the project (Buganová & Šimíčková, 2019). Both mega project governance and agile project management share a focus on continuous improvement (Lappi et al., 2018; Uwadi et al., 2022). Integrating agile principles into construction project processes can cultivate a culture of learning, adaptation, and innovation. This alignment can establish a more conducive environment for agile project management, enhancing its effectiveness in delivering successful outcomes (Stern, 2020; Olszewski, 2023). While mega project governance and agile project management may initially appear to be in conflict due to their differing approaches, they can be positively associated when balanced correctly. By combining the structure and control of governance with the flexibility and adaptability of agile methodologies, organizations can improve project outcomes and better navigate the complexities of mega construction projects.

5.4 Agile project management and mega construction project success

The current study result indicate that a positive and significant impact of agile project management on mega construction project success. Hence, the hypothesis 3 was supported. Findings were consistent with several studies, according to Manurung and Kurniawan (2021) agile project management is a project management approach that emphasizes flexibility, collaboration, and continuous improvement. Conforto et al. (2014) illustrated that APM is often associated with software development, but it has also been applied to other domains, including construction. Therefore, APM can be particularly useful in the context of mega construction projects, which are characterized by high levels of uncertainty, ambiguity, and risk. APM involves a set of principles and practices that enable project teams to respond to changing circumstances, prioritize stakeholder needs, and deliver value incrementally (Kaim et al., 2019). Some of the key principles of agile project management include. Prior studies Gomes Silva et al. (2022) and Hutter et al. (2023) indicated that APM emphasizes collaboration with stakeholders, including customers, to ensure that project objectives are aligned with stakeholder needs. APM acknowledges the potential for evolving project requirements and highlights the importance of remaining flexible and adaptable in response to changing circumstances (Olszewski, 2023). Additionally, it promotes the frequent delivery of working solutions, advocating incremental value delivery instead of waiting until the project's conclusion.

Agile methodologies prioritize flexibility and responsiveness to change (Conforto et al., 2014). By embracing iterative planning and continuous improvement, agile project management enables construction teams to quickly adapt to evolving requirements, unforeseen challenges, and new opportunities (Lappi & Karvonen, 2018). This adaptability helps ensure that the project remains on track and aligned with stakeholder expectations, contributing to overall project success. Mega construction projects are often associated with significant risks and uncertainties (Eyiah-Botwe et al., 2016). Findings were consistent with prior research. Several studies have shown that agile project management practices, such as iterative development, allow teams to identify, assess, and address risks more dynamically and proactively throughout the project lifecycle (Larson & Chang, 2016). This continuous risk management process helps minimize potential negative impacts on the project, enhancing the likelihood of successful outcomes (Buganová & Šimíčková, 2019). APM emphasizes close collaboration with stakeholders, particularly end-users, to ensure that project deliverables are aligned with their needs and expectations (Khalil & Khalil, 2020). Regular communication and feedback loops enable project teams to better understand stakeholder requirements and make necessary adjustments, leading to higher stakeholder satisfaction and ultimately, project success (Ciric et al., 2019). Agile methodologies focus on delivering value incrementally by breaking down the project into smaller, manageable parts or sprints. This approach allows project teams to prioritize and deliver high impact features first, ensuring that stakeholders see tangible progress and benefits throughout the project (Albuquerque et al., 2020).

To seize fleeting market opportunities, agility is crucial (Haider & Kayani, 2020). Organizational agility can be defined as achieving the right balance between speed and stability. This equilibrium is built upon the management's goals and vision, a shared rationale, and established protocols for ongoing customer interaction. The objective is to uncover the unspoken, genuine needs of customers, allowing for the provision of valuable solutions. For organizations aiming to move quickly without sacrificing unity or, more importantly, their mission, flexible and adaptable communication is essential (Inman & Green, 2021). While the literature has traditionally concentrated on the interaction between the market and the company to fuel the learning cycle, recent practitioner and academic-focused literature underlines the importance of firm coordination and control for effectively implementing agile methodologies (Amorim et al., 2021). This is particularly significant when deploying agile techniques in complex organizations and when dealing with the general challenges of applying agile methods beyond the IT sector (Mohammed et al., 2020).

However, the adoption of agile project management in the context of mega construction projects can also pose challenges (Arefazar et al., 2022). Agile project management requires a high degree of collaboration and communication among stakeholders, which can be difficult to achieve in the context of large, complex, and high-risk projects. Albuquerque et al. (2020) suggested that APM also requires a significant investment in time and resources, which may not be feasible in the context of mega construction projects with tight timelines and limited resources. This result from the current study is consistent with the studies conducted by various researchers in this domain. According to Arefazar et al. (2022), poor scheduling and planning were regarded as the most significant delay culprits by the consultant and subcontractors and suppliers. Abdullah et al. (2018) conducted research to determine the causes of schedule and cost overruns. They discovered that, out of 176 factors, lack of subcontractor expertise, poor planning, and poor scheduling were the leading causes of delay. Sambasivan et al. (2017) discovered the factors that are top rated in several research; these factors include payment delay, poor planning, poor project management, conditions of site and management, and material problems.

Planning and scheduling are crucial elements in the construction industry, playing a vital role in a project success. Traditional planning and scheduling systems often fail to execute tasks on time, with approximately half of the scheduled tasks experiencing delays. This issue arises when contractors and subcontractors are assigned tasks to fulfill the master schedule without considering factors that may impact project execution, such as resource and material availability, funding shortages, and insufficient oversight by governing bodies (Jarak's, 2017). Moreover, ongoing monitoring is essential to track project progress and prevent delays (Kamal et al., 2019). A study by Ud Din et al. (2020) found that delays result from inadequate planning, scope creep, financial limitations, and poor scheduling. The current study findings align with research conducted worldwide, demonstrating the importance of planning in mitigating project delays; otherwise, insufficient planning can lead to significant delays (AlAmeri et al., 2020; Balali et al., 2020). A successful construction project should integrate both planned and emergent activities. Project managers have noted that inadequate planning, heavily influenced by consultants' perceptions, is a major cause of significant delays.

APM can be particularly useful in the context of mega construction projects because it enables project teams to respond to changing circumstances and stakeholder needs (Kumara, 2017; Arefazar et al., 2022). Mega construction projects are often subject to significant uncertainty and risk, which can make it difficult to predict project outcomes and requirements. APM can enable project teams to adapt to changing circumstances and stakeholder needs, while also ensuring that project objectives are achieved within the project constraints of time, cost, and quality (Albuquerque et al., 2020). APM can also facilitate collaboration and communication among stakeholders, which is critical to the success of mega construction projects (Malla, 2023). Effective collaboration and communication among stakeholders can help to identify and manage risks, ensure that project objectives are aligned with stakeholder needs, and facilitate the timely delivery of project milestones.

5.5 Agile project management as a mediator

The result revealed that agile project management positively and significantly mediates the relationship between mega project governance and mega construction project success. Therefore, hypothesis 4 was supported. Findings were consistent with prior research. Numerous studies have shown that more frequent use of mega project governance and agile project management in routine projects also helps organizations to avoid institutional complexity conflicts between project managers and business change managers (Lappi et al., 2018; Mohammed & Chambrelin, 2020), as well as between business change managers and the potential stakeholders of the project (Nowotarski et al., 2015; Albuquerque et al., 2020). When mega project governance and agile project management approaches work together for a long period of time, they become tightly linked, in contrast to loose coupling, in which organizations operate as independent and separate from one another but may still be responsive to each other (ul Musawir et al., 2020). When considering the paradox of whether or not agile project management practices affect the success of mega construction projects, it's important to note that the more an organization institutionalizes agile project management practices, the more likely it is to achieve MCPS.

The current study extends the findings of Arefazar et al. (2022), who explored how an organization's project history and the availability of agile project-management practices are crucial for the future success of new mega projects. Interestingly, the current study findings show that the mega project governance direct effect on MCPS is greater than the indirect effect through agile project management. Therefore, the current study has partial mediation. According to Bergmann et al. (2018) to maintain success, mega construction project organizations have to continuously improve the efficiency of their business. Modern agile methodologies hold good prospects for improving the business processes of the construction industry, particularly in the field of business management (Sohi et al., 2016).

However, effectively managing the increased complexity associated with the agile mindset is still a relatively new area of research, especially as the agile methodology is relatively new to the construction sector. Complexity paradigms are necessary but currently lacking in project management education and credentialing frameworks (Arefazar et al., 2022). The inclusion of complexity not only challenges traditional beliefs about project failure but also shifts the blame away from individuals and the technologies they develop and manage, focusing instead on the powerful and enigmatic nature of complex systems (Brandl et al., 2021). Teams that work cohesively and purposefully, guided by an effective project manager, team leader, or other leadership roles, are more likely to successfully identify and overcome uncertainties within complex adaptive systems. To achieve this, developing soft skills such as empathy, influence, creativity, group facilitation, and others that are essential elements of successful socio-technical ventures is crucial. The current study has a better chance of building understanding when dealing with complex systems and dynamic environments by focusing on these skills. Future project managers who take on the challenges of complex adaptive projects would be wise to understand human behavior and interactions, possess the ability to motivate project team members and imbue situations with meaning, and are mindful of the higher levels of human values.

