



**EFFECTS OF CONSTRUCTION PROJECT MANAGER LEADERSHIP
COMPETENCIES ON PROJECT TEAM PERFORMANCE IN CHINA**

By

WANG PENG

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of
Philosophy**

August 2024

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in
fulfilment of the requirement for the degree of Doctor of Philosophy

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This study investigates the effect of construction project manager's leadership competencies on project team performance in China, addressing the critical role of effective leadership in ensuring project success within the construction industry. Leadership competencies, which include task-related, people-related, and self-related skills, are essential for guiding team processes such as learning, monitoring, and climate, all of which influence overall team performance. However, previous research lacks a detailed understanding of how these competencies impact team dynamics, particularly in the Chinese construction sector. To address this gap, the study explores the specific mechanisms through which different leadership competencies affect project team performance. Using a mixed-methods approach, the research includes a systematic literature review and empirical data collected from 483 construction professionals in China, with a theoretical framework grounded in social information processing theory. Structural equation modeling (SEM) was employed to validate the framework. The findings reveal that project manager

leadership competencies significantly enhance team performance both directly and through the mediating roles of team learning, monitoring, and climate. Task-related competencies facilitate task execution, people-related competencies strengthen team relationships, and self-related competencies foster trust and resilience over time. These insights contribute to both theory and practice by expanding leadership competency models to include team processes and by providing practical recommendations for improving the recruitment, training, and management of project managers. Despite its contributions, the study is limited by its focus on internal team processes, exclusion of contextual factors, and reliance on self-reported data. Future research should consider external influences, dynamic project stages, and cross-regional comparisons to further enhance the understanding of leadership in the construction industry.

Keywords: Construction Project Manager, Leadership Competencies, Project Team Performance

SDG: GOAL 9: Industry, Innovation and Infrastructure

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Doktor Falsafah

**KESAN KEPAKARAN KEPEMIMPINAN PENGURUS PROJEK PEMBINAAN
TERHADAP PRESTASI PASUKAN PROJEK DI CHINA**

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Kajian ini menyelidik kesan kecekapan kepimpinan pengurus projek pembinaan terhadap prestasi pasukan projek di China, dengan menekankan peranan penting kepimpinan yang berkesan dalam memastikan kejayaan projek dalam industri pembinaan. Kecekapan kepimpinan, yang merangkumi kemahiran berkaitan tugas, kemahiran berkaitan manusia, dan kemahiran berkaitan diri, adalah penting untuk membimbing proses pasukan seperti pembelajaran, pemantauan, dan iklim pasukan, yang kesemuanya mempengaruhi prestasi keseluruhan pasukan. Walau bagaimanapun, kajian terdahulu kurang memberikan pemahaman yang terperinci tentang bagaimana kecekapan ini mempengaruhi dinamika pasukan, terutamanya dalam sektor pembinaan di China. Untuk menangani jurang ini, kajian ini meneroka mekanisme khusus di mana kecekapan kepimpinan yang berbeza mempengaruhi prestasi pasukan projek. Menggunakan pendekatan kaedah campuran, penyelidikan ini merangkumi tinjauan literatur sistematik dan data empirikal yang dikumpul daripada 483 profesional pembinaan di China,

dengan kerangka teori yang berasaskan teori pemprosesan maklumat sosial. Pemodelan persamaan struktur (SEM) digunakan untuk mengesahkan kerangka kerja tersebut. Dapatan kajian menunjukkan bahawa kecekapan kepimpinan pengurus projek secara signifikan meningkatkan prestasi pasukan, baik secara langsung mahupun melalui peranan perantaraan proses pembelajaran pasukan, pemantauan, dan iklim pasukan. Kecekapan berkaitan tugas memudahkan pelaksanaan tugas, kecekapan berkaitan manusia mengukuhkan hubungan pasukan, dan kecekapan berkaitan diri memupuk kepercayaan dan daya tahan dari masa ke masa. Penemuan ini menyumbang kepada teori dan amalan dengan memperluaskan model kecekapan kepimpinan untuk merangkumi proses pasukan dan menyediakan cadangan praktikal untuk memperbaiki pengambilan, latihan, dan pengurusan pengurus projek. Walaupun menyumbang kepada pemahaman dalam bidang ini, kajian ini mempunyai keterbatasan, termasuk tumpuan kepada proses dalaman pasukan, pengecualian faktor kontekstual, dan kebergantungan kepada data yang dilaporkan sendiri. Penyelidikan masa depan perlu mempertimbangkan pengaruh luaran, peringkat projek yang dinamik, dan perbandingan rentas wilayah untuk meningkatkan lagi pemahaman mengenai kepimpinan dalam industri pembinaan.

Kata Kunci: Kompetensi Kepimpinan, Pengurus Projek Pembinaan, Prestasi Pasukan Projek

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

CPM	Construction Project Manager
TR	Task Related
PR	People Related
SR	Self-Related
TP	Team Performance
TL	Team Learning
TM	Team Monitoring
TC	Team Climate

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter provides an overview of the thesis, which is organized into several sections. The first section introduces the background of the study, which is elaborated further in subsequent subsections, including the roles of project managers and teams in the construction industry. Section 1.2 provides a detailed background, covering key topics such as project manager leadership in the construction industry, the significance of project teams, and the role of project managers in enhancing project performance. In Section 1.3, the problem statement is presented, identifying the specific research gap addressed by this study. Following that, Section 1.4 outlines the research questions, while Section 1.5 defines the research objectives. The significance of the study is highlighted in Section 1.6, discussing the relevance of the research to both academic and practical fields. Section 1.7 defines the scope and limitations of the study, clarifying what the research covers and the constraints it faces. Lastly, Section 1.8 provides a clear outline of the thesis structure, summarizing the content of each chapter to offer a roadmap for the reader.

1.2 Background of the Study

The construction industry is pivotal to global economic development, contributing approximately 8-10% to national economies worldwide (Dixit et al., 2017). In China, this contribution is even more pronounced, with the construction sector accounting for about 7% of GDP and employing over 50 million individuals (National Bureau of Statistics of China, 2022). The industry has been a key driver of China's rapid economic growth, particularly in infrastructure development and urbanization (Shan et al., 2015). However, both globally and in China, the construction industry faces challenges such as low productivity and limited technological advancement (Opoku et al., 2021). The advent of Industry 4.0 has increased the complexity of construction projects, intensifying the demand for effective leadership (Criado et al., 2022).

1.2.1 Project Manager Leadership in the Construction Industry:

The integration of digital technologies in industrial processes, characteristic of Industry 4.0, has introduced unprecedented complexity to construction projects (Forcael et al., 2020). This technological revolution has incorporated advanced tools such as Building Information Modeling (BIM), the Internet of Things (IoT), and Artificial Intelligence (AI) into construction practices (Maskuriy et al., 2019), necessitating effective leadership capable of navigating these advancements while meeting diverse stakeholder expectations (Criado et al., 2022). In this evolving landscape, the significance of leadership in the construction industry has gained renewed emphasis.

Recent studies have demonstrated that effective leadership in construction is instrumental in cost savings, employee development, successful outcomes, fostering sustainability, and overall organizational enhancement (Rehan et al., 2024), building upon earlier research that established the impact of project managers' leadership on project success (Turner & Müller, 2005).

The inherent complexity of construction projects, characterized by unknowns, intricacies, and uncertainties, demands that project managers shoulder multifaceted responsibilities. These include leading diverse teams, navigating unpredictable environments, addressing people-related challenges, optimizing resource utilization, attaining project objectives, and adapting to change (Anantatmula, 2010). The enduring nature of these fundamental project management challenges has been corroborated by recent studies (Gunduz & Almuajebh, 2020). Project managers are increasingly recognized as central hubs linking organizational strategy with project execution (Loufrani & Missonier, 2015). This concept has evolved in recent years, with research emphasizing their strategic role in aligning project outcomes with organizational goals (Musawir et al., 2017). Consequently, the competencies of project managers are considered foundational assets in construction enterprises, warranting meticulous attention (Chen et al., 2019).

Industry reports underscore the critical importance of project management capabilities. The Project Management Institute's (PMI) Pulse of the Profession 2021 report indicates that a significant majority of high-performing organizations prioritize developing project management skills (PMI, 2021).

This trend highlights the growing recognition of project management talent as a key competitive advantage for construction enterprises (Ekrot et al., 2016), a finding consistently supported by subsequent industry reports and academic studies.

In China, the construction industry's rapid growth and transformation present unique challenges and opportunities for project managers. Recent research has emphasized the importance of culturally adapted leadership styles in Chinese construction projects (Zhang et al., 2018). The leadership competencies of project managers in China are particularly crucial due to the country's fast-paced development, large-scale infrastructure projects, and the need to balance traditional management practices with modern, globally recognized project management methodologies (Chan et al., 2018; Shi et al., 2015).

1.2.2 Importance of Project Teams in Construction Companies:

Project teams play a pivotal role in project success, directly influencing productivity and performance. The importance of effective teamwork in modern construction projects has been increasingly emphasized, particularly in navigating the complexities of large-scale endeavors, risk management, and innovation adoption (Li et al., 2022). In rapidly developing countries like China, the construction industry has witnessed a paradigm shift towards more collaborative and integrated project delivery methods. Research has shown that in the Chinese context, project teams demonstrating high levels of

collaboration and trust are more likely to achieve success, particularly in terms of schedule performance and quality outcomes (Lianying et al., 2018).

The advent of Building Information Modeling (BIM) and other digital technologies has transformed project team operations, necessitating high levels of coordination and information sharing among team members (Wang et al., 2018). As project complexity increases, the concept of "teamwork" has evolved from simple cooperation to more sophisticated notions of collaboration and synergy. The idea of "partnering" from enterprise management has been widely adopted in project management practices, with recent studies demonstrating that partnering relationships within project teams significantly contribute to success in Chinese mega construction projects (Liu et al., 2020).

Project teams also serve as crucial conduits for knowledge transfer and creation within construction companies, contributing to long-term organizational competitiveness (Sun et al., 2019). This finding is particularly pertinent in China, where rapid industry growth necessitates efficient knowledge dissemination and application. The COVID-19 pandemic has further underscored the resilience and adaptability of effective project teams, with cohesive and communicative teams better equipped to navigate challenges such as remote work and supply chain disruptions (Ogunnusi et al., 2020).

In the Chinese construction industry, project teams often encounter additional challenges due to the scale and complexity of projects, as well as cultural

factors influencing team dynamics. Recent research has shown that Chinese construction project teams integrating diverse expertise and managing cultural differences tend to achieve higher levels of innovation and project performance (Jiang et al., 2016). The competencies of project participants, the effectiveness of their communication, collaboration tendencies, and mutual trust within project teams have become significantly correlated with project success. This observation has been consistently validated in recent studies, with trust and effective communication within project teams identified as crucial determinants of success in Chinese construction projects, particularly regarding stakeholder satisfaction and long-term relationship building (Luo et al., 2017).

1.2.3 Role of Project Managers in Enhancing Project Performance:

Project managers are increasingly recognized as key drivers of project success, particularly in the complex and challenging environment of modern construction projects. Recent studies have emphasized their multifaceted role in influencing outcomes, balancing economic, environmental, and social aspects of sustainability beyond traditional metrics of time, cost, and quality (Segura et al., 2019). In the Chinese construction industry, project managers play a crucial role in navigating the complexities of large-scale infrastructure projects, particularly regarding stakeholder management and risk mitigation, necessitating a diverse skill set including technical expertise, leadership abilities, and cultural competence (Lianying et al., 2018).

The advent of digital technologies in construction has further transformed the role of project managers, requiring them to be tech-savvy and capable of leveraging digital tools like Building Information Modeling (BIM) to enhance project performance (Maskuriy et al., 2019). This finding is particularly relevant in the Chinese context, where rapid technological adoption is reshaping the construction landscape.

Recent research has reinforced the project managers' influence on team performance and project outcomes. Project managers who effectively foster team cohesion and psychological safety significantly enhance project performance, particularly in terms of innovation and problem-solving (Kim et al., 2020). Their role in knowledge management and organizational learning has gained increased attention, with studies demonstrating that project managers in Chinese construction firms play a crucial role in facilitating knowledge transfer between projects, contributing to long-term organizational competitiveness (Yu & Yang, 2018).

In the face of increasing project complexity and uncertainty, the adaptive capabilities of project managers have become paramount. Research has revealed that project managers who demonstrate high levels of adaptive leadership and systems thinking are more effective in navigating complexities and achieving superior performance outcomes in large-scale Chinese construction projects (Yunpeng & Zaman, 2024). The COVID-19 pandemic has further highlighted the importance of project managers' agile leadership

and effective crisis management skills in mitigating negative impacts on project performance (Ogunnusi et al., 2020).

Furthermore, project managers play a crucial role in fostering innovation within construction projects. Those who encourage creativity and provide a supportive environment for idea generation significantly enhance project innovation performance (Zheng et al., 2017). This research highlights the evolving role of project managers as innovation catalysts within their teams and organizations, underscoring their strategic importance beyond individual project success.

1.3 Problem Statement

The construction industry, particularly in China, is facing significant challenges in project management and leadership. Despite the sector's crucial role in economic development, contributing 7% to China's GDP and employing over 50 million people (National Bureau of Statistics of China, 2022), it struggles with low productivity and high failure rates in project delivery. According to a recent study by the China Construction Industry Association (2023), approximately 40% of construction projects in China fail to meet their intended objectives, with 25% exceeding their budgets and 30% missing deadlines. These statistics underscore a pressing need to address the root causes of project failures, with leadership competencies of project managers emerging as a critical factor.

The rapid technological advancements and increasing project complexities in the construction industry have transformed the role of project managers. While traditional project management skills remain essential, they are no longer sufficient to ensure project success in today's dynamic environment. Leadership abilities have become increasingly crucial, yet there is a significant gap between the required leadership competencies and those possessed by many project managers in the Chinese construction industry.

A survey conducted by the China Project Management Research Committee (2022) revealed that 65% of construction project managers in China primarily focus on technical and operational aspects of project management, with only 35% demonstrating strong leadership skills. This discrepancy is particularly pronounced among project managers with engineering backgrounds, who often lack formal leadership training. The study found that 70% of project managers with engineering degrees reported feeling underprepared for the leadership aspects of their role.

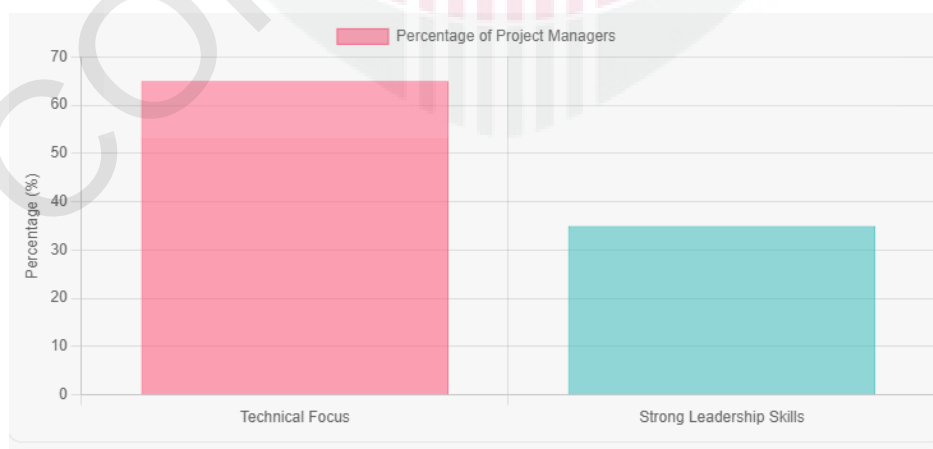


Figure 1.1: Skills Focus of Construction Project Managers in China
(Source: China Project Management Research Committee)

This skills gap in leadership competencies has significant implications for project performance and success rates. Research has consistently shown that project manager leadership competencies are a decisive factor for project success (Nixon et al., 2012; Turner & Müller, 2005). However, the specific leadership competencies required for successful project management in the Chinese construction industry, and how these competencies influence project team performance, remain poorly understood.

The existing literature on project management leadership has primarily focused on Western contexts or has not adequately addressed the unique challenges present in the Chinese market. There is a lack of comprehensive understanding of how project managers' leadership competencies specifically impact project team performance in the face of emerging technologies and sustainability requirements in China's construction industry.

This research gap has several critical implications:

- a. It hinders the development of effective leadership training programs tailored to the needs of the Chinese construction industry.
- b. It impedes the ability of construction companies to select and develop project managers with the right mix of technical and leadership skills.
- c. It potentially contributes to the high failure rates of construction projects, affecting the overall efficiency and competitiveness of the Chinese construction sector.

Therefore, this study aims to address this critical gap by examining the relationship between project managers' leadership competencies and project team performance in the Chinese construction industry. Specifically, the research will focus on:

- a. Identifying the key leadership competencies required for successful project management in the Chinese construction industry.
- b. Analyzing how these leadership competencies influence project team performance.
- c. Exploring the mechanisms through which project manager leadership competencies impact project outcomes.

By focusing on these aspects, this study seeks to provide both theoretical insights into the role of leadership in project management and practical recommendations for improving project success rates in the Chinese construction industry. The findings will contribute to the development of more effective leadership training programs, inform the selection and development of project managers, and ultimately help to enhance the performance and competitiveness of China's construction sector.

1.4 Research Questions

This study aims to investigate the complexities of leadership in construction project management and its influence on team performance within the context of the Chinese construction industry. To achieve a thorough insight and

address the identified research gaps, this study will explore three key areas: the identification of crucial leadership competencies, their impact on team performance, and the mechanisms through which these competencies influence project outcomes.

To methodically unravel these aspects, the study will probe the following research questions:

RQ1: What are the key leadership competencies required for successful project management in the Chinese construction industry?

RQ2: How do project managers' leadership competencies directly influence team processes and team performance in the Chinese construction industry?

RQ3: What mechanisms do the leadership competencies of project managers employ to impact project outcomes in the Chinese construction industry?

Through detailed examination of these sub-questions, the study seeks to clarify the complex mechanisms by which leadership competencies of construction project managers shape team performance, thus filling gaps in current understanding.

1.5 Research Objectives

This study investigates the complex relationship between leadership competencies of project managers and team performance within the Chinese construction industry. As an exploratory study, it adheres to established methodologies in project management research while considering the unique context of China's construction sector.

The research objectives, structured to address the three research questions outlined in the previous section, are as follows:

RO1: To identify and analyze the key leadership competencies required for successful project management in the Chinese construction industry.

RO2: To develop and validate a theoretical model illustrating the direct relationships between project manager leadership competencies, team processes, and team performance.

RO3: To explore the mechanisms through which project manager leadership competencies impact project outcomes by testing an improved model with mediating effects.

These objectives are designed to progressively address the research questions. The theoretical model in RO2 is based on the leadership competencies identified in RO1, while the improved model in RO3 is

developed by refining the model from RO2, removing non-significant direct relationships, and introducing mediating effects. This stepwise approach allows for a comprehensive understanding of how project managers' leadership competencies influence team performance and project success in the Chinese construction industry. The improved model enables a more nuanced exploration of the indirect mechanisms through which leadership competencies affect project outcomes. The findings will contribute to both theoretical knowledge in the field of project management and practical applications for improving project success rates and enhancing the overall performance of China's construction sector.

1.6 Significance of the Study

This study contributes significantly to the understanding of project managers' leadership in the construction industry, particularly within the Chinese context. The significance of this research can be articulated in two key aspects: theoretical and practical implications.

At the theoretical level, this study aims to fill a critical gap in the existing literature by providing a systematic understanding of how leadership competencies contribute to team performance in the construction industry. While previous research has explored the relationship between leadership and project success, the specific mechanisms through which project managers' leadership competencies influence team performance remain unclear. The importance and originality of this study lie in its exploration of these underlying

mechanisms.

Based on the social information processing model framework, this research develops and validates a theoretical framework of construction project managers' leadership competencies. By integrating insights from organizational psychology, organizational behavior, and project management, this study establishes a stronger connection between project management theory and organizational theory. This interdisciplinary approach not only enriches the project management literature but also contributes to a more holistic understanding of leadership dynamics in complex organizational settings.

Furthermore, this study addresses the evolving nature of leadership in the context of rapid technological advancements and changing workforce demographics in the Chinese construction industry. By examining how traditional leadership competencies interact with modern project management challenges, this research provides a timely update to existing theories and models. It offers a nuanced perspective on how leadership adapts to and influences team performance in a dynamic, knowledge-intensive industry.

The theoretical framework developed in this study also has the potential to serve as a foundation for future research in related fields, such as cross-cultural project management, virtual team leadership, and sustainable construction management. By identifying key leadership competencies and their pathways of influence, this study opens up new avenues for investigating

leadership effectiveness across various project contexts and cultural settings.

At the practical level, this study offers valuable insights for project managers, construction companies, and industry stakeholders. By studying the role of project manager leadership, this research helps project managers evaluate the impact of different leadership approaches on team performance, thereby improving the effectiveness of their leadership strategies. This knowledge can lead to more informed decision-making, improved project outcomes, and potentially higher success rates in construction projects.

One of the key practical contributions of this study is its focus on managing new generations of knowledge-based employees who have become the main force in the construction industry. These employees, often characterized by youth, strong personality, high education, and thirst for knowledge, require innovative management approaches. By studying the mediating effect of the team's information processing between leadership and team performance, this research provides valuable reference for project managers to predict perceived team cohesion and team learning behavior. This understanding can be directly applied to developing more effective team-building strategies, fostering a positive team climate, and enhancing overall project performance.

Moreover, the findings of this study have implications for leadership development and training programs in the construction industry. By identifying the most critical leadership competencies and understanding their mechanisms of influence, organizations can design more targeted and

effective leadership training initiatives. This can lead to the development of a new generation of project managers who are better equipped to handle the complex challenges of modern construction projects.

The practical insights from this research also extend to human resource management practices in construction firms. Understanding the relationship between leadership competencies and team performance can inform recruitment, selection, and performance evaluation processes for project managers. Companies can use these insights to align their human resource strategies with the leadership requirements of successful project management.

Lastly, this study's findings can contribute to the development of industry standards and best practices for project management in the Chinese construction sector. By providing empirical evidence on effective leadership approaches, this research can inform policy-making and industry regulations, potentially leading to improvements in project management standards across the industry.

1.7 Scope and Limitation

This study sought to establish the intricate relationship between project manager competencies and team performance within the construction industry. The study's scope is exclusively centered on the dynamic realm of construction, with a specific focus on project managers and their corresponding teams. However, owing to constraints related to the

researcher's resources, both in terms of energy and funding, the study's samples were sourced exclusively from China. In an earnest attempt to mitigate potential sampling errors, the study deliberately broadened its sampling parameters. Consequently, every member of a construction project team was considered as a potential subject for research.

Despite the comprehensive approach, several limitations of this study should be acknowledged. The study's focus is mainly delineated within the project team, and the effective results only consider the team-level output results of the project team performance. In reality, project manager leadership also affects cross-border activities outside the team. Furthermore, the results of the project manager's leadership could be considered from a broader perspective, even encompassing the entire construction enterprise.

The study design also presented certain limitations. In the current pandemic situation, the questionnaire survey is primarily conducted online. Participants in the study included project management practitioners who had busy schedules with minimal spare time available to participate in the study. This time constraint may have impacted the depth and quality of responses, potentially leading to issues of common variance. Additionally, for expert interviews, the selection of experts relies heavily on the author's personal social networks, which may introduce potential bias in the qualitative data collection process.

Another limitation relates to the research instruments used. The dependent

variable is project management performance, which presents measurement challenges. While some project-level performance outcomes are tangible and can be measured, others, particularly those related to firm-level performance in meeting long-term objectives, cannot be physically measured. This presents difficulties in comprehensively assessing the full impact of project manager leadership on organizational outcomes.

These limitations, while not invalidating the study's findings, do highlight areas where future research could expand upon this work. Future studies could broaden the geographical scope beyond China, incorporate more diverse sampling methods, and develop more comprehensive measures of project and organizational performance. Additionally, longitudinal studies could provide insights into the long-term effects of project manager competencies on team and organizational outcomes. Despite these constraints, this study provides valuable insights into the relationship between project manager competencies and team performance in the Chinese construction industry, contributing to both theoretical understanding and practical applications in the field.

1.8 Thesis Outline

This thesis consists of five chapters. Chapter One introduces the study background, problem statement, research questions and objectives, scope and limitation, and the significance of the study. Chapter Two reviews the literature of this study, developing the related definitions and concepts and determining the factors of project managers' leadership competencies.

Chapter Three presents the methodology and research design, and questionnaire development, sampling design, pilot study and the way of data collection are all described in this chapter. Chapter Four displays the data of the questionnaire collected, and the statistical analysis is conducted after the data screening, reliability check and validity check. The results for hypotheses testing are discussed in this chapter. Chapter Five summarizes the results and findings of the study, as well as the limitation of this study and further research direction in the future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides a comprehensive overview and systematic analysis of the literature related to leadership in construction project management, leadership competencies, project team performance, team processes, and social information processing theory. The chapter is organized into several sections. The first section introduces the chapter, while the second section reviews the evolution of leadership theories in project management, with a focus on their application in the construction industry. Section 2.2 delves into the key factors contributing to construction project managers' leadership competencies through a systematic review. Section 2.3 examines project team performance, including an analysis of performance factors and measurement models developed by scholars. Section 2.4 explores team processes as mediating mechanisms, with specific attention to team learning, monitoring, and climate. In Section 2.5, social information processing theory is introduced, along with its application in this study. Based on the literature review, a theoretical framework for this research is developed in Section 2.6.

2.2 Leadership Competencies in Construction Project Management

This section explores the critical role of leadership competencies in the context of construction project management, examining how specific skills and attributes contribute to effective project leadership in this complex industry.

2.2.1 Evolution of Leadership Theories in Project Management

To understand the current state of leadership in construction project management, tracing the development of leadership theories and their application in project-based environments is essential. This subsection provides an overview of how leadership concepts have evolved and shaped the understanding of effective project management.

2.2.1.1 Contemporary Leadership Theories

As organizations face increasingly complex challenges in the 21st century, leadership theories have evolved to address the nuanced demands of modern workplaces. Contemporary leadership theories build upon earlier frameworks while incorporating new insights into human behavior, motivation, and organizational dynamics. These theories recognize the multifaceted nature of leadership and its critical role in navigating the complexities of today's business environment, particularly in project-based industries like construction. One of the most influential contemporary leadership theories focuses on the transformative power of leaders who can inspire and motivate their followers

to achieve extraordinary outcomes. This approach, developed by Burns (2012) and further refined by Bass & Avolio (1990), emphasizes the importance of leaders who can articulate a compelling vision, stimulate intellectual curiosity, and provide individualized consideration to their team members. Recent studies have demonstrated the efficacy of this leadership style in fostering innovation and creativity within project teams. For instance, Aga et al., (2016) found that transformative leadership practices significantly enhanced the innovative capabilities of construction project teams, leading to improved project outcomes and organizational performance.

Another significant strand of contemporary leadership theory emphasizes the importance of leaders being true to themselves and their values. This approach, which gained prominence in the early 2000s, posits that effective leaders demonstrate high levels of self-awareness, transparency in relationships, balanced processing of information, and a strong ethical foundation (Avolio & Gardner, 2005). Recent research by Cheng (2022) has highlighted the positive impact of this authentic leadership style on employee well-being and organizational performance, particularly in high-stress environments such as the construction industry. Their study found that authentic leaders were better equipped to manage the complexities of large-scale construction projects while maintaining high levels of team morale and productivity.

The concept of servant leadership, first proposed by Greenleaf (2008), has also gained renewed attention in contemporary leadership discourse. This

approach focuses on the leader's primary motivation to serve others, emphasizing empathy, stewardship, and commitment to the growth of people. Eva et al., (2019) conducted a comprehensive review of servant leadership research and found that this leadership style can significantly enhance team performance and job satisfaction in project-based organizations. Their findings suggest that servant leadership practices are particularly effective in fostering a collaborative culture and promoting knowledge sharing within construction project teams.

In response to the increasingly volatile and uncertain business environment, adaptive leadership theory has emerged as a crucial framework for understanding effective leadership in complex situations. Developed by Heifetz (1994) and further expanded by scholars like Bien & Arena (2018), this approach emphasizes the importance of leaders helping their teams navigate uncertainty and adapt to new realities. Recent research has demonstrated the effectiveness of adaptive leadership in managing complex construction projects and fostering resilience in project teams. For example, a study by Liao (2017) found that project managers who exhibited adaptive leadership behaviors were more successful in managing the challenges associated with global construction projects, including cultural differences and virtual team dynamics.

The digital transformation of the construction industry has also necessitated new leadership approaches. Emerging research is exploring the concept of digital leadership, which focuses on the skills and competencies required to

lead effectively in a digitally-driven environment. Zulu & Khosrowshahi (2021) argue that digital leaders in the construction industry must not only possess technical knowledge but also the ability to drive cultural change and foster innovation in the face of technological disruption.

Furthermore, the growing emphasis on sustainability and corporate social responsibility has led to the development of responsible leadership theories. These approaches integrate ethical considerations, stakeholder engagement, and long-term sustainability into leadership practices. In the context of construction project management, responsible leadership has been linked to improved environmental performance, enhanced stakeholder relationships, and more sustainable project outcomes (Opoku et al., 2015). As the field of leadership studies continues to evolve, there is a growing recognition of the need for more integrative and context-specific leadership models. Hoch et al. (2018) conducted a meta-analysis of contemporary leadership theories and found that different leadership styles may be more or less effective depending on the specific project phase, team composition, and organizational culture. This suggests that effective leadership in construction project management requires a flexible and adaptive approach, drawing on various leadership theories and practices as appropriate to the specific context and challenges at hand.

Contemporary leadership theories offer a rich and diverse set of frameworks for understanding effective leadership in the complex and dynamic environment of construction project management. These theories emphasize

the importance of inspiration, authenticity, service, adaptability, and responsibility in leadership practice. As the construction industry continues to evolve, further research is needed to develop more nuanced, context-specific leadership models that can account for the unique challenges and opportunities in this field.

2.2.1.2 Synthesis of Leadership Theories

The evolution of leadership theories reflects a deepening understanding of the complexity of effective leadership. Early theories focused primarily on individual traits or behaviors, while contemporary theories recognize the importance of context, follower characteristics, and the dynamic nature of the leadership process. In the context of construction project management, an approach that integrates multiple leadership theories may be most effective.