Agile methodologies differ from traditional approaches in several fundamental ways, especially in the aspects of organization and leadership (Buganová & Šimíčková, 2019). Agile places a strong emphasis on the value of small, cross-functional teams rather than large, top-down ones (Bäcklund et al., 2024). It also highlights the importance of iterative design changes based on user input and testing. To effectively manage all projects and programs, agile project management must strike a balance between empowering the project team and utilizing traditional communication and coordination methods (Carroll et al., 2023). While traditional models revolve around process-centered management and control, agile approaches highly value a leader's capacity to inspire and motivate their team. Unlike the conventional, individualized approach to specialization, Agile encourages teams to be more adaptable and self-organizing in terms of roles (Sohi et al., 2016). In contrast to the traditional, bureaucratic, and mechanistic organizational structure that favors formalization, the organizational structure in agile can be described as organic, characterized by flexibility, cooperation, and participation (Bochum et al., 2022).

Despite its potential, APM has its limitations as its benefits and values are yet to be definitively established in the construction sector, and there are no established guidelines for agile construction management (Olszewski, 2023).. All agile change management methods have constraints stemming from factors such as initial costs, limited resources, challenging work environments, complex coordination, and regulatory or societal pressures (Verma, 2022). For instance, creating an environment that embraces change and ensuring active engagement and coordination of all project participants throughout the project's lifecycle can be challenging. Some are concerned that APM may not be well-suited for hierarchical organizations like unions and heavily regulated industries. The current research seeks to illuminate the most effective agile strategies for managing project modifications.

Construction project managers seeking to employ the most effective agile solutions in their practices are expected to be better equipped to overcome the challenges of implementing the APM strategy (Balali et al., 2020; Kassem et al., 2020). The current study proposes further research into the potential of agile solutions to address essential changes in construction, providing researchers with new insights on how to further leverage APM in construction. Exploring new areas, such as Building Information Modeling (BIM), envisioned as a platform for change management and project information coordination, can be advanced under the banners of ‘continuous improvement,’ ‘progress monitoring and evaluation,’ and ‘flexible workflows,’ among other objectives (Caldas et al., 2017).

Researchers and developers can also focus on cutting-edge Extended Reality (XR) systems, which include augmented reality (AR), virtual reality (VR), and mixed reality (MR), showing promise for practical use in construction management (Catbas et al., 2022). These modern tools may enhance construction projects' adaptability to unforeseen changes by facilitating communication between clients, contractors, and consultants, while also providing improved project tracking, analysis, and enhancement capabilities. Prioritizing APM enablers for the construction industry to adapt to new realities might be more effectively achieved through comprehensive field investigations rather than relying on the methods used in this study. However, the implementation of these concepts in a real construction project and their evaluation may be challenging due to the complex nature of such endeavors.

The appropriateness of agile change management is influenced by the organizational structure. Agile solutions are better suited for the design phase (Owen et al., 2006). While contractors may be reluctant to adopt agile solutions in their organizations, consultants are more eager to do so, given the visible benefits of enhanced interaction with clients and contractors in the final design phase. However, achieving agility during the execution phase is more challenging due to the multitude of interconnected tasks. The construction industry often involves a high number of subcontractors, making it more challenging to foster a culture of loyalty among employees (Jarkas, 2017). Consequently, implementing new project management techniques in construction often encounters significant cultural barriers that must be overcome to establish self-managing teams. Despite these cultural challenges, managers willing to adapt to changes in the project's scope may benefit from using agile enablers in construction at the site level (Owen et al., 2006)

Both large and small businesses may encounter challenges when implementing agile project management practices (Žužek et al., 2020). Large organizations often face difficulties due to their established non-agile culture, complex structures, and numerous internal rules and processes. When introducing agile project management, teams within these organizations may lack experience, requiring training or recruitment efforts to prepare them. In such cases, the human resources department's responsibilities expand to define the specific skills and knowledge required for team members and their roles. To address this issue, a competence model, as presented by Žužek et al. (2020), outlines various skill sets and serves as an industry standard for hiring and professional development.

Traditional management typically follows a hierarchical structure where decisions are made by supervisors and executed by subordinates who report back (Buganová et al., 2019). Agile practices are reshaping this power dynamic, emphasizing the need for managers to set the stage for team success rather than dictating actions. This shift can be challenging for traditional managers who may be hesitant to relinquish control. It also requires time and effort to foster the mindset of autonomy within teams. Furthermore, public services must align with the needs of the people they serve. Shifting from a traditional management model to one that empowers teams to make decisions can be time-consuming and challenging to implement.

Implementing agile methodology at the enterprise level is a time-consuming process that involves overcoming various challenges. The 'Challenges of Agile Adoption' study suggests that governments should progressively adopt agile practices. It is advisable to start with one group and expands the strategy to additional groups only after witnessing positive results (Nuottila et al., 2016). To introduce a degree of team autonomy, organizations should be willing to reconfigure their processes. This can be hindered by government regulations and established organizational routines. One of the significant challenges in any organizational transformation is the widespread fear of loss, which affects both employees and supervisors. During the initial phase of a shift, many employees experience anxiety and uncertainty as they adapt to their new roles. Recognizing the need to let go of old perspectives is crucial at this stage. As the transformation progresses, people become more aware of the differences between the old and new approaches, allowing them to assess the advantages of the changes.

Organizational change often occurs in phases, similar to the experience of the U.S. state government of Michigan in its decision to adopt project management for its operations (Bogdanova et al., 2020). This transition took place in two distinct phases over many years. The first phase involved laying the foundation for effective project management and establishing the necessary organizational conditions, including infrastructure and the formation of a statewide project management infrastructure (Sankaran, 2018). A central group was responsible for its development, including assembling the project management office, recruiting professional project managers, and developing a training package. During this phase, efforts were made to introduce the project management approach to the administration (Marcucci & Jordan, 2013).

In the second phase, enhancements were made to the depth, scope, and daily support of project management, aiming to make it routine for middle and lower-level managers. This involved updating and improving mechanisms for integrating methodology and tools and modifying the project management methodology (Grandage & Mitchell, 2023). Additional training and education were provided, exploring inadequacies in project management education and expanding training for support employees. The state of Michigan established a project management center of excellence, serving as a hub for leaders, promoting knowledge exchange, best practices, and information sharing, along with the practical application of methodology, tools, and training (Bogdanova et al., 2020). The Center for Excellence was created to address the increasing complexity of the state's project management landscape, fostering collaboration between project teams through knowledge exchange and the dissemination of best practices.

5.6 Mega project complexity as a moderator between mega project governance and mega construction project success

Current study results show that mega project complexity negatively and significantly moderate the relationship between mega project governance and mega construction project success. Hence, hypothesis 5 was supported. The findings align with those of Lebcir et al. (2011) and Jarkas (2017), who studied the impact of project complexity on construction project completion times. Similarly, Bosch-Rekveldt et al. (2011) and Floricel et al. (2016) concluded that project complexity generally tends to negatively affect project performance, with Luo et al. (2017) finding a negative correlation between project complexity and construction project success. To tackle project complexity, organizations can employ a program management approach, which simplifies complexities and maintains control over the project's dispersed execution (Ahn et al., 2017). Extended and rigorous work hours required to complete project assignments are often attributed to the prevailing business culture. Dissatisfied employees can impede project progress, underscoring the importance of a workplace culture that is conducive to the well-being of all involved. Each project carries its own distinct work culture, overseen by a separate entity. Hence, it is vital for organizations to strike a balance that promotes a work-life culture within project teams to optimize the project's longevity. In poorly managed settings, requirements, issues, and defects tend to accumulate unchecked as the project advances. Misjudging or overestimating needs strains available resources and results in confusion during the planning phase when team members are expected to address problems and get to work. Meeting all criteria simultaneously is typically unfeasible, prompting the division of tasks into multiple iterations and stages.

To ensure effective planning of development activities, it is crucial to discuss and reach a consensus on the scope of requirements during the planning phase. The project manager's responsibilities increase when requirements are exceeded, and they must safeguard the team and prevent further expansion of the project's scope or needs. Safeguarding team members from potential harm necessitates careful planning and a protective mindset. Sohi et al. (2016) suggest that agile program management is a practical way to address various types of project complexity. One of the key contributions of the current study to the enhancement of the theoretical basis of project management lies in the identification of the fundamental causes of complexity in projects, often referred to as complexity indicators. Through the definition and quantification of these complexity attributes, the study has successfully determined the project's level of complexity. The insights generated from this research can be of value to participants involved in future challenging projects spanning various industries, as it can aid them in refining their project management skills. Furthermore, this information can serve as a starting point for researchers in the field of project management who wish to delve deeper into the advantages of managing complex projects and explore strategies for mitigating associated challenges.

Hartono et al. (2019) and De Toni et al. (2021) demonstrated that project complexity influences collaboration, sharing, and understanding. Consequently, the industry must consider refining the timing and approach for implementing suitable techniques. Based on the information complexity factors identified in the current study, project managers could develop a distinct communication management system to facilitate and integrate communication activities among designers, suppliers, and government agencies while analyzing progress information and satisfying decision-makers' information needs. Task complexity was introduced as a new dimension of project complexity for Pakistan's mega construction projects. The findings reveal that, despite their diverse tasks and high interdependence, complex construction projects have similar relationships among tasks (Luo et al., 2017). Ma and Fu (2020) also showed that technological complexity and novelty are crucial project characteristics with unique impacts on project performance. Therefore, project managers should explicitly analyze technical complexity and novelty, incorporating them into their planning processes to achieve superior performance.