Various leadership theories are not mutually exclusive but complementary, collectively forming a comprehensive understanding of leadership. Trait and behavioral theories provide insights into the fundamental characteristics and behavioral patterns of effective leaders, while situational theories emphasize the contextual adaptability of leadership. Contemporary theories such as transformational and authentic leadership further explore how leaders can inspire followers' potential and build trust relationships. Day et al. (2014) argue that an integrative approach to leadership development can provide a more comprehensive framework, addressing both individual capacity enhancement (such as traits and behaviors) and broader social capital building (such as

relationship networks and organizational culture). This perspective is particularly crucial in construction project management, where project managers need both technical competence and interpersonal skills.

Recent meta-analyses suggest that different leadership styles may be more effective in specific project phases, team compositions, and organizational cultures. For instance, transformational leadership might be particularly important during project initiation and planning stages, requiring leaders to articulate visionary goals and stimulate team creativity. In contrast, servant leadership may be more effective during execution and monitoring phases, where leaders need to support team members and remove obstacles (Hoch et al., 2018). Zhang et al. (2018) found that successful construction project managers can flexibly adjust their leadership style according to different project stages and challenges, switching between directive, supportive, and participative leadership behaviors to adapt to varying project needs.

As construction projects become increasingly international, leaders need to develop cross-cultural leadership capabilities. Ozorhon & Oral (2017) identified cultural intelligence and cross-cultural adaptability as key factors for success in international construction projects. They emphasize that effective cross-cultural leadership requires the integration of transformational leadership, situational leadership, and cultural sensitivity. Moreover, the rise of virtual teams has brought new challenges to construction project management. Wen & Gheisari (2020) explored the application of virtual leadership in construction projects and found that effective virtual leaders need strong communication

skills, technological literacy, and the ability to build trust. This requires leaders to integrate multiple leadership theories, such as authentic leadership (building trust), transformational leadership (inspiring motivation), and digital leadership (leveraging technology).

With sustainability becoming an increasingly central focus in the construction industry, responsible leadership theory has gained importance in project management. Opoku et al. (2015) demonstrated that practicing responsible leadership in construction projects can improve environmental performance, strengthen stakeholder relationships, and achieve more sustainable project outcomes. This requires leaders to focus not only on short-term project goals but also on long-term social and environmental impacts. Given the complexity of construction project management, scholars increasingly recognize the need to develop more nuanced and context-specific leadership models. (Toor & Ofori (2008) proposed a comprehensive construction project leadership framework that integrates elements of transformational, authentic, servant, and adaptive leadership. Their research suggests that such an integrative model can better predict project success and team performance.

Despite extensive research on leadership, many questions remain to be explored in the field of construction project management. For example, how can effective leadership be cultivated in highly technical and digitalized environments? How can short-term project goals be balanced with long-term sustainability needs? How can trust and cohesion be built in cross-cultural and virtual teams? These questions require further empirical research and

theoretical exploration. Therefore, effective leadership in construction project management requires integrating insights from multiple leadership theories and applying them flexibly according to specific situations. Future research should focus on developing more nuanced, context-specific leadership models that fully consider the unique challenges and opportunities in the construction industry. Meanwhile, leadership development programs should emphasize cultivating leaders' adaptability and flexibility, enabling them to lead effectively in complex and dynamic project environments. By synthesizing and applying various leadership theories, construction project managers can better address the challenges facing the industry and drive project and organizational success.

2.2.2 Leadership in Construction Program Management

Research on leadership has a rich history, attracting the attention of scholars worldwide. It is a well-explored theory that has been investigated through a wide range of qualitative and quantitative approaches. Some scholars conceptualize leadership as a behavior or a personality trait, while others approach it from a social information processing perspective.(Northouse, 2021). For many years, the importance of leadership was overlooked in construction project management, as traditional researchers in this field primarily focused on project technology (Pries et al., 2004; Skipper & Bell, 2006).

For many years, the importance of leadership was overlooked in construction project management, as traditional researchers in this field primarily focused

on project technology. For example, Sui Pheng & Lee(1997) attempted to integrate the managerial grid framework with an ancient Chinese strategy to enhance leadership in construction project management. Similarly, Weingardt(1997) emphasized the importance of engineers actively participating in leadership at all levels and expanding their influence on public policy. During this period, scholars recognized that construction projects are people-oriented, and the significance of effective leadership became evident in relation to project success (Spatz, 1999; Holt & Rowe, 2000).

At the beginning of the 21st century, leadership has been recognized as a crucial skill for effective project leaders (Odusami et al., 2003) and engineering management students (Bergeron, 2001) to complement their technical expertise. The behaviors of the project leader were found to be more significant in predicting project performance compared to the characteristics of other team members(Ammeter & Dukerich, 2002).

In the literature on leadership in construction projects, there is a growing utilization of quantitative methods. Liu et al.(2003) developed a model to examine the power structures of leaders in construction projects, while Fellows et al.(2003) studied leadership style and power relations. Odusami et al. (2003) analyzed data from 60 project team leaders and found a significant impact of project managers' leadership style on project performance. Numerous studies have investigated the factors contributing to an ideal construction project manager leadership style from various perspectives(Bossink, 2004; Keegan & Den Hartog, 2004; Mäkilouko, 2004; Giritli & Oraz, 2004; Chan & Chan,

2005). The work of Turner & Müller(2005) has provided new momentum to the study of project managers' leadership. Turner and Müller emphasized the importance of examining the competence, including personality and leadership style, of project managers in relation to project success. Müller & Turner(2007) conducted qualitative and quantitative studies, concluding that the project manager's leadership style influences project success and that different leadership styles are suitable for different types of projects. However, most of the studies, particularly empirical ones at that time, primarily focused on the behavioral dimensions of leadership, paying less attention to other aspects.

In the past two decades, leadership has been widely recognized as a significant factor influencing project success or failure (Nixon et al., 2012). Research on the personal and interpersonal factors of project managers that contribute to project performance has been investigated to some extent (Larsson et al., 2015; Potter et al., 2018; Tabassi et al., 2016). Given this context, several studies have reviewed and analyzed the existing literature. Toor & Ofori(2008) selected 49 studies and summarized the empirical research on leadership in the construction industry. Simmons et al.(2017) conducted a critical review that identified future trends. Graham's (2020) systematic review study utilized computerized techniques for bibliometric analysis to establish clear criteria for informing thematic analysis and comparing analyses among multiple authors. Other studies have focused on specific branches of leadership theory within the construction industry (Carroll et al., 2008; Saini & Sengupta, 2016; Ahmed et al., 2021; Ngayo Fotso, 2021). However, most of these studies rely on the subjective judgment of experts,

resulting in a lack of quantitative bibliometric analysis in this field. Despite the increasing number of publications, little is known about the overall structure of the knowledge landscape in this field.

As construction leaders confront increasingly complex challenges, the research framework for architectural leadership becomes more diverse, encompassing new leadership styles and the interaction between project managers and team members. These emerging topics provide avenues for further exploration.

To clarify the knowledge structure of this research field, this study employs bibliometric analysis (Peng et al., 2022). This method allows for a systematic examination of the field, enabling the identification of five prominent research hotspots. These hotspots are outlined below:

2.2.2.1 Transactional Leadership

The cluster of "transactional leadership" holds the largest size in the construction leadership field, focusing on the relationship between project managers' leadership styles and project success. Project success is a central concern in the project management field, and while there is ongoing debate on its definition, leading scholars generally agree that the project manager plays a crucial role in achieving project success (Prabhakar, 2008). Consequently, the factors associated with project manager leadership have received significant attention in research. For instance, Aga (2016) conducted a field

survey of 200 development project managers to examine the mediating role of team building between transformational leadership and project success. Similarly, Raziq et al (2018) contextualized transactional and transformational leadership styles within the project environment to explore their impact on project success.

Despite the prominence of this research branch in the construction leadership field, there are limited studies directly investigating the relationship between leadership and program success. Zhang (2018) explored the mediating role of leadership styles between project managers' emotional intelligence and other participants' satisfaction. Tabassi (2016) highlighted the criticality of project managers' leadership competency for project success. Maqbool (2017) conducted a quantitative study in the Pakistani construction industry, demonstrating that project managers with desired leadership competencies yield higher project success rates. Other literature works incorporate leadership as a factor in their research models. Gaining a comprehensive understanding of the factors influencing project success is of utmost importance for project-based organizations, with the project manager being one of the most crucial factors. Thus, using project success as a criterion provides insights into the leadership of project managers and enhances understanding of the mechanisms underlying their leadership. (Aga et al., 2016).

2.2.2.2 Safety Leadership

Safety levels in the construction industry have significantly improved due to advancements in technology. Concerns regarding security have transitioned from individual jobs to organizational-level considerations. Concurrently, there has been a notable increase in research on leadership and safety (Hofmann et al., 2017).. For instance, Hoffmeister et al (2014) investigated the association between various aspects of personal leadership and employee safety outcomes. Mullen (2017) explored the moderating effect of transformational leadership, based on social exchange theory, on the relationship between employer safety obligations and employee safety performance. Wu (2015) identified four dimensions of safety leadership practices that align with different types of construction project leaders.

While most studies within this cluster have focused on the safety performance of individual workers (Chen et al., 2017; Fang et al., 2015; Newaz et al., 2019), two highly cited papers have introduced multilevel models and additional research topics. Wu et al. (2016) proposed that safety leadership exhibited by owners, contractors, and subcontractors in construction projects mutually influence one another, elucidating the path of influence. Guo (2016) developed a comprehensive model for predicting safety behavior in the construction industry. Thus, given the continuous development of the construction industry, it becomes imperative to develop a more comprehensive and holistic exploration model that captures the mechanisms of safety leadership within the construction industry.

2.2.2.3 Team Performance

Project teams play a vital role within an organization. However, due to the temporary nature of project teams, some may struggle to develop into stable and mature teams even after project completion, leading to project failure (Schmid & Adams, 2008). Consequently, ensuring the effective functioning of project teams becomes imperative in construction projects (Chiocchio & Hobbs, 2014).

Project teams consist of members with diverse needs, goals, and expectations. It is crucial for team leaders to motivate members early on to foster a cohesive team with shared goals and a shared vision (Kragt & Day, 2020). As project team members often come from different professional backgrounds, the project manager's ability to motivate them directly impacts team performance (Skipper & Bell, 2006a). Leadership and motivation have been identified as the most essential skills for project leaders (Odusami et al. 2003). Schmid and Adams (2008) highlighted the significant influence of the project manager on team motivation, particularly in the initial project stages. Similarly, a study by Müller and Turner (2007) reached similar conclusions. According to Gehring (2007), the project manager's capacity to understand the motivations and needs of project team members forms the foundation of effective team leadership. Moreover, empirical research has demonstrated that the project manager's ability to provide task direction to project team members significantly impacts project performance (Ralf Müller & Turner, 2007).

2.2.2.4 Leadership Interaction Processes

Leadership is constructed and functions during actual interactions (Crevani et al., 2010). At the same time, leadership is considered to contribute positively to the course of action in most modern organizations (Lindgren et al., 2011). In practice, different interaction styles of leaders and followers always mean different levels of team productivity (Monica Lindgren & Packendorff, 2009). Thus, Carroll et al. (2008) called for leadership research to focus on the “practice-turned” interactions between leaders and followers in social settings. Within this cluster, scholars' interests focus on leadership interactions among different project stakeholders. Chunlin Wu explored leadership interactions among key project stakeholders in two of his studies (Wu et al., 2015, 2016). Limao Zhang developed a model to elucidate the relationship between different stakeholders' leadership and safety performance in a changing construction project environment. In addition, this cluster also focuses on the interaction of individuals with project environments (Zheng et al., 2019). The research on leadership interaction is interdisciplinary (Larsson, 2016), which requires the collaborative research of scholars with different disciplinary backgrounds.

2.2.2.5 Actual Leader Behaviour

Leader behavior has been found to positively influence role clarity and work engagement (Mendes & Stander, 2011). Within this research cluster, the focus is on examining the impact of project managers' behavior on project team

members. For instance, Naoum (2018) developed a behavioral model of stress coping specifically for UK construction project managers. Nannan Wang (2016) conducted a comparative study to investigate how project managers' conflict resolution behaviors affect project success. Additionally, Owusu-Manu (2020) explored the relationship between a project manager's leadership style and their mindset behavior. The research conducted in this cluster provides valuable empirical insights that contribute to a better understanding of project manager leadership.

2.2.3 Critical Analysis of Leadership Competencies for Construction Project Managers

The effective management of construction projects relies heavily on the leadership competencies of project managers. These competencies encompass a wide range of skills, knowledge, and personal attributes that enable project managers to guide their teams, navigate complex challenges, and deliver successful outcomes in the dynamic and often unpredictable construction environment. This section critically examines the key leadership competencies required for construction project managers, evaluating their relative importance and impact on project success.

2.2.3.1 The Importance of Research on Leadership Competencies

As previously mentioned, leadership scholars have conducted theoretical and empirical research on leadership from various perspectives across different fields of study. Initially, leadership was understood as the influence exerted by

leaders based on their characteristics. This perspective later expanded to include leader behavior (Chris Argyris, 1976), situational factors (Fiedler, 1964), the leader-follower relationship (Greene, 1975; Hollander, 1978), and emotional intelligence (Goleman et al., 2002). Additionally, the inclusion of leader competence in leadership research aligns with the dominant paradigm in leadership research (Avolio & Bass, 1995; Goffee & Jones, 2000).

Research on leadership competency gained popularity in the late 1990s (Turner & Müller, 2005). Initially, competency was defined as "a set of related knowledge, attitudes, skills, and other personal characteristics that significantly impact a person's work," independent of performance. Drawing from trait theory, ability was previously thought to encompass personal characteristics, knowledge, and skills (Geoghegan & Dulewicz, 2008). However, subsequent studies have demonstrated a relationship between ability and emotion, particularly emotional intelligence (Turner & Müller, 2005). As research progressed, leaders' ability to achieve performance, which includes professional knowledge, attitude, and skills, has also been considered within the scope of leadership ability (Dillon & Taylor, 2015).

Leadership competencies has garnered significant attention due to empirical research showing its comparable importance to technical ability in influencing performance. Combining leadership competencies with technical competencies can foster the development of proficient technical managers (Aisha et al., 2016). Effective methods for developing competencies can greatly enhance the performance of professionals (Buvakov et al., 2016), while

engineering managers who excessively prioritize technical competencies may experience a decline in their performance levels. Reich (2007) asserts that integrating technical and leadership skills can result in a 25% increase in performance compared to managers who solely rely on traditional technical skills. Similarly, Muzio et al. (2007) emphasize that approximately 90-95% of performance-related issues can be attributed to a deficiency in soft skills, including leadership. The impact of leadership on individual performance is significant.

Leadership competencies also play a crucial role in teams, and engineering managers who possess a balance of technical and leadership competencies can foster highly functional and effective teams (Kharbanda & Stallworthy, 1990). When teams are led in a cohesive and mutually supportive manner, they can naturally accomplish more (Anantatmula, 2010). Leadership competencies are widely considered as the cornerstone of engineering management (Kotnour & Farr, 2005).

2.2.3.2 Manager Competencies Theories

The competencies of managers have always been a research hotspot in management research. Boyatzis(1982) defined the competence of managers as" an underlying characteristic fo a person which results in effective and superior performance", which also brought this concept to widespread attention. During the three decades of development, scholars from different countries have formed completely different definitions and measurement

methods of competence, including the performance-based competence theory represented by British scholars and the quality competence theory represented by American scholars (Sandberg, 2000). Research on leadership competencies in construction projects has largely mirrored the evolutions in the broader discourse of competence in management (Crawford, 2005; Mazur et al., 2014).

Boyatzis (1982) posited that ability is a fundamental characteristic of individuals that directly influences task completion. He emphasized the impact of the match between ability and the environment on performance. Boyatzis categorized abilities into three domains: cognitive, emotional intelligence, and social intelligence.

In accordance with Boyatzis (1982), cognitive insight refers to the skill of evaluating information and the environment, thereby influencing task performance outcomes. Emotional insight encompasses the ability to recognize, understand, and leverage personal emotions to achieve mission goals. Social insight involves the ability to recognize, understand, and utilize the emotions of others to accomplish task goals. As research progressed and was influenced by other successful studies, Boyatzis continued to refine and expand his theory. He proposed that competencies comprise clusters of behaviors that are structured around envisioned goals, representing various expressions of intentions in relation to a specific environment and era (Boyatzis, 2011). Furthermore, competencies can be enhanced and enriched as individuals mature (Boyatzis, 2008).

Allredge & Nilan (2000) collaborated with executives and a global internal professional team at 3M to develop a comprehensive global executive competency model. This model encompasses 12 competencies along with associated behavioral indicators for each competency. The model's applications include assessing the readiness of the top 500 candidates within the company for global positions, developing current executives, and enhancing objectivity in the selection of future leaders. Allredge's model categorizes competencies into three domains: mandatory, critical, and prospective. According to Allredge & Nilan (2000), leaders' rational decision-making necessitates ethical governance, trust, and wisdom coupled with adaptability. Additionally, leaders should inspire their followers, foster innovation, and consistently prioritize employee training and development.

Bartram (2005) presents a performance model that introduces eight broad competency factors known as the "Great Eight". These factors were derived through factor analysis and multidimensional scale analysis, incorporating self and manager ratings of workplace performance. The eight competency factors are as follows: control, support for the social environment, relationship building, critical analytical reasoning, creativity, planning right, agility, and solution-driven approaches. These factors serve as a comprehensive measurement framework to assess the effectiveness of predictive tools in accounting for variations in workplace behavior. Meta-analysis results indicated that personality scales and competency tests exhibited moderate to strong correlations with line managers' competency ratings. The model emphasizes the significance of addressing customer concerns, such as job performance

and outcomes, and establishes direct links between predictor variables and criterion variables.

Sanghi (2016) presented a comprehensive guide aimed at developing and mapping competencies, as well as designing competency models. This guide assists management and executives in organizations to comprehend the intricate nature and dynamics of capability models, facilitating informed decision-making. By exploring various competency frameworks and integrating them with HR systems, the handbook offers guidance on the process of developing and mapping competencies and designing competency models. It delves into the "what," "why," and "how" aspects of creating a competency model and provides potential sources of information for competency mapping within assessment centers. The handbook also addresses the challenge of managing resistance during implementation. Moreover, it incorporates a job task analysis vocabulary to support job analysis, a crucial element in competency model development. Diagrams, tables, and examples are employed throughout the guide to aid in comprehending the complexity and dynamics of capability models and related decision-making. In this guide, Sanghi (2016) establishes a framework of personal competencies consisting of 45 competencies categorized under six main headings: Intellectual, Personal, Communication, Interpersonal, Leadership, and Result Oriented. The author defines social awareness as a cluster of competencies and proposes a comprehensive leadership model, which encompasses rational proficiency, human efficacy, self-management, and social awareness. Sanghi (2016) contends that thinking skills encompass behaviors aligned with

strategic thinking, foresight, and intellectual abilities required for assessing situations and making informed decisions to achieve strategic goals.

Grant & Baden-Fuller (2018) propose a four-stage process for strategy making, which involves: (1) situation appraisal and diagnosis, (2) strategic option generation, (3) strategic choice, and (4) strategy implementation. This model allows for an examination of the knowledge requirements associated with each stage. Within this model, strategic management capabilities are categorized into several key areas, including innovation, judgment, instinct, insight, knowledge of concepts and principles, and communication skills necessary for effective execution. The authors argue that the social dimensions of strategic leaders, which contribute to successful strategy implementation, predominantly encompass qualities that promote social awareness and social competence. These qualities are collectively referred to as "social intelligence."

2.2.3.3 Identification of Project Manager Competencies

In 2002, the Project Management Institute (PMI) introduced the Project Management Capability Development Framework (PMCD) with the aim of providing a framework for defining, evaluating, and developing competencies of project managers. The underlying premise was that competencies directly influence performance. The PMCD framework encompasses three dimensions of competencies: project management knowledge, project management performance, and personal competencies.

Since then, several studies have sought to identify the essential skills and competencies expected from project managers. Gehring (2007) utilized the PMCD framework's "capability clusters" to identify the most valued competencies in project management literature. These competencies included conceptual thinking, influence and persuasion, initiative, achievement orientation, information seeking, organizational awareness, teamwork, and organizational commitment.

Ahsan et al. (2013) emphasized the importance of delegation, negotiation, coordination, decision-making, and understanding of roles and responsibilities as key competencies for project managers. Murugesan (2012) identified nine dimensions of leadership crucial for successful engineering project managers: competence, empathy, enthusiasm, effective communication, integrity, problem-solving, shared vision, serenity, and trust. Pacheco et al. (2023) highlighted stability, communication skills, and enthusiasm as the most significant factors for project success as perceived by project managers. These studies demonstrate the varied perspectives on project manager competencies, ranging from conceptual thinking and influence to delegation, communication, leadership qualities, and personal attributes.

Turner et al. (2009) conducted a comprehensive review of the leadership literature and identified six schools of thought in leadership theory. These schools of thought represent different perspectives on leadership and include: trait school, behavioral school, contingent school, visionary school, emotional intelligence school, competence school. Among these schools,

Dulewicz & Higgs (2005) developed the Leadership Dimensions Questionnaire (LDQ) model, which integrates the insights from previous schools of thought and assesses a leader's competencies. The LDQ model has been validated in various contexts, including general manager groups (Dulewicz et al., 2005; Wren & Dulewicz, 2005; Young & Dulewicz, 2006) and project managers (Turner et al., 2009).

This model provides a comprehensive framework for assessing the key competencies required for effective leadership, taking into account the multidimensional aspects of leadership identified in the various schools of thought. Dulewicz & Higgs (2005) categorized the 15 leadership competencies into three areas of competence: intelligence (IQ), management (MQ), and emotion (EQ). They provided a comprehensive definition of all 15 competencies in the LDQ (Leadership Dimensions Questionnaire) along with technical support for the questionnaire (refer to Table 2.1).

Table 2.1: Three Dimensions of Leadership and 15 Leadership Competencies

Dimensions	Competencies
IQ	Critical analysis and judgement
	Vision and imagination
	Strategic perspective
MQ	Engaging communication
	Managing resources
	Empowering
EQ	Developing
	Achieving
	Self-awareness
	Emotional resilience
	Motivation
	Sensitivity
	Influence
	Intuitiveness
	Conscientiousness

(Source: Dulewicz & Higgs ,2005)

Indeed, the competencies of project managers have been extensively researched in the field of project management. Numerous studies have been conducted to identify and define the key competencies that contribute to the success of project managers. These research efforts aim to understand the knowledge, skills, abilities, and personal attributes that are essential for effective project management. By examining various aspects such as project management knowledge, performance, leadership qualities, communication skills, problem-solving abilities, and more, researchers have sought to provide insights into the competencies required for project management excellence.

The wealth of research in this area underscores the significance of project manager competencies in achieving project success and driving organizational performance. To explore this further, the present study conducted a comprehensive search for all research articles focusing on engineering project manager competencies published between 2000 and the present in four prominent international academic journals specializing in construction project management. The selected journals for this search were the International Journal of Project Management, Project Management Journal, Journal of Construction Engineering and Management, and Journal of Management in Engineering. A total of 70 papers were carefully chosen for analysis, considering their research topics, research methods employed, and the competency factors investigated. For more detailed information regarding the literature reviewed, please refer to Appendix B.

In this subsection of the research, Vaculik et al. (2014) serve as a foundational framework for identifying project manager competencies. Vaculik's model categorizes leadership capabilities into three dimensions: task-related competencies, people-related competencies, and self-related competencies. This classification comprehensively encompasses the activities that successful leaders engage in within their work contexts. Broadly, leaders manage diverse tasks, ensure subordinates' task completion, and navigate self-management. These competency categories distinctly delineate areas of leader behavior focus. Task-related competencies revolve around task accomplishment; people-related competencies center on interpersonal relationships; self-related competencies concern the leader's self-relationship.

Notably, prior studies, including Analoui et al. (2000) and Hamlin (2004), support the utility of this overarching competency model, asserting the presence of general leadership models. Research has shown that abilities within these three categories, such as achievement orientation, problem-solving, and influencing skills, correlate with leadership effectiveness. This straightforward classification method is operationally facile, reducing the intricacy of the leadership model. Given the relative stability of competence across these dimensions, they offer enhanced predictive validity. Importantly, this general competency model transcends specific leadership contexts, being adaptable to various leadership roles and organizational settings.

The identification of project manager competencies in this section serves to illustrate the wide consensus and consistent research findings regarding these crucial competencies. The recognition and agreement on these competencies across various studies provide a solid theoretical foundation for the entire research endeavor. This consensus underscores the significance of these competencies in the field of project management and highlights their importance for successful project outcomes. By establishing a solid theoretical framework based on the identified competencies, the research can build upon this foundation and delve further into investigating and exploring the implications and application of these competencies in practice.

2.2.3.3.1 Task-related Competencies

Task-related competencies signify a leader's capability to organize and execute work tasks. This encompasses adeptness in goal setting, planning, resource allocation, and progress monitoring. Specifically, task-related competencies encompass a leader's proficiency in defining team goals and priorities, comprehending and analyzing information, dedicating energy and effort to problem-solving, and adapting to diverse task requisites. Proficiency in task-related competencies indicates a leader's aptitude for methodically devising team tasks and workflows, orchestrating and aligning team resources, overseeing task advancement, and possessing adept problem analysis and resolution skills. Such proficiency empowers the leader to guide the team in effectively accomplishing a range of tasks. Figure counts the number of occurrences of each task-related competency factor in the 70 reviewed studies, which shows the attention to each competency.

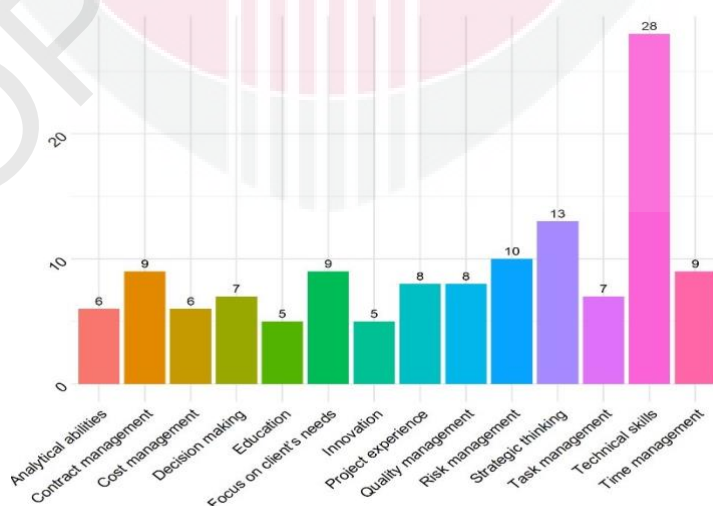


Figure 2.1: The Number of Occurrences of Task-Related Competencies in Existing Research (Only Including More Than 5 Occurrences)

The project manager is a profession derived from practical needs. A large number of practical industry standards describe in detail the specific professional knowledge required by the project manager, forming a project management knowledge system (Crawford, 2005). The most representative body of knowledge is the Project Management Institute's PMBOK, which identifies key areas of knowledge that project management practitioners in various industries generally need to master (PMI, 2017). The PMBOK-based project management professional certification (PMP) has also become one of the important qualifications for the project manager profession (Farashah et al., 2019). Another important project management body of knowledge is the International Project Management Association (IPMA) Competence Baseline (ICB 2.0), which defines in detail the competencies required of project managers from a KSA perspective.

These project management knowledge standards are derived from the experience of the project management practice, and the continuous updating of the content reflects the changing trend of the competencies required by project managers (Andersen, 2016). With the development of project management, the project management knowledge systems tend to be more and more consistent, which is conducive to the evaluation and training of the project manager's competencies (Cheng et al., 2005). The project manager's technical knowledge in construction, which occurred 28 times in the 70 reviewed papers, is also essential, along with general project management knowledge. Due to the application of complex technical knowledge required by construction projects, the Project Management Institute has published a

special edition (PMBOK Construction Extension) for the construction industry based on PMBOK. Rashidi et al.(2011) considered that technical knowledge is the basic competency of construction project managers. At the same time, professional knowledge has long been regarded as the basis for developing other competencies of project managers, such as teamwork and cooperation(Stevens & Campion, 1994) and risk management(Dillon & Taylor, 2015).

Skills and basic ability dimensions are closely related without boundaries, and they are often not absolutely distinguished in research(Stevens & Campion, 1994). As more and more organizations work through teams, it is recognized that team capabilities are not equal to the sum of members' competencies and that the skills required for teamwork are not the same as those required for individuals to work independently(Woolley et al., 2010), especially project team leaders.Stevens & Campion(1994) systematically reviewed the key knowledge, skills and basic abilities required for teamwork, and proposed 5 dimensions and 14 knowledge, skills and basic competencies for teamwork, with emphasis on communication and interpersonal skill. On the basis of Stevens's research, Day et al(2004) examined the competencies of team leaders and conceptualized team leadership competencies as a resource that develops as a function of individual human capital (knowledge, skills, and abilities)—including the leadership resources of a formal or informal leader—as well as teamwork and team learning. Weems-Landingham(2004) empirically analyses the impact of project managers' knowledge, skills and basic abilities on project team performance. Pant & Baroudi(2008) provided an insight into the

importance of human skills in project management success and called upon the viewpoints of many notable authors in respect to the human or soft skills that are necessary for the management of projects. In fact, construction project managers have a wide range of professional backgrounds. Therefore, what project managers need most in practice is not the technical knowledge involved in the project but communication and interpersonal skills (Odusami, 2002; Hodgson & Paton, 2016). More and more researches suggest that it is not only necessary to pay attention to the technical skills of project managers but also to the "soft skills" of project managers (Ahsan et al., 2013; Odusami et al., 2003; Hwang & Ng, 2013; Meng & Boyd, 2017).

Risk management occurred 10 times in the 70 reviewed studies. The project management theory from the perspective of risk management believes that the project life cycle corresponds to the process in which project risks are gradually managed and controlled. The key to project management is to increase the certainty of project delivery through risk management continuously (Ward & Chapman, 1995). Wang et al. (2016) showed that the risk management of project managers is a basic ability dimension closely related to individual personality traits, which determines the decision-making and management style of project managers.

Project experience occurred 8 times in the 70 reviewed studies. On the one hand, project experience is the career development process of construction project managers, most of whom have some experience in project management activities before serving as construction project

managers(Sabaa, 2001). On the other hand, project experience is the project manager's ability to apply knowledge, skills and basic competencies, and experience in similar projects is often an important factor to consider when appointing a project manager(Ogunlana et al., 2002).