The present research defines organizational complexity mainly in terms of its structure, which includes the total number of levels of management, units, and departments (Luo et al., 2017). The present study's finding that information complexity correlates with project success is consistent with Luo et al. (2020) selection of team members' training levels and the execution of suitable activities as determinants for project performance. There is a negative link between project complexity and performance, according to Bosch-Rekveldt et al. (2011), Luo et al. (2017), and Zhang et al. (2022). This is especially true in the domains of interdisciplinary interactions and inadequate internal corporate support. Concerning the intricacy of the goals, client organizations may use PBS/WBS solutions to coordinate activities across various organizational units and ensure they are in line with the overall aims of complex construction projects. Furthermore, the client organization might set up specialized divisions like time management and cost management to supervise the execution of important goals (He et al., 2021).

5.7 Mega project complexity as a moderator between mega project governance and agile project management

The result revealed that MPC negatively and not significantly moderate the relationship between mega project governance and agile project management. Thus, hypothesis H6 was not supported. The earlier studies suggested that agile methodologies prioritize team collaboration and customer engagement, enabling organizations to expedite the introduction of new products and enhance existing ones. Alongside the significant growth, organizations still face several challenges in implementing agile methodologies. Since Agile is merely applied to construction projects, little is known about it. Yet, the interest of the construction industry on the subject is rising (Owen, et al., 2006). Surveys conducted by Dikert et al. (2016) and Conboy et al. (2019) have identified various constraints encountered during Agile implementation (i.e. lack of leadership, inexperience team, lack of training, organization reluctant to change and immature organization governance). According to Raharjo (2023), the challenges in implementing agile projects in Indonesia have been identified through surveys, observations, and insights from project management and agile communities, as well as experts and practitioners. These challenges include organizational cultural constraints, inadequate education and training on agile concepts and practices, a lack of clear implementation guidelines, limited understanding of the agile mindset at management and team levels, and insufficient support and commitment from management.

Agile approaches, as pointed out by Hidalgo (2019), need to reduce the overall level of complexity in an organization. Instead of developing a complicated structure to address complex problems, agile methodologies break large problems down into manageable tasks of work that autonomous teams can solve through an iterative method of trial and error (Chan & Thong, 2009). Furthermore, agile approaches need decentralization, team autonomy, and even self-government, all of which are key criteria for dealing with complexity and capitalizing on transient market opportunities (Meredith et al., 2017). Thus, there are two obstacles to scaling agile approaches (Zhai et al., 2020). First, the non-agile parts of the company should support and collaborate with the agile parts of the firm. The second step is to apply agile methodologies to a complicated collection of teams, either because of the number of teams that must be coordinated or because of the size and heterogeneity of each team.

Based on the findings of this research, project management teams should focus less on preparing for external changes and more on enhancing their ability to adapt to internal ones. Project complexity may be reduced or avoided if project management teams are better able to adapt to shifting priorities and new technologies. Serrador and Pinto (2015) demonstrate this conclusion by stating that a project's performance improves in correlation with the quality of the agile method report. In the context of complicated projects, whose surroundings are both dynamic and unknown, it is realistic to anticipate that addressing these challenges will need time while maintaining the project's quality. The communication barrier between team members, such as highly skill team member only focuses on their task completion and did not help low skill team member, who do not have enough knowledge or skill to do their task, hence whole team will struggle and not able to complete their task on time.

Complex projects, defined by Chapman et al. (2020), rely significantly on their environment, encompassing political, economic, or legal factors, contend with conflicting stakeholder interests, face ongoing changes, lack comprehensive information, and contend with multiple variables. According to Florel, Michela, and Piperca (2016), project complexity stands as the foremost factor influencing project performance. Factors contributing to a project's complexity include the number of involved organizations, the level of collaboration and interaction within a single organization, the necessity for coordination across project facets, and the diversity of project management techniques employed. Adequate comprehension of a project's intricacy is vital for both management and team members involved, as project complexity hinges on its difficulty and the requisite time, effort, and expertise (Kermanshachi et al., 2016). Project complexity holds a dual nature: while it may impede performance, emergent traits can foster new possibilities and positively impact outcomes (Vidal & Marle, 2008). Rather than focusing solely on eliminating or drastically reducing project complexity, constructive management thereof is crucial. In today's fast-paced environment, construction projects that effectively handle complexity stand the best chance of success. Notably, both developed and developing countries within the software industry face high rates of project failure.

Bosch-Rekveldt et al. (2011) arrived at a similar conclusion, identifying adverse associations between project complexity and performance, especially concerning interdisciplinary interfaces and internal business support matters. Managing megaprojects presents greater complexity and challenges compared to small-scale projects due to the limited knowledge and skills of project managers in addressing the escalating complexities of megaprojects. There's a growing recognition that project complexity significantly impacts a project's success. The construction industry has its own set of norms, practices, and expectations that can influence the implementation of agile project management (Albuquerque et al., 2020). Mega projects often involve multiple stakeholders, including contractors, subcontractors, and suppliers, each with their own established ways of working. The institutional pressure to conform to these existing practices can hinder the adoption of agile methodologies or lead to a hybrid approach that combines elements of both traditional and agile project management (Meredith et al., 2017). Agile methods are frequently employed in technology due to their direct addressing of challenges linked to dynamic projects in swiftly evolving environments (Serrador & Pinto, 2015). The adeptness of the project management team in navigating these challenges significantly influences the success or failure of project management (Park et al., 2017). Within the stakeholder management framework for mega construction projects, Agile Project Management (APM) stands as a critical component (Park et al., 2017). According to Serrador and Pinto (2015), increased utilization of agile methods correlates with enhanced project performance.

Management can determine the necessary steps for ensuring the successful completion of a project by assessing its specific qualities (Soundararajan et al., 2021). One pivotal factor to consider is the project's level of complexity. As Bennett (2019) highlights, when addressing management concerns, practitioners frequently categorize their projects as either simple or complex. The significance of complexity in project management is now widely acknowledged, particularly in practice (San Cristóbal et al., 2018). It is not surprising that complex projects require exceptional management, and relying on traditional solutions designed for simpler projects may prove counterproductive. Additionally, Esquierro et al. (2014), a production manager's primary responsibility involves dealing with complexity. Projects are often employed for the development of large-scale or intricate products or services, leading to a frequent association between complex situations and project-based management.

5.8 Project management office as moderated moderator between MPC, MPG and MCPS

The current study results show negative and significant moderating effect of PMO on the relationship between MPC, MPG and MCPS. Hence, hypothesis 7 was supported. The current study aimed to examine the critical role of firm-level PMOs in addressing project management complexities in mega construction projects. Previous research has shown that MCP contractors manage their projects through various project teams dispersed across multiple locations, working with vast amounts of information, drawings, bill of quantities, and specifications (Ershadi et al., 2021a). The interconnected, multidisciplinary nature of construction work leads to intense interactions between project teams. Mega project complexities arise from factors such as third-party risks, procurement issues, interdependent variables, multiple technologies, compatibility, and multiple information sources (Müller et al., 2011). The current study findings indicate that PMOs, as units with operational dominance, help to address complexities, particularly through risk management, mentoring, and performance monitoring services. Overlapping responsibilities in projects are clarified to prevent rework and conflicts among designers, engineers, workers, and service providers.

The current study findings reveal that PMOs can address challenges stemming from the complex nature of construction contracting by leveraging ten functional capabilities, resulting in six underlying outcomes: improved processes, decisions, coordination, alignment, oversight, and minimized risks and uncertainties (Aubry et al., 2010; Sandhu et al., 2019; Steyn et al., 2020). Participants emphasized that PMOs' knowledge management roles should be strengthened due to complexities related to integrating the extensive knowledge generated during construction processes (Tshuma et al., 2018; Steyn et al., 2020). Additionally, efforts should be made to encourage collaboration among involved parties to comply with safety practices, waste generation, and environmental standards laws and regional regulations.

Project success depends on proper planning, with the PMBOK outlining the use of 21 planning-related methods out of 39 essentials for effective project management (PMI, 2017). Completing duties in accordance with the project's plan is contingent upon the PMO staff's knowledge of project planning and execution processes. The 1999 publication of IEEE Standard 1490-1998 established the PMBOK as the standard for electrical and electronic project management (Rozenes & Vitner, 2009). This indicates that the project management office is crucial to the performance of the project; therefore, it is essential to acquire this information. Prior research has employed survey-based methodologies to determine whether the presence of a PMO within an organization is associated with improved project performance (Wiewiora et al., 2020; Barbalho et al., 2022). PMO connects project managers to a network of experienced employees and project management professionals in order to assist them in resolving various issues that arise during project execution. It creates a framework for establishing mutually beneficial relationships between mentors and project teams in order to determine the optimal tools, techniques, and methods (Barbalho & Silva, 2022). In this regard, monitoring performance enables them to make informed decisions based on performance outcomes. Even project management training and resource allocation contribute to addressing complexities by designating qualified personnel to projects and training them to execute their responsibilities with the highest level of performance (Ershadi et al., 2021c).

5.9 Project management office as moderated moderator between MPC, MPG and APM

The current study result revealed that negative and significant moderating effect of PMO on the relationship between MPC, MPG and AMP. Therefore, hypothesis 8 was supported. PMO refers to the intensive internal communications between departments regarding project matters. Steyn et al. (2020) highlighted that the fragmented nature of projects and their inadequate integration with functional departments cause problems with on-target delivery. Therefore, addressing this complexity aspect is necessary to improve project outcomes (Açıkgöz et al., 2016; Naveed et al. 2021). The current study findings show that functions such as project management office, project governance, and agile project management contribute to promoting bottom-up integration and cross-functional collaboration by reconciling differing viewpoints and providing a foundation for informed decision-making.

The complexity pertains to environmental aspects, encompassing the effects of changes in the construction market, conflicting external stakeholder requirements, alliances with strategic partners, and third-party oversight (Bakhshi, et al., 2016). These factors create complexity in the PMO domain, as executives must consider multiple criteria to respond to changes and update strategies for managing external stakeholders (Sergeeva et al., 2020). The current study found that PMOs play a significant role in supporting project teams in handling environmental project management complexities, particularly through managing interfaces with third parties. The environmental scanning and timely actions of PMOs provide a basis for controlling factors that impose changes from the external environment.

From a functional capabilities' perspective, risk management is the most critical function, accounting for -17.6 of PMO contributions to addressing project complexity. Previous research has also emphasized the importance of project complexity management for effectively overseeing the multi project environment. According to Qi et al. (2014), other important functional capabilities for overcoming complexity include interface management (21%), PM tools and methods (17%), mentoring (14%), knowledge sharing (14%), project governance (10%), performance monitoring (10%), portfolio management (7%), PM training (3%), and resource allocation and sharing (3%). These functional capabilities form the foundation for successful outcomes at the project, program, and portfolio levels.

The results indicate that public sector organizations with a well-established PMO department were more effective in several key areas. These include promoting organizational culture and learning, improving intra-organizational communication, identifying, selecting, and prioritizing new project and portfolio opportunities, and aligning the organization with its strategic plan and scope. This additional value in terms of project management execution has the potential to facilitate the more efficient implementation of a business's strategic strategies. The authors of this research argue that the effective operation of a PMO can significantly assist a public sector organization in the management of its projects, whether they are individual projects or part of a portfolio. This, in turn, leads to more dependable project delivery and the establishment of robust business ecosystems.

Chapter 6: Conclusion

6.1 Introduction

Academics and industry professionals have directed considerable attention towards the field of mega project management as a distinct area of study. The anticipated upswing in investments for large-scale construction mega projects is poised to drive rapid expansion in the practice-driven research domain of mega project management in the coming years. Given the absence of studies addressing the implementation of agile change management in the construction sector, this current study sought to prioritize agility strategies based on their potential effectiveness in managing critical changes within construction projects. The purpose of the current study was to investigate the influence of mega project governance on mega construction project success through mediating role of agile project management. Furthermore, mega project complexity as moderator on the relationship between mega project governance on mega construction project success, also mega project governance on agile project management. Lastly, the project management office as a moderated moderator on the relation between mega project complexity and mega construction project success, and mega project complexity on agile project management. The data was collected from project managers, middle management, project engineers, HR directors, and CEOs/Presidents working on mega projects under CPEC. The analysis was performed on the SmartPLS v.4.

The result revealed that mega project governance positively and significantly influences mega construction project success directly and also indirectly through mediating variable agile project management. Furthermore, the moderating variable mega project complexity negatively and significantly moderate the mega project governance on mega construction project success, however, the moderating impact on the relationship between MPG and agile project management is insignificant. Moreover, the moderated moderator project management office negatively and significantly moderates the relationship between mega project complexity, mega project governance and mega construction project success, also mega project complexity, mega project governance and agile project management. Therefore, current study identified that if PMO is high it will reduce the impact of project complexity and increase the mega project governance, agile project management also mega construction project success. APM focuses on embracing change as an opportunity for enhanced, early, and sustained value delivery, necessitating organizations to be more proactive than lean ones. To achieve this, stakeholders, including clients and customers, leverage the power of organizational learning. However, an organization must have a highly trained, team-based workforce using their collective intelligence for organic learning; bi-directional loyalty and mutual long-term commitment are crucial for this learning process. The pre-design and design phases of construction appear to have significant potential for improvements through APM adoption; iterative and incremental development can enable creative solutions, particularly for complex and uncertain requirements.

However, the fragmented and temporary nature of the construction organization may hinder the continuation of these practices through construction and support. Restructuring the construction industry to include a more skilled and motivated workforce should lead to enhanced customer-perceived value delivery, establishing long-term trust networks. This could improve the bid-to-win ratios of construction companies, reduce the fluctuating nature of their contracts, and form the foundation for iterative and incremental progress for such innovators. APM recognizes change as inevitable and delivers real benefits to organizations that embrace change and cultivate a culture where workers contribute to organizational learning (and thus, profitability). Principal construction contracting companies shoulder the intricate duty of ensuring timely delivery of interim and final products across the lifecycle of megaprojects. Managing the integration of engineering, procurement, and construction outputs poses a significant challenge in this responsibility. Various technical, organizational, and environmental factors contribute to the complexity of project management (PM) in executing megaprojects within this sector. Effectively coordinating the design, procurement, construction, and commissioning/hand-over phases of multiple projects relies on adopting appropriate management frameworks. Within large construction organizations navigating numerous PM uncertainties, project management office emerge as pivotal precursors for implementing systematic PM methodologies, demanding increased attention and focus.

The study focused on project management offices as a strategy to navigate the complexities inherent in project management within a demanding context. It identified ten primary PMO functions that effectively address fifteen complexities in project management, notably in risk and interface management, and the use of project management tools and methodologies. Respondents highlighted that, when backed by executive support, PMOs can effectively resolve issues stemming from intricate interactions among project stakeholders. The study concluded that PMOs serve as central oversight for multiple megaprojects, fostering integration of construction work from the ground up and enhancing coordination among various stakeholders. The adoption of PMOs offers target companies several advantages in managing project management complexities, improving processes, decisions, coordination, alignment, oversight, and reducing uncertainties. These entities rely on insights gained from collaborations with subcontractors to make informed decisions and optimize delivery strategies.

6.2 Theoretical Implication

Agile project management maturity may be operationalized as the degree to which an organization uses project management methods and the degree to which it succeeds in executing projects. According to institutional theory, efficiency and effectiveness improve as levels of standardization, rule-making coordination, and rule enforcement increase. Thomas and Mullaly (2008), proponents of the institutional theory approach, claim that the more often an organization employs APM techniques, the more fully it develops its APM skills, and the more effectively it can achieve project success. This helps to explain why the use of agile project management methods has been shown to influence the success of both project governance and success. Lacking enough funding, governance, political influence, complex bureaucratic structures, and kick backs, public construction projects in developing countries often fail. However, relatively few academic studies have examined the public sector construction projects of a developing country like Pakistan. The primary contributors to the complexity of mega projects, as defined by complexity indicators (information complexity, task complexity, technological complexity, organizational complexity, environmental complexity, and goal complexity), were identified, and descriptions of those contributors from the perspectives of complexity management were obtained to characterize project complexity. In this manner, the research assisted in the development of project management's theoretical foundation. By identifying and assessing the complexity indicators, the project complexity level was determined. This approach facilitates the development of project participants' skills in administering complex projects across diverse industries. The research will also result in recommendations for scholars and experts in the field of project management to better exploit the benefits and mitigate the drawbacks of project complexity in order to better manage mega projects.

According to the knowledge of the author, this is the first research to provide insights on MPG and the performance of public mega construction projects within the framework of APM, PMO, and MPC. Prior research has studied the link between project governance and project performance, but it is insufficient to guide practitioners on MPG and MCPS. In addition to addressing the above theoretical and contextual gap, this research also provided findings specific to the culture and context of Pakistan's public sector mega construction projects. Furthermore, by providing new empirical findings from Pakistan, this research will help to enhance the literature to other developing countries. As stated earlier, the majority of studies are done within a Western context. The result revealed that MPG and APM together enhance mega construction project success. These findings demonstrate that MPG within a company, together with the support of effective APM, is the primary driver of continuous high performance, despite the importance of good governance of public MCP. These results will contribute to the governance school of project management.

One of the most critical aspects of an agile organization is its ability to communicate effectively so that it can respond to changing circumstances fast without sacrificing coordination or, more importantly, its goal. Since the focus has always been on the market-firm conversation to drive the learning cycle, much of the research has been on agile external communication (Aghina et al., 2017). Theoretically, it is said that APM incorporates ideas from institutional theory in addressing complex megaprojects. Emergent outcomes, according to institutional theory, may be formed in unexpected ways, and they frequently appear at a ‘tipping point’ between order and chaos (Leybourne, 2009). These emergent outcomes, as they are termed, are the result of the dilution of the rigidity imposed by procedure and detailed planning in support of flexibility and improvisation, which is the core assumption of such processes. However, the literature prepared for practitioners and scholars emphasizes the need of the firm's coordination and control in order to effectively deploy agile methodologies. This issue emerges from the need to adapt agile methodology outside of the IT industry and their use in complex work environments. Prior researchers have tried to map various types of dynamics using methods that aren't enough to dealing with the complexity required, such system dynamics (Zhong et al., 2018), network theory (Bashir et al., 2020), and others. The proposed approach can be applied to any type of project incorporating all dimensions of project complexity.

To further entrench this concept in the construction industry, current study delved into results pertaining to the implementation of the PMO phenomenon within the primary construction contracting sector. While PMOs, functioning as central coordination hubs, can play a significant role in fostering the integration of diverse work packages from designers, builders, service providers, and suppliers, existing research indicates that construction organizations may underutilize this beneficial phenomenon due to a lack of comprehension regarding its impacts (Almansoori et al., 2021). The current investigation contributes to the existing knowledge about the types of project management difficulties and the capabilities of PMOs to address them in the construction sector. Each complexity factor was attributed a delineated contribution from each functional capability. The current research elucidates PMO requirements in major construction contracting firms from the perspectives of key stakeholders in the sector. Drawing on interviews with project management experts, Ershadi et al. (2021c) identified the top three functional competencies for successfully navigating mega projects: (1) aiding businesses in recognizing, measuring, and responding to the unpredictability of third-party work through risk management between projects; (2) assisting project teams in managing intensive interfaces with overlapping disciplines; and (3) providing effective tools and methods to foster transparency and reliability.