Several studies have focused on the project manager's role in organizational decision-making related to the project, emphasizing the project manager's central role in project execution(Müller et al., 2018; Beringer et al., 2013). Meanwhile, the information provided by the project manager on the actual situation of the project helps to avoid the decision-making bias of the senior manager(Lechler & Thomas, 2015; Stingl & Geraldi, 2017; Unger et al., 2012). Therefore, the ability to participate in project decision-making is an important management ability of the project manager within the organization(González et al., 2013).

Strategic thinking occurred 13 times in the 70 reviewed studies. Sabaa(2001) evaluated how project managers and functional managers differ with respect to the attributes, skills and experiences they associate with successful management performance and careers, and suggested that the project manager's strategic positioning of the value of the project in the enterprise and even the industry is an important dimension of the project manager's management ability. Hanna et al.(2016) illustrated that having business and financial acumens, disciplinary understanding of all the phases of construction projects and their interrelationships, continuous monitoring of similar construction projects, and consistent awareness of the available information

technologies are among the most distinguishing competencies between exceptional and average project managers.

Dainty et al.(2005) found that effectively identifying the demands of stakeholders is the distinguishing feature of high-performance project managers from ordinary project managers. Meng & Boyd(2017) analyzed the project manager's stakeholder management competency from the perspective of relationship management and found that the project manager's ability to identify and meet the demands of stakeholders is the key factor for project success.

2.2.3.3.2 People-related Competencies

People-related competencies embody leaders' proficiency in forging relationships and engaging with team members. This encompasses the leader's communication acumen, collaborative capacity, conflict resolution proficiency, and adeptness in motivating and mentoring subordinates. Elevated interpersonal competence signifies a leader's capability to proficiently communicate and interact with team members, foster robust interpersonal bonds, mitigate intra-team conflicts, and kindle and nurture subordinates' latent potential. This contributes to the cultivation of a collaborative milieu, enhancement of team coherence, adept management of team dynamics, and consequent augmentation of team efficacy. Figure tabulates the frequency of occurrences of each people-related competency factor in the 70 scrutinized studies, thereby underscoring the prominence accorded to each competency.

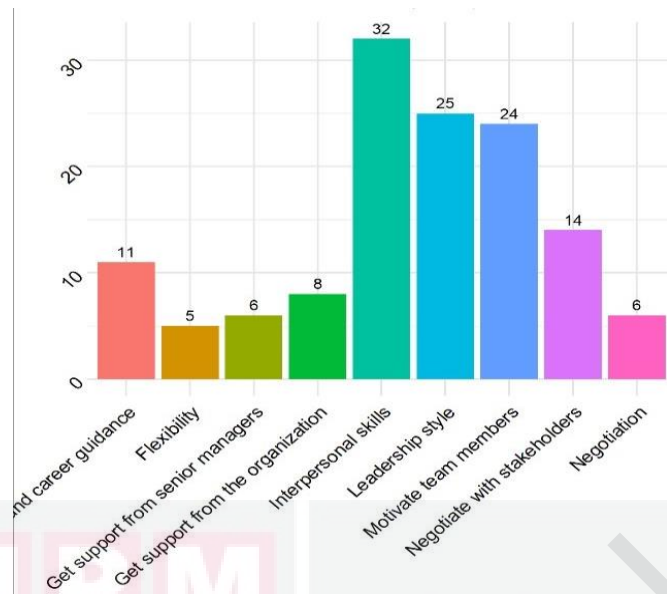


Figure 2.2: The Number of Occurrences of People-Related Competencies in Existing Research (Only Including More Than 5 Occurrences)

The team is composed of members with different demands, goals and expectations, and the team leader should motivate members in the early stage to form a team with consistent goals, vision and cohesion (Day et al., 2004). As a temporary organization, project team members often have different professional backgrounds, so the project manager's ability to motivate members will directly affect team collaboration (Skipper & Bell, 2006b). Odusami et al. (2003) ranked leadership and motivation as the most important skill for the project leader. Schmid & Adams (2008) emphasized that team motivation can be heavily influenced by the project manager, especially during the early stages of the project. Müller & Turner (2007)'s study came to a similar conclusion.

The temporary nature of the project makes it impossible for members to obtain a stable promotion path in the project, which makes project team members lack a sense of security for stable career development (Schmid & Adams,

2008). Gehring(2007) that the ability of project managers to perceive the motivations and demands of project team members is the basis of team leadership. Moreover, the competency of project managers to provide task guidance to project team members has been shown in empirical research to have a significant impact on project performance(Dainty et al., 2005).

Leadership style, which occurred 25 times in the 70 reviewed papers, is the basic quality of the project manager as the leader of the project team(Walker, 2011). Under the framework of leadership theory, project managers are positioned as leaders within the team with a formal role, and the temporary nature of the team makes leadership particularly important for project management(Day et al., 2004). Turner & Müller(2005) conducted research into whether the project manager's leadership style and competency is a success factor on projects, which systematically introduced leadership theory into the study of project manager competencies. Numerous follow-up studies have focused on the impact of transformational and transactional leadership on project management activities(Walker, 2011; Tyssen et al., 2014). Keegan(2004) compared the relationship between transformational leadership style and employee motivation, commitment and stress for employees reporting to either project or line managers and found that the relationships between transformational leadership and outcomes tend to be less strong for employees reporting to project managers than for those reporting to line managers. Clarke(2010) conducted an empirical analysis and showed that project managers' transformational leadership and team performance have a significant positive relationship. Although the existing research results need to

be further tested, there is a consensus among the studies that different leadership styles of project managers are suitable for different projects and organisational situations (Tyssen, Wald, & Heidenreich, 2014; Morgeson et al., 2010).

Dolfi & Andrews (2007) explored the organizational environment in which the project manager is located and argued that getting support from the organization is the basis competency for a project manager to deal with various challenges in the project. Chen & Lee (2007) constructed a performance evaluation model for project managers and found that gaining organizational support is a prerequisite for project managers to lead project teams effectively. Meng & Boyd (2017) have paid particular attention to the relationship between project managers and senior managers, which is regarded as the key to the environmental factors of a project. Crawford (2005) suggested different perceptions and expectations of project management competence between project managers and their supervisors, senior management; therefore, project managers need to communicate effectively with senior management for support.

2.2.3.3.3 Self-related Competencies

Self-related competencies demonstrate leaders' capacity to self-manage and exhibit discipline. These encompass the leader's values, fairness, integrity, pressure tolerance, and related aspects. Proficiency in self-management signifies leaders' ability to uphold integrity and ethical conduct, impartially treat

team members, effectively handle their own stress-induced emotions, and make judicious decisions. Such proficiencies contribute to establishing the leader's authority, molding their evaluation and perception, sustaining their role within the team, and consequently enhancing their leadership efficacy. Figure quantifies the frequency of occurrences of each self-related competency factor in the 70 scrutinized studies, thereby illustrating the degree of attention afforded to each competency.

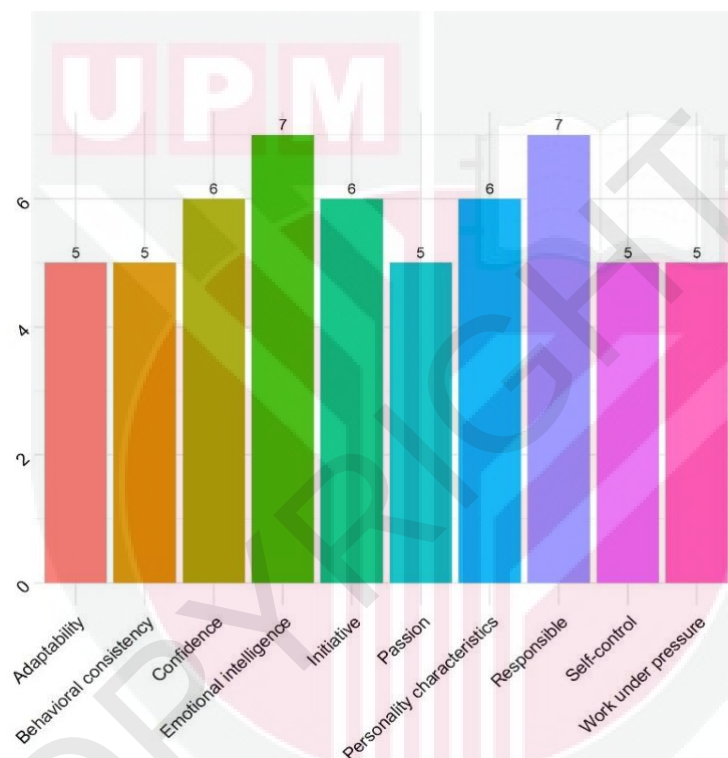


Figure 2.3: The Number of Occurrences of Self-Related Competencies in Existing Research (Only Including More Than 5 Occurrences)

Various facets of leadership theory, along with research investigating the project manager's role, and discussions surrounding project manager competence converge on the recognition that a project manager's leadership behavior encompasses task-oriented and relationship-oriented dimensions. Moreover, there's a consensus that the project manager often serves as a role model for team members, exhibiting behaviors that exert a demonstrative

influence (Rosen et al., 2011). This role-modeling aspect of the project manager significantly impacts the achievement of the project team's objectives. Project leaders uphold rigorous personal standards, effectively exemplifying qualities and charisma, thus serving as a guidepost for team members. This exemplary function represents a pivotal avenue for achieving effective leadership. The project manager's exemplary demeanor reinforces trust, reliance, respect, and support among team members, thereby influencing their attitudes and conduct—an aspect of paramount significance in project execution.

Leaders with heightened self-awareness adeptly grasp their emotions, steering the team towards enhanced project performance through adept control and positive emotional expression. Simultaneously, engineering project managers endowed with well-developed emotional self-management capabilities prod team members to navigate swiftly evolving scenarios with timely responses, enhancing owner and stakeholder satisfaction. Notably, Müller & Turner (2007) questionnaire survey underscored how the emotional intelligence dimensions of conscientiousness and sensitivity among engineering project managers significantly contributed to project success. Additionally, Zhang & Fan (2013) research demonstrated that the emotional intelligence facets of self-awareness, self-control, empathy, organizational acumen, cultural comprehension, and communication effectively elevated project performance.

2.2.3.4 Definition and Model of Project Manager Leadership Competencies in This Study

In order to conduct better research, it is necessary first to clarify the meaning of competencies. The concept of competency has been widely used in human resources management since it was first proposed as a critical differentiator of performance by McClelland(1973). There are two synonyms, competence and competency, in the Oxford English Dictionary. According to the dictionary, the forms of the two words are readily interchangeable, which are defined as follows: (i) the ability to do something successful or effective; (ii) jurisdiction, legal competence (of the court, judge, etc.); (iii) enough means to live in an easy situation. However, in the managerial literature, subtle changes can be found in the statements of different scholars. Burgoyne(1989) simply defined competence as the ability and willingness to perform a task. Boyatzis(1982) viewed competence as "an underlying characteristic fo a person which results in effective and superior performance in a job", and he argued that effective performance was believed to occur when the person's competency was consistently met job and organisational requirements. "An underlying characteristic" means that different people with different basic characteristics will lead to different job performances. Therefore, Boyatzis(2008) further developed his theory and defined competency as a capability or ability, which is a set of related but different sets of behaviour organised around the "intent". Furthermore, Boyatzis(2008) saw competencies are a cluster of behaviours of acquiring emotional, social, and cognitive intelligence.

Various researchers have attempted to define and categorize competencies in the context of project management. Moore et al.(2002) proposed basic characteristics of three related terms: competence as an area of work, competency as the behavior(s) supporting an area of work, and competencies as the attributes underpinning a behavior. Building on this, Deist & Winterton(2005) developed a multi-dimensional framework incorporating knowledge, skills, and competencies within a holistic competence typology. Despite these and other milestone definitions, there is still no definitive conclusion on the required or desired skills and competencies of project managers. An important consideration in this ongoing discussion is whether "competencies" are distinct from "leadership competencies" or if the two can be considered synonymous in the context of project management.

The distinction between general competencies and leadership competencies can vary depending on the context and perspective. Competencies, in a broader sense, encompass the knowledge, skills, abilities, and personal attributes that enable individuals to perform effectively in their roles. On the other hand, leadership competencies specifically focus on the capabilities required for effective leadership and influencing others towards achieving organizational goals.

While there may be overlapping elements between general competencies and leadership competencies, leadership competencies often emphasize additional qualities such as strategic thinking, vision setting, decision-making, and the ability to inspire and motivate others. These competencies are

particularly relevant for individuals in leadership positions or those who are responsible for guiding and directing teams. For instance, Ahmed & Anantatmula (2017) proposed a set of five leadership competencies specific to project managers. These competencies are defined as follows: define roles and responsibilities, communicate expectations, employ consistent processes, clarity in communication, and establish trust.

This study conducts a synthesis of previous research and defines leadership competencies as "a cluster of related knowledge, skills, and personal characteristics that have the potential to influence followers and lead to good job performance." It is emphasized that these competencies can be measured using well-accepted standards and developed through training and learning initiatives.

This definition underscores the interconnected nature of leadership competencies, encompassing not only the knowledge and skills required for effective leadership but also the personal characteristics and qualities that contribute to leadership effectiveness. Furthermore, the researchers highlight the importance of measuring these competencies using established standards and recognizing that they can be enhanced through targeted training and learning interventions.

By providing this definition, the study establishes a clear understanding of what leadership competencies entail and sets the foundation for examining and evaluating the specific competencies relevant to the context of the research.

This study categorizes leadership competencies into three distinct dimensions: Task-related (TR), People-related (PR), and Self-related competencies (SR). Task-related competencies encapsulate a leader's adeptness in orchestrating and accomplishing work tasks, encompassing aspects like goal establishment, strategic planning, and resource coordination. Interpersonal competencies underscore a leader's capacity to foster relationships and engage with team members through effective communication, collaborative teamwork, conflict resolution, and member development. Self-management competencies gauge a leader's capability to exercise self-regulation, embracing values, fairness, integrity, and stress resilience.

In conjunction with the preceding review and analysis, the identified leadership competencies are subsumed under these three dimensions, thereby constituting the analytical framework for leadership competencies within this study. This framework serves as a foundational criterion for evaluating the leadership proficiencies of project managers, forming the bedrock for subsequent research endeavors (Table illustrates these dimensions).

Table 2.2: The Modle of Project Manager Leadership Competencies - Dimensions and Competency

Dimensions	Competencies
TR	Technical skills Risk management Project experience Education Strategic thinking Analytical abilities Task management Organizational coordination abilities Innovation
PR	Decision making Flexibility Interpersonal skills Negotiation Motivate team members Competency development and career guidance Get support from the team Get support from senior managers
SR	Adaptability and Flexibility Self-control and behavioral consistency Initiative and passion Passion Responsible Confidence Self-control Work under pressure

2.2.4 Gaps in Current Research on Leadership Competencies

Despite the growing body of research on leadership competencies in construction project management, several significant gaps persist, limiting comprehensive understanding and practical application of these competencies

in the industry.

2.2.4.1 Conceptual and Definitional Challenges

One of the major challenges in current research on leadership competencies in construction project management arises from conceptual and definitional issues. Despite extensive studies in this field, there is no consensus on key definitions and concepts, which impedes the development of a cohesive body of knowledge and limits practical application.

First, there is no universally accepted definition of competencies, particularly in the context of construction project management. While researchers such as Moore et al. (2002) and Deist & Winterton (2005) have proposed frameworks for understanding competencies, these efforts have not produced a standardized definition. Moore et al. (2002) differentiate among competence (a domain of work), competency (the behaviors supporting a domain of work), and competencies (the attributes underlying those behaviors). Deist & Winterton (2005) developed a multi-dimensional framework that integrates knowledge, skills, and competencies within a holistic typology. However, the absence of a unified definition complicates the comparison and validation of research findings across different studies and contexts, ultimately obstructing the development of standardized assessment tools and training programs.