6.3 Managerial Implication

Moreover, the findings from this research have the following managerial implications: project professionals working on mega construction projects in the public sector could emphasize all three dimensions (governance structure, governance mechanism, and external environment) of project governance to improve project performance (Li et al., 2019). The viability of government organizations depends on their ability to cultivate, support, and maintain effective stakeholder relationships. Additionally, effective disclosure and reporting are essential for the efficient implementation of initiatives by fostering positive stakeholder relationships. Thus, managing communication and information needs can serve as a mechanism in the decision-making process to bring all legitimate stakeholders (i.e., the project sponsor, project manager, project team, consultants, contractors, political decision makers, the civil community, and the beneficiaries) on board and align them to have a positive effect on the project's success.

The present study findings can potentially be generalized to other developing countries, particularly a number of countries participating in China's Belt and Road Initiative that put a high priority on construction-driven economic growth yet face comparable complications as Pakistan. Pakistan is a perfect example of a typical developing country, with construction restrictions and a lack of ability to undertake sustainable construction projects due to an inefficient public sector and a lack of resources. As a consequence, the findings of this research are especially important for emerging countries who are working to enhance the performance of construction projects through various approaches, but significant changes are still needed to reach the intended performance indicators. Based on the results, it is recommended that policymakers and business leaders in developing countries prioritize stakeholder management in addition to the three dimensions of project governance (i.e., governance structure, governance mechanism, and external environment) to better manage the enhanced performance of government-sponsored mega construction projects.

The public sector MCPs typically maintain well-structured governance frameworks supported by control mechanisms, employing appropriate techniques and deploying resources across all project phases. However, the findings of this study suggest that APM enhances the resource management system and ensures resource availability both before and during project execution. This aspect is crucial as governments face pressure to meet public demands with limited resources. Participation, energy, and teamwork from members in underdeveloped nations often fall short of expectations, with culture in both the community and the workplace taking the blame. Political maneuvering within organizations stifles development in these nations, becoming a significant obstacle to successful project completion. Delays and blame-shifting are common hindrances, contributing to crumbling team unity, increased project complexity, and eventual failure. Moreover, team composition tends to be more influenced by personal preferences rather than specific project requirements, posing a challenge to success. However, this research aims to demonstrate strategies for effectively uniting teams and completing projects on time.

Furthermore, relational governance plays a crucial role in the function of MPG by fostering team connectedness. Team cohesiveness relies on key elements of relational governance, encompassing trust, information sharing, solidarity, and adaptability. The study also discovered that employing an agile team as an intermediary strengthened the positive and statistically significant relationship between MPG and project success. Therefore, establishing robust team cohesiveness becomes pivotal for the success of project teams, directly impacting the outcome of a project.

6.4 Limitation and Future Direction

No research is without limitations, and there is always an opportunity for further investigation. The current study also has certain limitations. Firstly, this research was performed in a single country and in the construction sector. Even though participants came from various departments and worked on various sorts of projects. Our results may be insufficiently generalizable. These outcomes may vary depending on the circumstances. However, the same model may be used to investigate the relationship between MPG and project success in different contexts, including non-profit organizations and the corporate sector.

Increasing urbanization throughout the world has prompted a rise in investment in construction megaprojects, both in developed as well as developing countries. McKinsey estimates that the world would need to spend approximately US$ 57 trillion in infrastructure by 2030 just to keep up with GDP growth (Garemo et al., 2015). There are several ways in which megaprojects deviate from standard projects, each of which has the potential to increase the risks associated with the project and the complexity of completing it successfully. Studies on the success of megaprojects are few, and most journal publications addressing project success in the subject of construction engineering and management (CEM) have solely focused on standard construction projects (He et al., 2019). Thus, the success of megaprojects should be a main focus of future study. This particular area of focus should include criteria or dimensions that reflect and indicate megaproject success, critical variables in the success of various kinds of megaprojects, and the diverse viewpoints of megaproject participants during different construction processes/stages.

Future work includes analysis of additional characteristics or methods for the team analysis that can help during adaptation and implementation of the APM technique; adding of guidelines how agile roles, artefacts, processes and practices can be used for improvement of the team self-organization and motivation; and application of the proposed method to new case studies.

6.4.1 Potential Areas for Improved Agility within Construction

In the construction sector, the pre-design, design, and actual construction stages can be examined individually. By mapping these phases against the APM analysis, as discussed above, the potential applicability and usefulness of APM for the industry can be assessed.

6.4.2 Pre-Design Phase

During the initial stage of a construction project, three primary concerns arise: concept development, planning involving procurement strategy, time, and cost, and the creation of a brief (Smith et al., 2014; Gardiner, 2017). The content, structure, and management principles employed in this initial stage can differ significantly among projects and client organizations, even when larger clients establish standard procedures for this stage. The pre-design stage is often characterized by considerable complexity (Owen et al., 2006). As a foundation for future stages, the output from pre-design should be thorough, integrated, and consistent (Uvarova et al., 2023). Prior research on the pre-design stage indicates that approaches in practice tend to be either overly systematic or excessively disordered (Gardiner, 2017). This leads to incomplete, inconsistent, or otherwise suboptimal guidance for later project stages. The applicability of agile principles during the pre-design stage is examined based on three criteria, in descending order of validity (Sakikhales et al., 2017):

- Agile principles have been successfully employed, either implicitly or explicitly.
- Previous literature has identified problems that agile principles can potentially address.
- Agile principles can be argued as applicable based on general knowledge of the pre-design stage.

Next, the implementation of various agile principles in the pre-design stage is assessed based on the aforementioned criteria (Fernandez & Fernandez, 2008). It is important to recognize the highly contextual nature of any statement and advice. Philosophy: A large number of issues in the pre-design phase are in flux, and the entire process is emergent. As such, process metaphysics can be beneficially utilized as a foundation for conceptualizing this stage. Attitude towards chaordic change: new opportunities continuously arise, and new risks are consistently identified; therefore, the situation is marked by chaordic change. Management style/work group structure: For large and complex pre-design efforts, it is wise to organize through an empowered team with frequent communication. Hierarchical decision-making has been found to cause issues, such as in the pre-design stage of primary healthcare facilities. Customer involvement: since capturing requirements is a central task in the pre-design phase, customer involvement is highly recommended, if not essential. Nature of planning: Given the complexities and uncertainties present in the pre-design stage, lightweight planning is likely the most effective approach. Sakikhales et al. (2017) observed minimal formal planning in the early phases of successful projects. Development approach: an iterative and incremental development approach is often recommended for the pre-design stage due to the need for integration and customer involvement. Lastly, requirements capture differentiating between stable requirements (captured upfront), volatile requirements (requiring flexible options), and evolving requirements (necessitating learning) is crucial in construction projects. Fernandez et al. (2008) report consequences of failing to categorize requirements appropriately and relying on immature requirements. Agile principles and methods arguably offer an improved approach for the pre-design phase, providing both adequate structure and flexibility for seizing opportunities and developing creative solutions.

6.4.3 Design

The design phase is a crucial stage in a construction project, where concepts from the pre-design phase are developed into solutions, such as specifications and guidelines, for the construction, operation, and maintenance of the building (Arefazar et al., 2022). Two primary concerns arise during this phase: the integration of design and production, and the dynamic process of capturing requirements. The content generated during this phase varies between projects and is subject to iteration intrinsic to design. APM is believed to add value to these two key issues. Philosophy: Contemporary methodologies and approaches, such as concurrent engineering and last planner, focus on delivering value throughout the design process (Owen et al., 2006). Trade-off identification, analysis and synthesis processes, and decision-making are in flux, making process metaphysics a suitable foundation for conceptualizing this phase.

Organizational attitudes and practices: in general, the construction industry forms new teams of companies for each project, resulting in varying design teams across projects. Although it is difficult to apply categories Y, X, and Z to construction, some Type Z characteristics, such as collective decision-making and improved employee-employer relationships, can be observed in long-term partnerships (Kamara et al., 2000) and projects like Heathrow Airport Terminal 5 (College, 2005).

Iterative and incremental value development is a natural process in the design phase. However, postponing decisions to the "last responsible moment" may cause issues in the current construction setting, with its discrete phases, and could lead to difficulties in project development coordination (Lane & Woodman, 2000; Senior, 2015). Design teams must consider the impact of changes on both the product and the design process itself. Planning: Design planning has been extensively researched in both manufacturing and construction, resulting in a wide range of ‘light’ and ‘heavyweight’ approaches. Heavyweight planning examples include Design Structure Matrix (DSM) and Analytical Design Plan Technique (ADePT) (Austin et al., 2000; Baldwin et al., 2009), while Last Planner (Choo et al., 2004) is considered lightweight.

Methods like Quality Function Deployment (QFD) focus on exhaustively detailing client requirements at the beginning of the design phase (Delgado-Hernandez, et al., 2007). However, there remains a gap in capturing requirements throughout the entire design phase, as significant uncertainty persists even at the start of construction. Work breakdown structures are commonly used to divide tasks according to products and sub-products to be delivered in construction, with the process protocol developed by Salford University (Wu et al., 2004) being one example. Execution: The design phase can adopt either sequential or iterative approaches, with the choice depending on the project (Senior, 2015). Iterative approaches lead to frequent value delivery for clients, while sequential approaches result in product delivery at the end, often accompanied by errors and corrections. Quality is delivered by considering both stakeholder value perception and defect reduction (e.g., design for manufacturing and constructability analysis). Client involvement during the design phase is a common practice in construction. Lastly, control and Learning: various metrics, such as cost, maintainability, and sustainability of solutions, are used to measure construction design.

However, the interrelationships among these measures remain unclear. Change management within the temporary organization and knowledge retention at the individual level, rather than the organizational level, define the fidelity of the learning process for each new project. Ultimately, the construction sector faces numerous challenges, such as the requirement to construct complex structures at the lowest feasible cost, prompting the adoption of APM principles throughout the design process. Though, its applicability varies depending on the project's complexity and level of uncertainty; it proves most beneficial when solutions to requirements change or evolve during the project's progression. Therefore, APM is most advantageous for projects involving multiple stakeholders, competing needs requiring ongoing trade-offs, and a focus on delivering value early in the process.

6.4.4 Construction

The construction phase has distinct characteristics compared to the design phase, which need to be considered when assessing the applicability of APM in construction (Albuquerque et al., 2020). The construction phase involves a more diverse range of employers and employees, often with lower professional qualifications and comparatively lower salaries (Schimanski et al., 2021). Implementing new management methodologies in construction, therefore, encounters significant cultural barriers that need to be overcome to enable training and learning for multi-skilled, self-managing teams as advocated by APM philosophy. Additionally, construction typically involves numerous subcontractors and temporary workers, making it challenging to foster strong loyalty among workers (BuHamdan et al., 2020).

Despite these cultural challenges in construction, there is potential for APM application in construction, particularly at the planning level, where managers can rapidly respond to changes in project scope. However, construction tends to be resistant to cultural change, making APM implementation more difficult at lower levels of execution, where changes can have substantial impacts and high costs for the workforce to bear. APM's applicability will also depend on the project's scale and the organization type. Some positive changes in construction philosophy have emerged, with a greater focus on human aspects within production management methods, such as the Last Planner System (Wu et al., 2004).

APM emphasizes defining value upfront and delivering value to customers early and continuously. While APM is well-suited for the design phase, applying it to the execution phase is more complex due to numerous interdependent activities. In summary, APM concepts are considered as a valuable tool for construction managers, primarily for planning in the production phase of construction. However, significant effort, beginning with a cultural shift within the sector, would be required to manage construction execution using APM.

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Appendix A: Questionnaire

SURVEY QUESTIONNAIRE

Dear respondent,

I am a student of PhD in Business Administration at Sunway University Business School, Sunway University, Malaysia, wishing to conduct research on "***Megaproject governance's impact on mega construction project CPEC success: the mediating role of agile project management and the moderating effects of project complexity and project management office"*** for the completion of my research thesis.

In this regard, I have prepared following questionnaire, please note down that your identity as respondent is concealed. You can freely express whatever the ground realities you see and face. It will take your 10-15 minutes to answer the questions; any information obtained for this research will only be used for academic purpose.

For more queries, please email syed.h11@imail.sunway.edu.my. I really appreciate your time for filling up this questionnaire.

Thanks a lot for your help and support!

Sincerely

Regards

Syed Arslan Haider

Appendix B: Demographics

Please tick (√) which applies to you.

Gender	
Male	
Female	
Age	
21 to 30 years	
31 to 40 years	
41 to 50 years	
More than 50 years	
Experience	
Less than 5 years	
5 to 10 years	
11 to 15 years	
>15 years	
Education Level	
Bachelor	
Master	
MS/M.Phil.	
PhD.	
Others (please specify) _____	
Experience in Current Organization	
Less than 3 years	
3 to 5 years	
6 to 10 years	
>10 years	
Position	
Project manager	
Middle management	
Senior managers (vice presidents)	
Project engineer	
Human resource directors	
CEOs/presidents	
Others _____	

Appendix C: Project Related Information

Please tick (√) which applies to you

Please select one option	
Project Type ***What was the project type in your recently completed mega project?***	
Residential project	
Hydroelectric project	
Road and bridge project	
Industrial project	
Airport project	
Others _____	
Project Size ***What was the project size of your recently completed mega project?***	
50–100 million USD	
101– 200 million USD	
201– 300 million USD	
301– 400 million USD	
> 500 million USD	
Project Duration ***What was the project duration of your recently completed mega project?***	
1 to 3 years	
4 to 7 years	
8 to 10 years	
10 to 15 years	
Others _____	
Position ***Which position did you have in your recently completed mega project?***	
Stakeholders	
Government	
Contractors	
Suppliers	
Supervisors	
Others	

Appendix D: Agile Project Management (APM)

Please tick (√) which applies to you

Do you know the term Agile Project Management (APM)?	
Yes	
No	
If 'Yes', how did you know this?	
By reading	
By listening to a lecture	
As a partner of an application of APM	
Other _____	
Which industry do you know where APM is applied?	
Information Technology (IT)	
Manufacturing	
Construction	
Agriculture	
Apparel	
Other _____	
Do you have any experience of APM application in Pakistani Construction Industry?	
Yes	
No	
Do you think APM is adapting to Pakistani Construction Industry?	
Yes	
No	
Not Having Exact idea	

Please select the appropriate option for each of the following statements:

Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agreed = 4, Strongly Agreed = 5

Agile Project Management (APM)

General information of your recently completed mega project.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agreed**	**Strongly Agreed**
1: The project team plans first and then implement it.	**1**	**2**	**3**	**4**	**5**
2: The project team first categorizes the project scope which covers the client requirements of the project.	**1**	**2**	**3**	**4**	**5**
3: The scope of the construction project is needed to be fixed earlier before implementation.	**1**	**2**	**3**	**4**	**5**
4: The construction project time and costs are planned to achieve the fixed project scope.	**1**	**2**	**3**	**4**	**5**
5: The project scope changes during implemention of a construction project.	**1**	**2**	**3**	**4**	**5**
6: The modifications in project scope have a significant impact on construction project time.	**1**	**2**	**3**	**4**	**5**
7: The project scope change significantly influences the change in the cost of the construction project.	**1**	**2**	**3**	**4**	**5**
8 The clients are mostly worried about the exceeding project costs and project time.	**1**	**2**	**3**	**4**	**5**
9 The clients might be happy when the construction project closes within available budget and expected time.	**1**	**2**	**3**	**4**	**5**
10: To change the scope of the project without affecting the cost or timeline for the project is the best option.	**1**	**2**	**3**	**4**	**5**
11: Client requirements for the construction project could be prioritized (from most important to least important).	**1**	**2**	**3**	**4**	**5**
12: The client will be satisfied if their earlier requirements are fulfilled within the available project	**1**	**2**	**3**	**4**	**5**

cost and expected project time period.					
Project Documents details of your recently completed mega project.					
13: It is not difficult to prepare the documents for construction projects.	**1**	**2**	**3**	**4**	**5**
14: The same document templates were used in all projects and did not differ from one project to the next or from one manager to the next.	**1**	**2**	**3**	**4**	**5**
15: The documents support to complete the project within time and cost.	**1**	**2**	**3**	**4**	**5**
16: The documentation process causes problems for the project-based approach.	**1**	**2**	**3**	**4**	**5**
17: The documents are important to the construction project's progress monitoring.	**1**	**2**	**3**	**4**	**5**
18: It is necessary to simplify the project documents.	**1**	**2**	**3**	**4**	**5**
19: To Create and maintain the project documents is a time-wasting process.	**1**	**2**	**3**	**4**	**5**
20: Project documents should represent the client prior needs.	**1**	**2**	**3**	**4**	**5**
21: The upcoming task to be implemented must be clearly stated in the project document.	**1**	**2**	**3**	**4**	**5**
22: The project documents should clearly state the task that is completed to finish the implemented elements.	**1**	**2**	**3**	**4**	**5**
Team Members details of your recently completed mega project.					
23: The construction project's stakeholders are clearly classified.	**1**	**2**	**3**	**4**	**5**
24: The project team members have a good relationship with each other.	**1**	**2**	**3**	**4**	**5**
25: The project team members know their limitations while interacting with different stakeholders.	**1**	**2**	**3**	**4**	**5**
26: Irrelevant interactions generally happen among different parties in the project.	**1**	**2**	**3**	**4**	**5**
27: Project teams of a smaller size are more effective in their work.	**1**	**2**	**3**	**4**	**5**

Project Meeting details of your recently completed mega project.					
28: The construction project meetings were necessary.	**1**	**2**	**3**	**4**	**5**
29 The construction project meetings were effective in present practice.	**1**	**2**	**3**	**4**	**5**
30: The time duration of the project meetings between the client and project team was pre-decided.	**1**	**2**	**3**	**4**	**5**
31: Sometimes, there were irrelevant participants who attended the project meetings.	**1**	**2**	**3**	**4**	**5**
32: Project meetings were held in order to review a pre-prepared agenda.	**1**	**2**	**3**	**4**	**5**
33: The project meeting duration needed to be fixed.	**1**	**2**	**3**	**4**	**5**
34: It was necessary to specify the scope of the project meeting before it could take place.	**1**	**2**	**3**	**4**	**5**
35: Prior to the meeting, it was necessary to identify all of the major stakeholders in the project.	**1**	**2**	**3**	**4**	**5**
36: The daily 5-minute standup meeting with the project's stakeholders was a successful strategy.	**1**	**2**	**3**	**4**	**5**