Second, existing research often fails to clearly distinguish between general project management competencies and specific leadership competencies.

This lack of clarity creates confusion in both academic and practical contexts. Without a clear distinction between these two categories, it is difficult to design leadership development programs tailored to construction project managers. The field requires a better understanding of which competencies are foundational to project management and which are uniquely linked to effective leadership in the construction industry.

Additionally, while research frequently categorizes competencies into different domains, there is limited understanding of how these domains interact and influence one another. This fragmented approach may oversimplify the complex nature of leadership in construction projects. The interaction among these competency areas is critical for effective leadership, yet current research lacks an integrative perspective. A deeper understanding of these interactions could inform more comprehensive leadership development strategies that address multiple competency domains concurrently.

These conceptual and definitional challenges have significant implications. They hinder comparative studies, the development of comprehensive leadership models, and the creation of effective assessment and development tools. Moreover, they limit the practical application of research findings, as organizations struggle to translate ambiguous or inconsistent concepts into concrete leadership development initiatives. Addressing these conceptual and definitional challenges would establish a stronger foundation for future research and practical application, ultimately enhancing leadership effectiveness in the construction industry.

2.2.4.2 Contextual and Methodological Limitations

Current research on leadership competencies in construction project management is constrained by significant contextual and methodological limitations, which restrict a comprehensive understanding of the subject and its practical application.

One key contextual limitation is the insufficient consideration of the unique factors that define the construction industry. Many studies on leadership competencies fail to fully account for the specific challenges and complexities inherent in construction projects, such as the project-based nature of the work, the temporary and diverse composition of project teams, the high levels of risk and uncertainty, and the intricate stakeholder relationships. This omission reduces the relevance and applicability of research findings to real-world construction scenarios.

Furthermore, the rapidly evolving nature of the construction industry presents challenges to current research methodologies. Technological advancements, shifting project delivery methods, and increasing globalization are reshaping the industry at an unprecedented pace. However, much of the existing research views competencies as static attributes, neglecting their dynamic nature. This oversight ignores the fact that leadership competencies must evolve in response to industry changes, which may render some research findings obsolete shortly after publication.

The globalization of the construction industry adds another layer of complexity that is often insufficiently explored in current research. As projects increasingly span national and cultural boundaries, there is a growing need for cross-cultural studies on leadership competencies. However, much of the research fails to adequately address how leadership competencies vary across different cultural contexts, often leading to a Western-centric view of effective leadership. This gap is particularly concerning given the multinational nature of many large-scale construction projects and the diverse workforce involved.

From a methodological standpoint, a major limitation is the lack of validated, industry-specific tools to measure leadership competencies in construction project managers. This measurement gap significantly hampers efforts to assess and develop these competencies in practice. Without reliable and valid assessment tools, it is difficult to identify areas for improvement, track progress in leadership development, and link specific competencies to project outcomes. The development of robust, context-specific measurement instruments is critical to advancing both research and practice in construction project leadership.

Additionally, there is a notable shortage of longitudinal studies in this field. Most research provides only snapshot views of leadership competencies, failing to capture how these competencies develop over time and throughout a project manager's career progression. This limitation restricts our understanding of the learning processes and experiences that contribute to the development of effective leadership in construction project management.

Another methodological shortcoming is the limited empirical evidence linking specific leadership competencies to project outcomes. While many studies assume a positive relationship between leadership competencies and project success, this assumption often lacks rigorous empirical support. There is a critical need for more comprehensive and methodologically sound research to establish clear connections between specific leadership competencies and various project outcomes, such as time and cost performance, quality, safety, stakeholder satisfaction, and long-term sustainability.

2.2.4.3 Future-Oriented Research Needs

As the construction industry evolves rapidly, there is an urgent need for forward-looking research to address emerging challenges and opportunities in leadership competencies. First, there is a pressing need to identify and define emerging leadership competencies essential for future construction project managers. The increasing use of advanced technologies, such as Building Information Modeling (BIM), artificial intelligence, robotics, and sustainable construction practices, is reshaping the industry. Consequently, future project managers will likely require new competencies to lead effectively in this evolving environment. Research should anticipate these competencies, which may include digital literacy, data-driven decision-making, virtual team leadership, and the integration of sustainability principles into project management. Additionally, studies should examine how these emerging competencies interact with traditional leadership skills and how they can be effectively developed and integrated into existing leadership frameworks.

Second, research is needed on strategies for developing leadership competencies specifically tailored to construction project managers. While various training and development approaches, such as mentoring, simulation-based learning, action learning, and executive education, are available, their effectiveness in the construction context remains largely unexplored. Future research should evaluate these methods, assessing not only their immediate impact but also their long-term effects on leadership performance and project outcomes. Additionally, studies should explore how different learning approaches can be customized to address the unique challenges faced by construction project managers at various career stages and in different project contexts.

Third, more robust empirical research is required to establish clear links between specific leadership competencies and project outcomes. While many studies assume a positive relationship between leadership competencies and project success, this assumption often lacks rigorous empirical support. Future research should identify which competencies are most crucial for various project outcomes, such as time and cost performance, quality, safety, stakeholder satisfaction, and sustainability. Such research would validate the importance of leadership development in construction project management and help prioritize competencies in training programs.

Fourth, as the construction industry becomes increasingly globalized, there is a growing need for cross-cultural studies on leadership competencies. Future research should explore how cultural factors influence the perception,

development, and effectiveness of leadership competencies in different global contexts. This includes examining how cultural values and norms impact leadership styles, communication, decision-making, and team dynamics in construction projects. Additionally, research should investigate how leaders can adapt their competencies when working in multicultural environments or on international projects, contributing to the development of culturally intelligent leaders capable of navigating global complexities.

Fifth, research should address the dynamic nature of leadership competencies in the construction industry. Longitudinal studies are needed to understand how leadership competencies evolve over time in response to industry changes and throughout a project manager's career. Such research could offer valuable insights into the learning processes and experiences that foster effective leadership in construction project management.

Finally, interdisciplinary research is needed to integrate insights from fields such as organizational psychology, management science, and construction engineering. This interdisciplinary approach could yield more comprehensive and nuanced models of leadership in construction project management, addressing the complex interplay between technical, managerial, and leadership competencies.

2.3 Project Team Performance in Construction Industry

Project team performance is a critical factor in the success of construction projects, encompassing various elements that contribute to the overall efficiency and effectiveness of the team in achieving project goals.

2.3.1 Project Team Performance Factors

A team is a group of two or more individuals with defined roles who collaborate and depend on each other to accomplish a shared objective (Salas et al., 1992). Teamwork is indeed a prevailing trend in many organizations, and it holds particular importance in labor-intensive industries like construction (West, 2012). By organizing work into teams, organizations can leverage the diverse skills, knowledge, attitudes, and other characteristics of team members to enhance performance and accomplish organizational objectives more effectively.

In the construction industry, teamwork is crucial due to the collaborative nature of projects. Construction projects often involve various stakeholders, including architects, engineers, contractors, subcontractors, and suppliers, among others. Bringing together individuals with different expertise and backgrounds allows for a comprehensive and integrated approach to problem-solving and goal achievement. As construction projects become increasingly complex, the need for interdisciplinary collaboration becomes even more significant (Wang & Zhang, 2015). Different professionals from various fields of study and with

diverse management principles must work together in teams to facilitate the exchange of information, coordinate activities, and align efforts towards common project goals.

Collaboration, cooperation, and team integration are key factors that foster effective teamwork in construction. By promoting open communication, mutual trust, and shared accountability, construction teams can overcome challenges, mitigate risks, and ensure project success. Emphasizing teamwork not only enhances the performance of individuals but also improves overall project outcomes. Therefore, project teams are central to organizations. However, teamwork and communication are often described as “soft” and subjective, which is understood in opposition to “hard” and objective domains (Crawford & Pollack, 2004). Therefore, Chiochio & Hobbs (2014) called for interdisciplinary research projects devoted to developing a research agenda on project teams. Due to the temporary nature of project teams, some project teams still cannot reach a stable and mature team when the project is completed, resulting in project failure. Hence, Chiochio & Hobb (2014) suggested that the project manager must highly value the effective operation of the project team. A high-performing team is a collection of individuals with complementary skills, committed to common goals, working in the same way, and sharing responsibility for tasks (Furman, 2008). Dyer (2013) defined high-performance teams as those with members whose skills, attitudes, and competencies enable them to achieve team goals; and in an assumed supportive trusting atmosphere, are able to effectively set goals, make decisions, communicate, manage conflict, and solve problems.

Over the past few decades, a substantial amount of research has been conducted to identify a wide range of factors that contribute to the enhancement of team performance (Ilgen, Hollenbeck, Johnson, & Jundt, 2005). Similarly, the current research on the factors influencing project team performance is multifaceted. This section provides a comprehensive summary of several notable studies conducted in this area.

Liu & Cross(2016) used a diverse sample of 133 project teams to develop a comprehensive model of project team technical performance and found that management support, cooperation, and communication were positively related to effectiveness; efficiency was positively related to goal clarity, cooperation, and team harmony, but negatively related to team diversity; and, innovation was positively associated with knowledge/skill and cohesion, but negatively associated with team harmony.

Du (2012) proposed a conceptual framework to demonstrate the relationship between interpersonal cooperation and the measurements of team performance. According to the conceptual framework, there are four major categories of factors representing or determining the processes of interpersonal cooperation: task characteristics, individual characteristics, relational behaviours and organisational context. The contents of each category of factors are shown in Figure.

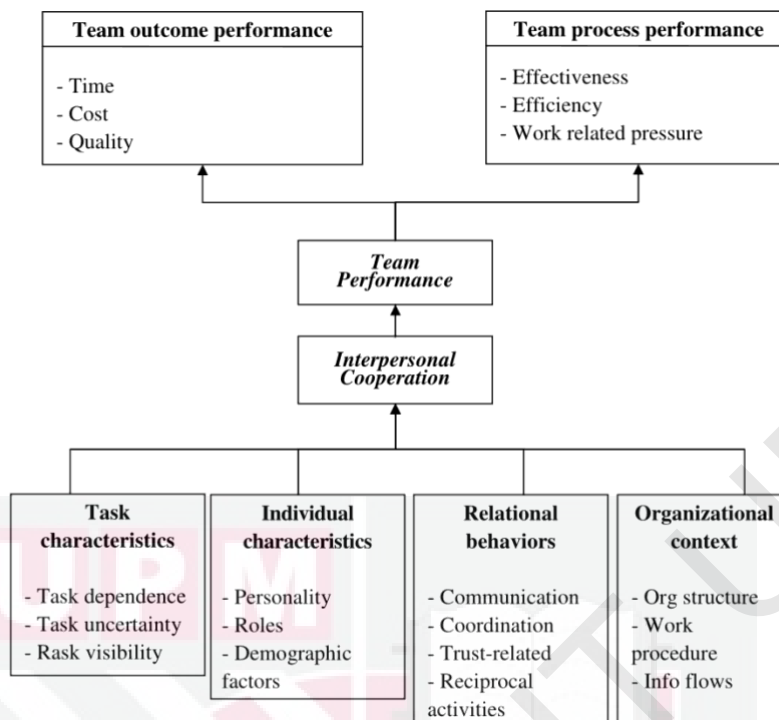


Figure 2.4: Conceptual Framework of Interpersonal Cooperation in Construction Project Teams
(Source: Du, 2012)

Azmy (2012) examined different factors that associated with team effectiveness and the relationship between the team effectiveness factors and project performance aspects and found that team leadership is the most important factor in project management and project quality largely depends on the skills and experience of the project team leader. Peterson (2007) suggested that the project manager should avoid applying abroad application of motivation to all team members based solely on the manager's perception and take the time to work with each team member to understand personal work drivers. (Ammeter & Dukerich, 2002) surveyed 151 construction project teams and identified nine factors that affect project team performance, including team orientation, leadership behaviours, team communication, ownership, location, team building, competition, rewards, and support.

The previous literature indicates a growing understanding among scholars of the role of human factors, such as project managers and project teams, in achieving project expectations. However, research on behavioral and attitudinal factors remains insufficient.

2.3.2 The Measurement of Project Team Performance

The measurement of team performance has consistently captured the attention of researchers and practitioners alike. Evaluating team performance enables the identification of strengths and challenges within teams and facilitates the assessment of training requirements (Ilgen et al., 2005). However, an effective and reliable method is crucial for these purposes. Additionally, since individual-level rewards can potentially undermine team motivation, many organizations opt for team-based compensation/reward systems (Salas et al., 2004). To ensure equitable distribution of these rewards, the development of robust team performance measures becomes imperative.

Motowidlo and Kell (2012) provided a definition of team performance as the collective display of positive expected behaviors that facilitate team members' performance activities within a specific time period. In order to assess the explanatory dimensions of team performance, scholars have developed various conceptual models. Rousseau (2006) conducted a comprehensive literature review on teamwork behaviors and proposed a framework that takes into account the temporal aspect of behaviors, allowing for a better understanding of how team members contribute to team success. This

framework also helps in identifying optimal timing for engaging in these teamwork behaviors. Subsequently, a portion of the research literature builds upon this theoretical foundation(Cusí et al., 2021).

In the field of project management, iron-triangle(cost, time and quality) are the main criteria for project team performance evaluation. If the project organisation narrowly pursues the iron triangle, the project manager is forced to focus too much on achieving the short-term goals of the project, which is potentially limiting in terms of optimising project performance(Bryde, 2005). Atkinson(1999) argued that the iron triangle evaluation criteria had not been broken for a long time because schoolers paid too much attention to project process management and other criteria were ignored. Therefore, some shoolers extended the new factors affecting quality performance, such as environment, complexity(Chan & Tam, 2000), team creativity(Ford & Sullivan, 2004), quality of coordination(Gautam, 2009), and project team member performance(Azmy, 2012).

Due to these limitations, project teams frequently prioritize operational matters, resulting in performance paradoxes. For instance, achieving project completion within the designated timeframe, budget, and quality standards may not necessarily translate into satisfactory commercial outcomes (Zheng et al., 2019). Researchers have addressed this issue by examining the influence of measurement systems on individuals' behavior. By manipulating specific variables and observing their impact on team members' decisions and

behaviors, the literature on performance measurement sheds light on this paradoxical phenomenon (Varajão et al., 2022).

To address the performance paradox in project management, Pavez et al. (2022) conducted a systematic literature review. This review aimed to conceptualize project team performance measurement and develop a comprehensive framework encompassing four dimensions: project team processes, project team emergent states, project team tangible outcomes, and project team perceptual benefits (refer to Figure). The study offers an evidence-based framework that can assist practitioners in enhancing the design of project team performance measurement systems. It represents the latest research contribution in the field of project performance measurement and contributes to the advancement of theory in this area.