Appendix E: Mega Project Governance (MPG)

Governance Structure of your recently completed mega project.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agreed**	**Strongly Agreed**
Organization structure: 1. Moderate degree of centralized management, proper management level, good department setup, high resource use capacity, and good adaptability.	**1**	**2**	**3**	**4**	**5**
Stakeholder role: 2. Clearly defined rights, responsibilities, benefits, and job tasks of different stakeholders.	**1**	**2**	**3**	**4**	**5**
Supply chain management: 3. Properly selected procurement characteristics, high supply-chain integration, and fast response.	**1**	**2**	**3**	**4**	**5**
Project financing structure: 4. Different project investment and financing channels, effective sharing of government investment pressure, and reasonable project financing structure.	**1**	**2**	**3**	**4**	**5**
Target management system: 5. Complete and clear management hierarchies in which all levels are feasible and easy to measure and decompose.	**1**	**2**	**3**	**4**	**5**
Governance Mechanism of your recently completed mega project.					
Communication mechanism: 6. Diverse communication means, high communication frequency, and a sound and systematic information-sharing and feedback system.	**1**	**2**	**3**	**4**	**5**
Coordination mechanism: 7. Construction of coordination subjects, methods (based on meetings, conversations, and writings), and coordination procedure.	**1**	**2**	**3**	**4**	**5**
Conflict resolution mechanism: 8. Proper and different degree of conflict resolution methods (e.g., law enforcement, authority's	**1**	**2**	**3**	**4**	**5**

mitigation, and arbitration), and the creation of conflict emergency plans.					
Incentive mechanism: 9. Clear incentive criteria and assessment indicators, diverse incentive means (e.g., spiritual, material, and publicity incentives).	**1**	**2**	**3**	**4**	**5**
Supervision mechanism: 10. Regular inspections by the management team and functional groups are critical to the organization's accountability system.	**1**	**2**	**3**	**4**	**5**
Decision-making mechanism: 11. Process highest decision-making power to coordinate work assignments by expertise and professional background; create clear responsibility-benefit boundary.	**1**	**2**	**3**	**4**	**5**
External environment of your recently completed mega project.					
Organization Culture: 12. Emphasize a people-oriented and mutual-trust organizational value; organize different activities to form and promote organizational culture.	**1**	**2**	**3**	**4**	**5**
Market environment: 13. Have orderly labor, contracting, and engineering consulting markets and a sound market environment.	**1**	**2**	**3**	**4**	**5**
Government regulation: 14. Have proper and reasonable regulatory department to regulate and appropriately supervise the project life cycle.	**1**	**2**	**3**	**4**	**5**
Social supervision: 15. Have different project information publicity channels (e.g., press conference, government website, and public hearing); direct public supervision channel to engage public opinions.	**1**	**2**	**3**	**4**	**5**

Appendix F: Mega Project Complexity

Criteria of the definition of project complexity levels

1	Simple	Worker is able to manage subtask easily.
2	Mildly complex	Worker is able to manage subtask to an acceptable extent.
3	Moderately complex	Worker needs an explanation of the subtask although it is clearly defined.
4	Highly complex	Worker is not able to take small decisions with regard to a subtask without help from others.
5	Extremely complex	Worker is not able to manage a subtask owing to his inexperience and insufficient skill.

Mega Project Complexity

Information Complexity of your recently completed mega project.	**Simple**	**Mildly complex**	**Moderately complex**	**Highly complex**	**Extremely complex**
1. Complexity in developing the trust among organizations.	**1**	**2**	**3**	**4**	**5**
2. Complexity in improving the sense of cooperation.	**1**	**2**	**3**	**4**	**5**
3. Complexity in transferring the information.	**1**	**2**	**3**	**4**	**5**
4. Complexity in obtaining the information.	**1**	**2**	**3**	**4**	**5**
5. Complexity associated with the cultural differences.	**1**	**2**	**3**	**4**	**5**
6. Complexity in processing the information.	**1**	**2**	**3**	**4**	**5**
7. Complexity due to insufficient experience of participants.	**1**	**2**	**3**	**4**	**5**
8. Complexity involved with the information uncertainty.	**1**	**2**	**3**	**4**	**5**
9. Complexity involving the uncertainty in the project management methods and tools.	**1**	**2**	**3**	**4**	**5**
Task Complexity of your recently completed mega project.					

10. Complexity in the dependency among tasks.	**1**	**2**	**3**	**4**	**5**
11. Complexity in the diversity of technology.	**1**	**2**	**3**	**4**	**5**
12. Complexity in the diversity of tasks	**1**	**2**	**3**	**4**	**5**
13. Complexity in the dependence of information system.	**1**	**2**	**3**	**4**	**5**
Technological Complexity of your recently completed mega project.					
14. Complexity in implementing the novel technology in construction products.	**1**	**2**	**3**	**4**	**5**
15. Complexity in adopting highly difficult technology.	**1**	**2**	**3**	**4**	**5**
16. Complexity in gaining knowledge about new technology.	**1**	**2**	**3**	**4**	**5**
17. Complexity in attaining the resources and skills.	**1**	**2**	**3**	**4**	**5**
Organizational Complexity of your recently completed mega project.					
18. Complexity linked to organizational structure hierarchies.	**1**	**2**	**3**	**4**	**5**
19. Complexity linked with organizational units and departments.	**1**	**2**	**3**	**4**	**5**
Environmental Complexity of your recently completed mega project.					
20. Complexity related to changing policy and regulations.	**1**	**2**	**3**	**4**	**5**
21. Complexity related to changing economy.	**1**	**2**	**3**	**4**	**5**
22. Complexity related to	**1**	**2**	**3**	**4**	**5**

changes in the construction site.					
23. Complexity due to the impact of external stakeholder.	**1**	**2**	**3**	**4**	**5**
Goal Complexity of your recently completed mega project.					
24. Complexity related to the change in the stakeholders' requirements.	**1**	**2**	**3**	**4**	**5**
25. Complexity due to the change in project organization.	**1**	**2**	**3**	**4**	**5**
26. Complexity associated with the uncertain goals.	**1**	**2**	**3**	**4**	**5**
27. Complexity involved with the contractual relationship.	**1**	**2**	**3**	**4**	**5**

Appendix G: Project Management Office

Please tick (√) which applies to you

Age of PMO in the organization.	
Under 5 years	
5 to 10 years	
More than 10 years	
PMOs' staff composition	
Staff of PMO (other than project/program managers)	
Presence of project managers within the PMO	
Experience of the staff	
Specialty of the staff	
The status and authority of the PMO	
Location of PMO within the organizational hierarchy	
Percentage of projects within the mandate of the PMO	
Decision-making authority of the PMO about projects and project managers	
Amount of supportive role of PMO	
Amount of managerial role of PMO	

Project Management Office (PMO)

Facilitated Processes of your recently completed mega project.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agreed**	**Strongly Agreed**
1. Introducing proper reporting tools speeds up the flow of project information among involved parties.	**1**	**2**	**3**	**4**	**5**
2. PM methodologies clarify the roles and facilitates the management of interfaces across multiple involved disciplines.	**1**	**2**	**3**	**4**	**5**
Improved Decisions of your recently completed mega project.					
3. Providing project managers	**1**	**2**	**3**	**4**	**5**

with mentoring services help them to deal with complex decisions throughout the lifecycle.					
4. Risk analysis from a systematic perspective enables project leaders to decide on the best scenario for addressing issues with the least side effects.	**1**	**2**	**3**	**4**	**5**
Improved Coordination of your recently completed mega project.					
5. Managing interfaces of the projects with suppliers improves coordination for timely procurement of supplies.	**1**	**2**	**3**	**4**	**5**
6. Knowledge sharing among the members of a multidisciplinary team enhances their coordination to manage interfaces of their tasks.	**1**	**2**	**3**	**4**	**5**
Enhanced Alignment of your recently completed mega project.					
7. Employing portfolio management practices enables an organization to improve alignment with dynamic changes and variations in the construction environment.	**1**	**2**	**3**	**4**	**5**
8. PMOs systematically evaluate and align PM tools and systems to be compatible so that they can be integrated into a single platform.	**1**	**2**	**3**	**4**	**5**
Addressed Uncertainties of your recently completed mega project.					
9. Sharing the lessons learned among projects helps to take preventive measures necessary for addressing uncertainties and avoid recurrence of similar issues.	**1**	**2**	**3**	**4**	**5**

10. PMOs give consultation to projects on how to deal with new technologies on construction sites, which significantly addressed associated uncertainties.	**1**	**2**	**3**	**4**	**5**
Integrated Oversight of your recently completed mega project.					
11. Establishing a project governance framework enables the integrated oversight of third parties involved in project execution.	**1**	**2**	**3**	**4**	**5**
12. Monitoring the performance of vendors and suppliers benefits principal contractors in overseeing parties in the procurement process to avoid any delay.	**1**	**2**	**3**	**4**	**5**

Please select the appropriate option for each of the following statements:

Not successful = 1, Slightly successful = 2, Moderately successful = 3, Highly successful = 4, Very Highly successful = 5

Appendix H: Mega Construction Project Success (MCPS)