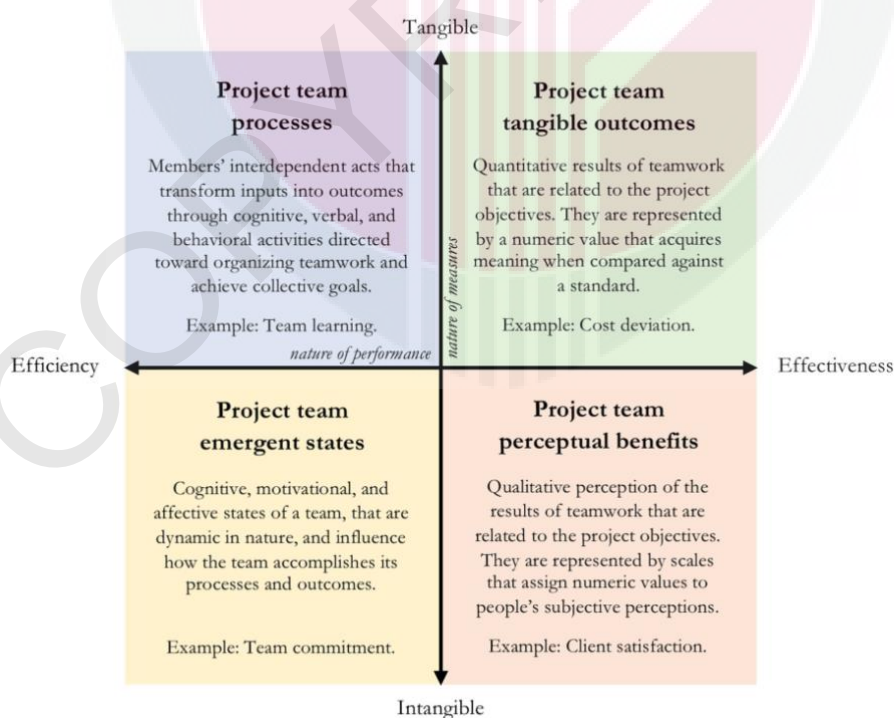


Figure 2.5: Pavez's Integrated Framework for Project Team Performance Measurement
 (Source: Pavez et al. 2022)

While these studies offer valuable insights into the factors affecting construction project team performance, several limitations and areas for future research remain. Most studies adopt a static perspective, neglecting how these factors change dynamically throughout the project lifecycle. Future research should use longitudinal designs to investigate how team performance factors evolve over time and affect project outcomes. Although Liu and Cross (2016) present a comprehensive model, further research is needed to validate these findings across various types and scales of construction projects, with particular focus on the relative importance of factors like management support, cooperation, and communication in different project environments. Du's (2012) conceptual framework provides a useful perspective on interpersonal cooperation in project teams, but it requires empirical validation and refinement, especially within the specific context of the construction industry. Moreover, research on behavioral and attitudinal factors remains relatively scarce. Given the highly interpersonal nature of construction projects, future studies should emphasize these "soft" factors—such as emotional intelligence, cultural intelligence, and adaptability—and explore their impact on team performance and project success. Therefore, while existing research offers important insights, there is a need for more interdisciplinary studies that integrate perspectives from organizational behavior, psychology, and project management to fully understand the complex dynamics of construction project team performance. This integrated approach can advance academic theory and provide practitioners with more effective strategies for team management.

2.4 Team Processes as Mediating Mechanisms

As highlighted in the previous section, team process is a crucial dimension in Pavez et al. (2022) team performance measurement model. Team process refers to the interdependent behaviors of team members, involving cognitive, verbal, and behavioral activities, aimed at transforming inputs into outcomes to achieve collective goals (Marks et al., 2001). The input-process-outcome approach suggests that leader behavior influences team outcomes through team processes (Mathieu et al., 2008). This holds true even for temporary project leaders who face time constraints (Siddiquei et al., 2022).

In addition to team process, another dimension in Pavez et al. (2022) team performance measurement model is team emergent states. To clarify the concept, team emergent states pertain to the dynamic cognitive, motivational, and affective states of the team, which influence how the team carries out its processes and achieves outcomes (Marks et al., 2001). These emergent states can be understood as team engagement and proximal results. It is important to distinguish team emergent states from process metrics for interactions, as emergencies do not directly represent team interactions or actions leading to results. Instead, they are products of the team's experience, including team processes, and become new inputs for subsequent processes and outcomes. As this study focuses on the mechanism through which leadership ability affects teams and team emergent states do not describe the nature of member interactions, the indicators of team emergent states will not be reflected in the subsequent research models. Instead, this study

focuses on three specific team processes: team learning, team monitoring, and team climate. The following section will review relevant research in these three areas.

2.4.1 Taxonomy of Team Processes

There has been a longstanding research tradition focused on developing taxonomy systems for team processes, and several studies have presented more comprehensive taxonomic schemes. For instance, Prince & Salas (1993) identified a set of seven critical team skills through a literature review and key event interviews. Fleishman & Zaccaro (1992) constructed a taxonomy of team performance functions after multiple revisions. While categorizing team processes does not introduce new dimensions, it allows for a logical presentation of these dimensions in their sequential order of occurrence. This is undoubtedly significant in gaining insights into the inner workings of teams.

This study will adopt the taxonomy of team processes proposed by Marks et al. (2001). This classification method is widely utilized and has been validated in research on project teams as well (Siddiquei et al., 2022).

According to the research conducted by Marks et al. (2001), team processes can be categorized into three phases: transition phase processes, action phase processes, and interpersonal processes. Within these phases, there are ten specific team process dimensions that fall under three overarching categories. The occurrence of these processes is influenced by the temporal

logic, with certain processes more likely to happen during the transition phase, others during the action phase, and interpersonal processes expected to take place throughout both transition and action. Figure provides an illustration of the process dimensions that emerge during the transition and action phases.



Figure 2.6: The Process Dimensions as They Occur within Each Phases
(Source: Marks et al., 2001)

Among the three team processes examined in this study, team learning is classified as a transition phase process according to Marks et al.'s (2001) taxonomy. Team monitoring, on the other hand, is categorized as an action phase process. Lastly, team climate falls under the third process category identified by Marks et al. (2001), namely personal processes.

2.4.2 Team Learning

Team learning, also known as group learning, traces its roots back to Senge (1990) seminal work, "The Art and Practice of the Learning Organization." It involves the process of enhancing team members' overall coordination and capabilities to achieve shared objectives. In the context of organizational learning, teams serve as the fundamental unit and play a crucial role. Senge argued that without team learning, organizations cannot effectively learn and adapt. However, the concept of team learning has been subject to varying interpretations in theoretical and empirical studies, leading to a lack of consensus (Wilson et al., 2007). This study aims to address this gap by conducting a comprehensive review of the existing literature on team learning and presenting it from four distinct research perspectives.

The behavioral orientation is the first perspective on team learning, emphasizing that it involves a series of interactive behaviors among team members aimed at achieving goals such as information exchange, knowledge transfer, and problem-solving. For instance, Edmondson (1999) views team learning as an ongoing process of reflection and action, encompassing specific

behaviors like raising questions, seeking feedback, conducting experiments, reflecting on outcomes, and discussing errors or unexpected results. Kozlowski & Ilgen (2006) propose that team learning, team climate, shared mental models, and interactive memory can be understood as dynamic behavioral processes. Wilson et al. (2007) describe team learning as a process through which team members construct and acquire shared knowledge about team tasks, resources, and background, involving sharing, storing, and retrieving information. Andres & Shipps (2010) suggest that team learning involves a series of activities, including exchanging information, improving opinions, presenting ideas, making decisions, and eventually reaching consensus. Kozlowski (2018) identifies various behaviors within team learning, such as actively asking questions, exploring different viewpoints, discussing differences in perspectives, identifying existing flaws, and solving complex problems, all aimed at building new understandings and approaches.

The second perspective is the information processing orientation, which understands team learning as a process rooted in information processing theory. It views team members as information processors and considers team learning as an information processing activity at the team level. For example, Hinsz et al. (1997) proposes that the team learning process involves four steps: clear goals, processing information, responding, and receiving feedback. Mathieu et al. (2008) suggest that team learning involves team members learning by documenting the work process, encoding team knowledge, and transforming tacit knowledge into explicit knowledge. (Woerkom & Croon (2009) argue that team learning comprises interrelated activities such as

knowledge acquisition, information processing, information storage, and retrieval. Decuyper et al. (2010) identify eight information activities within team learning, including information sharing, information reconstruction, creative conflict, information feedback, team activities, overcoming barriers, information storage, and information retrieval. These perspectives highlight the role of information processing and knowledge creation within team learning processes.

The third perspective is the result orientation, which emphasizes the outcomes of team learning. It focuses on the improvements in organizational behavior, member skills, and team performance that can be achieved through team learning. For example, Argyris & Schön (1997) view team learning as a process of identifying work problems and correcting work mistakes. Ellis et al., (2003) define team learning as the collective knowledge generated through the sharing of experiences among team members, resulting in persistent changes in skill levels at the team level. Zellmer-Bruhn & Gibson (2006) propose that team learning involves three processes: performance improvement, task control, and team processing. These perspectives highlight the tangible benefits and positive changes that can arise from team learning, both at the individual and team levels.

The fourth perspective is the comprehensive orientation, which integrates the behavioral orientation, information processing orientation, and result orientation to provide a comprehensive understanding of team learning. It takes into account the interactive behaviors of team members, the information

processing processes at the team level, and the outcomes and benefits of team learning. For example, Day et al. (2004) synthesized the process perspective of Edmondson (1999) and the result perspective of Ellis et al. (2003) to develop a model that explores the influencing factors and functions of team learning. This comprehensive perspective recognizes the multidimensional nature of team learning and provides a more holistic framework for understanding its complexities and impacts.

In recent years, there has been an increasing number of theoretical and empirical studies on team learning. In line with the chosen theoretical perspective of information processing theory, team members are viewed as information processors, and team learning is seen as the collective process of information processing at the team level. Woerkom & Croon (2009) investigated the relationship between different team learning activities and various types of team performance assessed by team members and managers. They identified activities such as information acquisition, processing, storage, and retrieval as integral components of team learning. Similarly, Mathieu et al. (2008) defined team learning as the process through which team members encode knowledge by documenting their work processes, leading to the formation of internal team knowledge.

Two notable models of team learning are discussed here. Edmondson(1999) introduced the concept of team psychological safety, which refers to the shared belief among team members that it is safe to take interpersonal risks. Edmondson's theoretical model positions team learning as an intermediate

variable, linking team psychological safety to team performance (as depicted in Figure). On the other hand, Knapp (2010) proposed a model (Figure) that views team learning as a dynamic process capable of influencing team performance and efficiency.

These models offer a valuable framework for comprehending the intricate dynamics of team learning and its influence on team outcomes. By examining the linkages between team learning, team inputs, and team outputs, these models highlight the mediating role of team learning in the overall process. They shed light on how team learning serves as a bond between input factors and output outcomes, providing a foundation for understanding the mediating effects of team learning. This emphasis on the mediating role of team learning underscores the significance of team learning in shaping team performance and effectiveness.

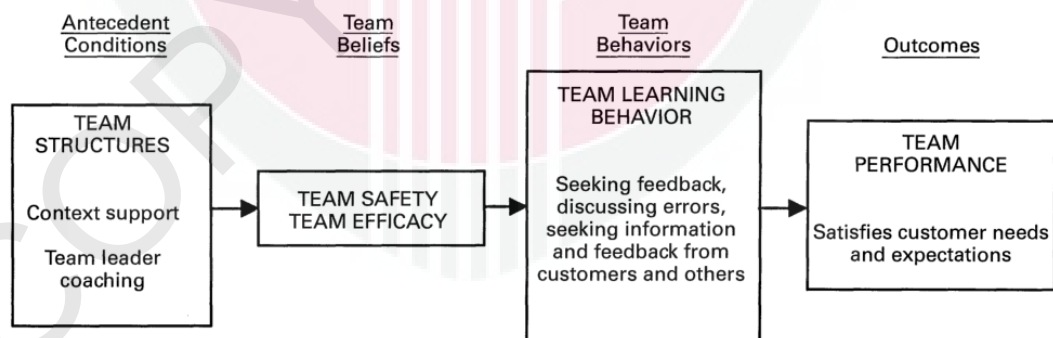


Figure 2.7: Team Learning Model of Edmondson
(Source: Edmondson, 1999)

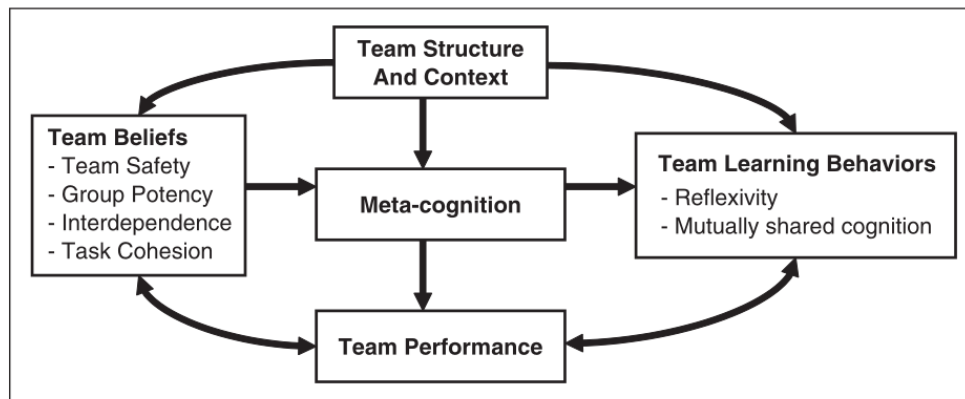


Figure 2.8: Model of Team Learning Process
(Source: Knapp, 2010)

2.4.3 Team Monitoring

According to Marks et al. (2001), the action process phase of team functioning involves four types of activities. The first is monitoring progress towards the team's goals, which entails tracking and communicating information necessary to assess progress. The second is system monitoring, which involves keeping track of team resources and environmental factors to ensure adequate support for goal attainment. The third is team monitoring and backup behavior, where members provide assistance to one another through feedback, task help, or compensatory actions. This behavior is related to concepts like cooperation, workload sharing, and team-level organizational citizenship behavior. Lastly, coordination refers to synchronizing and adjusting the activities of team members.

During the action process phase, monitoring serves as a team self-discipline strategy (Marks et al., 2001). It involves tracking goal progress, assessing necessary actions, and communicating progress to team members. Monitoring

is a direct driver of performance, motivated by goals and effectiveness. It is the process closest to task-focused actions and plays a crucial role in motivating and influencing team behavior(Locke, 1991).

While monitoring has been categorized as a leader behavior in some studies(Fleishman et al., 1991), this study focuses more on team-level monitoring, specifically the observation of other team members' activities. This enhances awareness of team situational factors, facilitates coordination, and allows for the identification of mistakes or poor performance, enabling teammates to provide assistance.

Team monitoring is a significant action process in teams. It involves close attention to individual members' goal attainment and the tracking of their task performance. Research has shown a positive relationship between team monitoring and team performance(Jong & Elfring, 2010).

In a team with a high learning goal orientation, team members compare their own work abilities and performance with others. They closely monitor and evaluate the task completion and work behavior of fellow members to ensure adherence to team expectations and norms. This monitoring process helps identify whether work behaviors and results align with the team's goals. Team learning goal orientation promotes team monitoring, which, in turn, enhances team performance by reducing slack(Rapp et al., 2014). Through team monitoring, members not only focus on their own performance but also compare and supervise each other, mitigating the "free rider" phenomenon

and encouraging all team members to prioritize task achievement. Additionally, team monitoring facilitates a better understanding of each other's actions and task completion, enabling effective coordination of team member contributions and maximizing the achievement of team goals. Therefore, team goal monitoring plays a crucial role in the relationship between team progress and team outcomes (Marks et al., 2001).