Project Success of your recently completed mega Construction project.	Not successful	Slightly successful	Moderately successful	Highly successful	Very highly successful
1. Your recent mega construction project was completed according to the specification.	1	2	3	4	5
2. The suppliers were satisfied in your recently completed mega construction project.	1	2	3	4	5
3. Other project work was enabled for future in your recently completed mega construction project.	1	2	3	4	5
4. The high national profile was achieved in your recently completed mega construction project.	1	2	3	4	5
5. Business and other benefits were yielded in your recently completed mega construction project.	1	2	3	4	5
6. Client's requirement were met in your recently completed mega construction project.	1	2	3	4	5
7. There was minimum disruption to the organization in your recently completed mega construction project.	1	2	3	4	5
8. There was cost effectiveness of work in your recently	1	2	3	4	5

completed mega construction project.					
9. Planned quality standards were met in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
10. There was adherence to the defined procedures in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
11. You learned from your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
12. Project outputs were smoothly handed over in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
13. Resources were mobilized and used as planned in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
14. There was improvement in organizational capability in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
15. Safety standards were met in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
16. There were minimum number of agreed scope changes in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
17. You were motivated for future projects after completing your recently mega construction project.	**1**	**2**	**3**	**4**	**5**
18. Project's impacts on beneficiaries were visible in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**

19. Project achieved its purpose in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
20. Your recently completed mega project had good reputation.	**1**	**2**	**3**	**4**	**5**
21. Your recent mega project was finished on time.	**1**	**2**	**3**	**4**	**5**
22. You gained new understanding/ knowledge from your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
23. Group satisfaction was achieved in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
24. The environmental regulations were compiled in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
25. End-user satisfaction was achieved in your recently mega completed construction project.	**1**	**2**	**3**	**4**	**5**
26. Project team satisfaction was achieved in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
27. Activities were carried out as scheduled was achieved in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
28. Your recently completed mega construction project was Finished within budget.	**1**	**2**	**3**	**4**	**5**
29. Sponsor satisfaction was gained in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
30. End product was used as	**1**	**2**	**3**	**4**	**5**

planned in your recently completed mega construction project.					
31. Personal financial rewards were given in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
32. Organizational objectives were met in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**
33. Your recently completed mega construction project satisfied the needs of users.	**1**	**2**	**3**	**4**	**5**
34. Personal nonfinancial rewards were given in your recently completed mega construction project.	**1**	**2**	**3**	**4**	**5**

Thank you for your participation, I really appreciate your cooperation and support.

List of Publications

1. **Haider S. A*,** Tehseen. S., Koay, K. Y., Afsar, B., (2023), Megaproject governance's impact on mega construction project CPEC success: The mediating role of agile project management and the moderating effects of project complexity and project management office. *Acta Psychologica.* (Scopus: Q1, ABDC "A" and SSCI index) *(Published)*
2. **Haider S. A*,** Zubair. M, Tehseen. S., Iqbal S., Sohail M., (2023), How Does Ambidextrous Leadership Promote Innovation in project-based organizations? The Mediating Role of Knowledge sharing and Moderating Role of innovativeness as a project requirement. *European journal of innovation management* (Scopus: Q1, ABDC "C" index, and SSCI index) *(Published)*
3. **Haider, S. A.*,** Akbar, A., Tehseen, S., Poulova, P., & Jaleel, F. (2022). The impact of responsible leadership on knowledge sharing behavior through the mediating role of person–organization fit and moderating role of higher educational institute culture. Journal of Innovation & Knowledge, 7(4), 100265. Impact Factor 18.215, Scopus: Q1, ABDC "A" index) *(Published)*
4. **Haider S. A***, Mata, M. N., Tehseen, S., Martins J. M., (2024). Antecedents of Construction Project Performance and Contingent Role of Prosocial Behavior. Int. J. of Economics and Business Research. (ABDC "C" and Scopus: Q2 index) *(Accepted in Publication Process)*
5. Idrees, H., **Haider, S. A.*,** Xu, J., Tehseen, S., & Jan, N. (2023). Impact of knowledge management capabilities on organisational performance in construction firms: the mediating role of innovation. Measuring Business Excellence. (Scopus: Q2, ABDC "B" index). *(Published)*
6. Ali A., Iqbal S., **Haider S. A*,** Tehseen. S., Anwar B., Sohail M., and Rehman K., (2021). Does Governance in Information Technology Matters When it comes to Organizational Performance in Public Sector: Mediating Effect of Innovation. *Sage Open.* (Scopus: Q1 and SSCI index) *(Published)*
7. S.M.H.S. Khairuddin, **S.A. Haider***, S. Tahseen, and S. Iqbal. (2021) "Creativity in Construction Project Through Entrepreneurial Leadership, Innovative Ambidexterity and Collaborative Culture". *Advances in Mathematics: Scientific Journal* 10(3), 1529–1546. 0026 (Impact Factor: 1.494, and Scopus index) *(Published)*

Conference Papers Presentations

1) Khairuddin, S. M. H. S., Tehseen S., Iqbal S., **Haider S. A.,** Sohail M. (2020**).** Importance of Workplace Safety Behavior in Covid-19 Pandemic for Project Based Construction Companies of Pakistan. Paper Presented in 2nd International Conference of World Academy of Islamic Management On 17th October 2020 at Universiti Kuala Lumpur, Malaysia.

2) Khairuddin, S. M. H. S., **Haider S. A.,** Tehseen S., Iqbal S. (2020**).** Creativity in Construction Project through Entrepreneurial Leadership, Innovative Ambidexterity and Collaborative Culture. Paper Presented in 2nd International Conference of World Academy of Islamic Management On 17th October 2020 at Universiti Kuala Lumpur, Malaysia.

Appendix I: Supplementary Results

Harman single factor

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	21.889	17.653	17.653	21.889	17.653	17.653
2	10.516	8.480	26.133			
3	7.683	6.196	32.329			
4	5.474	4.415	36.743			
5	5.239	4.225	40.968			
6	3.982	3.212	44.180			
7	3.563	2.874	47.054			
8	3.391	2.734	49.788			
9	2.133	1.721	51.509			
10	1.900	1.532	53.041			
11	1.787	1.441	54.482			
12	1.697	1.369	55.851			
13	1.613	1.301	57.152			
14	1.546	1.247	58.399			
15	1.465	1.181	59.580			
16	1.369	1.104	60.685			
17	1.346	1.085	61.770			
18	1.328	1.071	62.841			
19	1.283	1.035	63.876			
20	1.245	1.004	64.880			
21	1.203	.970	65.850			
22	1.154	.930	66.780			
23	1.117	.901	67.681			
24	1.101	.888	68.569			
25	1.065	.859	69.428			
26	1.016	.819	70.247			
27	.997	.804	71.052			
28	.951	.767	71.818			
29	.916	.738	72.556			
30	.892	.720	73.276			
31	.880	.710	73.986			
32	.870	.702	74.688			
33	.863	.696	75.384			
34	.822	.663	76.047			
35	.803	.647	76.695			
36	.776	.625	77.320			
37	.757	.610	77.931			
38	.736	.593	78.524			

39	.721	.581	79.105			
40	.693	.559	79.664			
41	.690	.556	80.221			
42	.681	.550	80.770			
43	.679	.547	81.318			
44	.652	.526	81.843			
45	.618	.499	82.342			
46	.603	.486	82.828			
47	.594	.479	83.308			
48	.583	.470	83.778			
49	.573	.462	84.240			
50	.566	.457	84.697			
51	.548	.442	85.139			
52	.530	.427	85.566			
53	.527	.425	85.991			
54	.507	.409	86.400			
55	.501	.404	86.805			
56	.487	.392	87.197			
57	.477	.385	87.582			
58	.464	.374	87.956			
59	.457	.369	88.325			
60	.446	.360	88.685			
61	.444	.358	89.043			
62	.434	.350	89.393			
63	.429	.346	89.739			
64	.406	.327	90.066			
65	.402	.324	90.391			
66	.393	.317	90.707			
67	.390	.315	91.022			
68	.374	.301	91.323			
69	.362	.292	91.615			
70	.358	.289	91.904			
71	.352	.284	92.188			
72	.344	.278	92.466			
73	.331	.267	92.733			
74	.323	.260	92.993			
75	.318	.257	93.250			
76	.310	.250	93.500			
77	.306	.247	93.747			
78	.296	.239	93.986			
79	.289	.233	94.219			
80	.279	.225	94.444			
81	.273	.220	94.664			
82	.263	.212	94.876			
83	.251	.202	95.079			
84	.248	.200	95.278			
85	.244	.197	95.475			
86	.240	.193	95.669			
87	.233	.188	95.857			
88	.231	.186	96.043			

89	.227	.183	96.226			
90	.223	.180	96.406			
91	.216	.174	96.580			
92	.206	.166	96.746			
93	.201	.162	96.908			
94	.194	.157	97.065			
95	.188	.152	97.217			
96	.185	.149	97.366			
97	.179	.144	97.510			
98	.172	.139	97.649			
99	.169	.136	97.786			
100	.161	.130	97.916			
101	.159	.129	98.044			
102	.157	.126	98.171			
103	.150	.121	98.291			
104	.146	.118	98.409			
105	.142	.115	98.524			
106	.138	.112	98.636			
107	.136	.110	98.745			
108	.128	.104	98.849			
109	.122	.098	98.947			
110	.118	.095	99.042			
111	.111	.090	99.132			
112	.107	.086	99.218			
113	.107	.086	99.304			
114	.102	.082	99.387			
115	.099	.080	99.466			
116	.092	.074	99.541			
117	.083	.067	99.607			
118	.082	.066	99.674			
119	.078	.063	99.736			
120	.076	.061	99.797			
121	.072	.058	99.855			
122	.066	.053	99.908			
123	.060	.049	99.957			
124	.053	.043	100.000			
Extraction Method: Principal Component Analysis.						