The study recognizes the existing research on team monitoring and team performance but acknowledges that further investigation in this area is needed. It aims to contribute to the existing body of knowledge on teams by considering team monitoring as a significant research process. The study intends to make theoretical and empirical contributions to enhance our understanding of the relationship between team monitoring and team performance. By delving deeper into this topic, the study seeks to fill gaps in the current literature and provide valuable insights to advance our knowledge of team dynamics.

2.4.4 Team Climate

Team climate has been a longstanding subject of research in the field of organizational psychology, with its roots traced back to the work of Lewin, Lewin et al. (1939) on social climate. They defined climate as the shared perception or cognitive map that individuals have of their social environment, marking the starting point for climate research. Subsequent researchers have primarily defined climate from two perspectives: as a cognitive schema or as a shared perception of individuals regarding the surrounding environment. The

former perspective focuses on the individual level, which poses challenges in establishing its connection with organizational and team effectiveness. However, when individuals within an organization or team share the same psychological understanding of their environmental conditions, the concept of climate can be discussed at the organizational or team level (James et al., 1993). This team-level perspective resolves the dilemma faced by the individual-level concept of climate, allowing researchers to study climate as a collective perception within an organizational or team context.

In the study of organizational behavior, there is a prevailing perspective that views climate as individuals' psychological perception of the organizational situation. This perception is formed through the interaction between individuals and their organizational context. Climate is considered a representation of organizational characteristics, events, and inherent qualities of operational processes (Kozlowski, 1998). George H. Litwin (1968) suggest that climate comprises measurable attributes of the work environment that individuals directly or indirectly perceive, and it influences their motivation and behavior. Schneider (1975) argues that climate is a product of organizational practices and procedures, and different practices and procedures result in different organizational climates. Team climate establishes the overall social interaction environment and behavioral norms within a team. These social norms and interactions are intangible yet pervasive, consistently shaping the team's culture and serving as the basis for maintaining and changing the organizational team culture. Moreover, team climate significantly impacts individual attitudes, motivations, and behaviors (Blake et al., 1964), and it also

has a substantial influence on organizational, team, and individual performance.

Empirical research on team climate has focused on three main aspects: the factors influencing its formation, the mechanisms through which it influences outcome variables, and its impact on those variables. Among the factors influencing team climate, leadership is considered the most important and extensively studied factor. Team leaders play a crucial role in fostering a healthy work atmosphere among their subordinates (Grandori & Kogut, 2002). Research by Sarin & McDermott (2003) revealed that a more democratic leadership style has a positive impact on team climate formation. These studies have shown a significant positive correlation between leadership and team climate, with team climate being positively associated with knowledge sharing and team performance. In recent years, there has been increased attention to the influence of team climate on innovation (He, 2015; Li et al., 2015), and the mediating role of team climate on innovation performance has also been verified (Chatzi et al., 2023).

According to Marks et al.'s (2001) taxonomy of team progress, team climate falls under the category of interpersonal processes. It is an expression of how team members perceive and engage in mutually supportive behaviors and specific procedures within the team (Schneider et al., 1998). Team climate influences individual employee behavior, and this influence occurs through social information processing mechanisms (Salancik & Pfeffer, 1978), whereby an individual's thoughts and feelings about their environment are shaped.

Therefore, team climate has been found to have an impact on team performance in various studies. For example, Lynn & Rebecca (2001) demonstrated the relationship between team innovation climate and team innovation performance as a hidden dynamic mechanism. Jong et al. (2004) explored the connection between service climate and team performance in self-managed teams. Colquitt et al. (2002) investigated the relationship between fair climate within teams and performance and membership outcomes. Scholars hold different perspectives on the effects of team climate on team performance, but most agree that team innovation climate is influenced by team leaders and serves as a mediating factor through which leaders impact team performance.

2.5 Development of Theoretical Framework: A Social Information Processing Perspective

2.5.1 Research Content of Social Information Processing

Social Information Processing Theory (SIPT) builds upon information processing theory and focuses on how individuals encode, interpret, and respond to social cues and information in ambiguous social situations. It was initially proposed by Salancik & Pfeffer(1978) to address the limitations of work attitude and motivation models that focused on individual dispositions and rational decision-making processes. SIPT emphasizes the influence of the social context and the consequences of past choices on attitudes and behaviors.

Scholars have further developed social information processing models (Crick & Dodge, 1994; Dodge & Crick, 1990), which outline the processes involved in social information processing, including attitude formation, attribution, goal setting, coping response decision generation, coping response selection, and speech/action/behavior generation. Some researchers also incorporate emotional processes into the analysis (Lemerise & Arsenio, 2000). The model suggests that the social environment directly influences individual attitudes and behaviors through social information, including the views and positions of people such as leaders or colleagues (refer to Figure).

The theoretical research in this area covers work attitudes and organizational climate (Lu et al., 2019). Attitudes and behaviors are influenced by the social environment, history, and current situation. The social environment provides cues that individuals use to construct and interpret events and form attitudes and behaviors. Social information processing theory suggests that multiple social influences on attitudes are better predictors than individual needs or characteristics alone. The interaction between individuals and the environment contributes to the work climate within an organization (Salancik & Pfeffer, 1978).

A cohesive work climate leads to less variance in attitudes expressed by employees. The social mediation of attitudes, influenced by the work climate, needs to be considered when individuals express attitudes similar to others within their organization but different from those in similar groups (Gangadharbatla, 2008). Attitudinal responses to work are influenced by

individual characteristics but also constrained by the organizational situation (Boekhorst, 2014). The assumption is that employees within the same organization have similar needs and respond similarly to tasks within a similar work atmosphere.

Indeed, social information processing theory has gained significant popularity and has been extensively applied in the fields of management, organizational behavior, and psychology. Researchers have employed this theory to study various aspects of organizational dynamics and individual behavior.

For instance, Liao and Chuang (2004) utilized social information processing theory to examine service climate within organizations. They viewed service climate as a form of social information that provides employees with cues regarding the desired and rewarded service behaviors. The presence of a positive service climate can influence employees' service performance and their understanding of what constitutes effective service delivery.

Additionally, Edmondson (2002) emphasized the importance of teams as the fundamental learning units within organizations. According to social information processing theory, teams serve as a crucial source of social information that influences individuals' cognition and behavior. By studying team dynamics and the exchange of social information within teams, researchers can gain insights into how individuals' attitudes and actions are shaped by their team environment.

These examples demonstrate how social information processing theory has been applied to better understand and explain various phenomena in organizational settings, including service performance and team dynamics. The theory's focus on the impact of social cues and information on individual cognition and behavior provides a valuable framework for examining interpersonal processes within organizations.

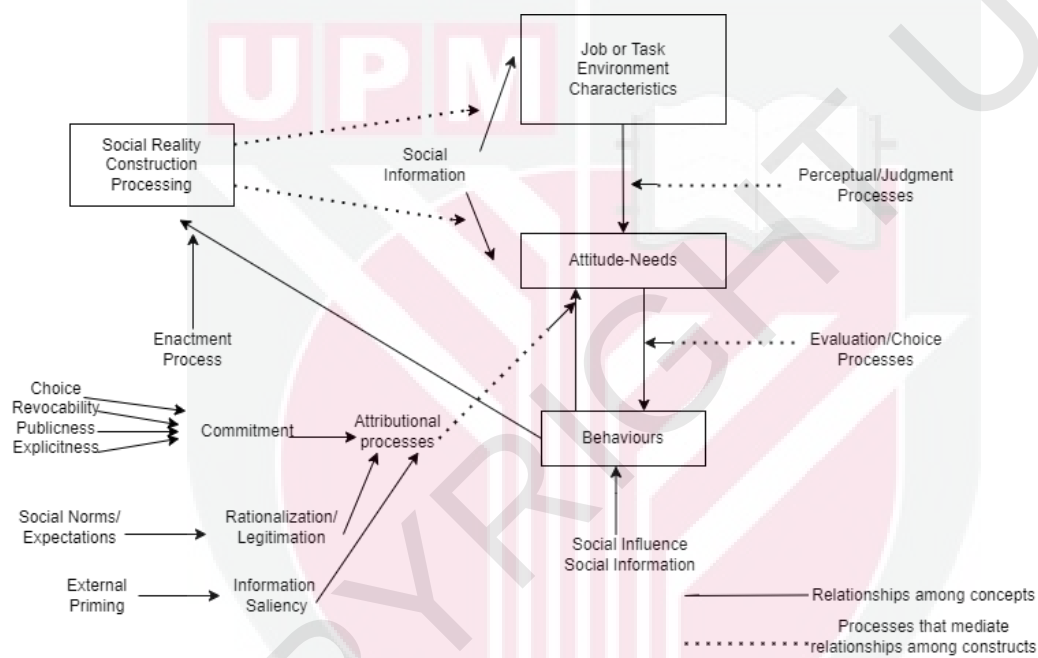


Figure 2.9: Social Information Processing Model
(Source: Salancik & Pfeffer, 1978)

2.5.2 Application of Social Information Processing in This Study

This study examines the information processing dynamics between project leaders and team members. It focuses on three aspects: the handling of feedback information from knowledge workers by humble leaders, the processing of humility information from leaders by knowledge workers, and the information exchange among knowledge workers. Ultimately, the study

investigates whether these processes contribute to achieving a common goal. Leaders play a vital role in providing information regarding social inclusion in the workplace. According to the theory of social information processing (Wadei et al., 2021), leaders transmit essential social information about the organization through their work attitude and behavior, which influences employees' work attitudes and behaviors. Leaders can consciously guide employees to understand and integrate into the work environment (Shamir et al., 1993) by focusing on areas for improvement, valuing employee suggestions, and being open to receiving feedback (Ashford et al., 2018). They can also provide relevant clues and information, such as industry standard improvements, institutional changes, and technological innovations, while fostering a growth mindset that encourages innovative work capabilities. By interpreting the cues provided by leaders, employees view them as role models, leading to the emulation of their work attitudes and styles and fostering a shared goal of cooperation (Schneider et al., 2013).

Moreover, the scope of research on social information processing theory has expanded from the individual to the team level. In a team context, members share the same social environment and receive signals from the same social information source. Over time, their behavior and interactions contribute to the formation of a collective perception, thus enhancing collective output. Edmondson (2002) suggests that teams, as the fundamental learning units of organizations, serve as crucial sources of social information that influence individual cognition and behavior through organizational learning. Empirical research supports the idea that team interaction processes result from the

socialization of information within the team. The emergence of collective attributes in cognition, attitudes, emotions, and behaviors stems from the similar processing of socialization cues by team members.

Moreover, although Zalesny & Ford(1990)pointed out that the SIP theory lacks further research on the social information processing process, there is still a lack of research on the mediating mechanism of social information and employee response from the existing studies. To fill this gap, in this study, team learning, team monitoring and team climate will be used as the team process reflecting social information processing.

2.5.3 Proposed Theoretical Framework

In the preceding subsection, this research reviewed the core concepts of social information processing theory and its relevance to the current study. It is evident that social information processing theory revolves around the notion that individuals utilize information from their social environment to guide their own behavior. In the context of project teams' work environment, team members perceive social information primarily from the project manager as a single source. They then exchange the information received through communication and other processes, facilitating the team's ability to provide information to the leader. This sharing of social information generates consistent responses among team members, leading to the emergence of convergent team perceptions and behaviors that subsequently influence team output. Project managers can utilize their power, leadership, influence, and

effective decision-making to influence the team's reception, interpretation, and analysis of the information regarding the project manager's leadership behavior, ultimately impacting the performance of the project team. Thus, social information processing theory provides a robust framework for elucidating how the information released by the project manager influences the team's processes and overall performance. Consequently, this study adopts the principles of social information processing theory to establish the theoretical framework.

To begin, the project manager assumes the role of the most influential social information source within a construction project team. The leadership competencies of the project manager itself serve as a critical factor within the social environment, driving team members to form specific perceptions and engage in a learning process that subsequently impacts their job performance. Furthermore, the information processing process is further delineated. Drawing upon Marks et al.'s (2001) taxonomy of team processes, this study categorizes team processes into transition phase processes, action phase processes, and personal processes. Team learning, team monitoring, and team climate are employed as representative mechanisms for each stage. This investigation also delves into an in-depth examination of the mediating factors that link the project manager's leadership competencies to team output. Ultimately, the outcomes of processing social information are centered around the criterion of project team performance. This study adopts the theoretical model depicted in Figure, which illustrates the "social information source-social

information processing process-social information processing result" framework.

The subsequent section will provide a comprehensive explanation of this model.

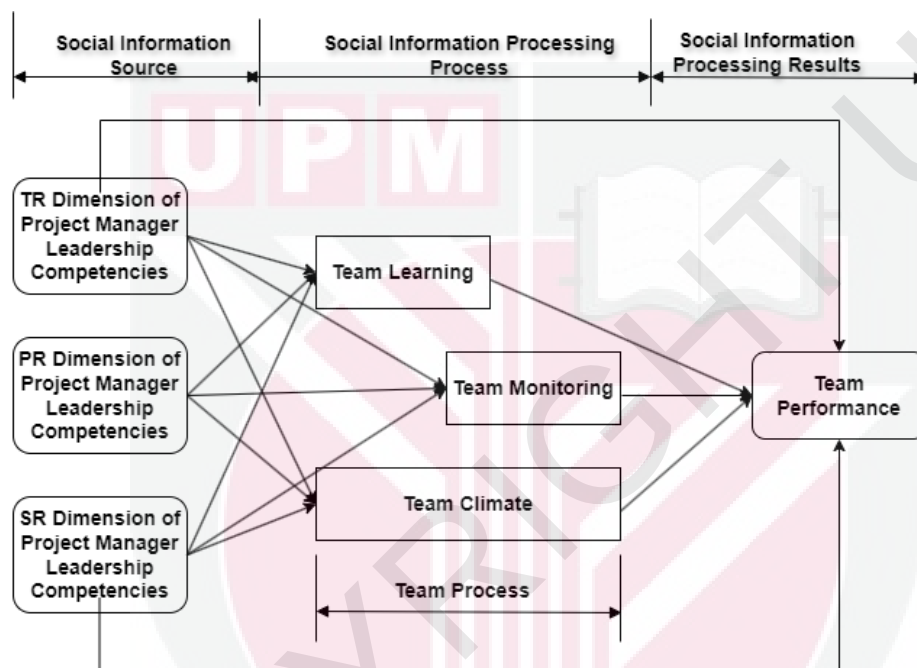


Figure 2.10: Proposed Theoretical Framework

2.5.3.1 Social Information Source: Leadership Competencies for Construction Project Managers

The theoretical framework developed in this study, drawing upon social information processing theory, utilizes the leadership competencies of project managers in construction projects as a source of social information. Construction projects possess unique characteristics such as long cycles, complex processes, harsh environments, significant capital investment, and

dynamic organizational structures (Zou et al., 2007), distinguishing them from other types of projects.

As the key figure bridging the superior construction company and the subordinate team members, the project manager assumes the role of the project team's top leader. Through methods like work breakdown structure, the project manager effectively communicates the organizational goals and project planning tasks to the team members (Kreiner, 1995). The project manager serves as the information provider and plays a crucial role in addressing resource constraints, integrating team members, navigating project uncertainties, and managing the interests of various project stakeholders. They shoulder substantial responsibilities and are responsible for project integration, team leadership, motivation of team members, seeking support from higher organizational levels, engaging external stakeholders, and demonstrating competence to ensure smooth project operations and the achievement of project objectives (Goodwin, 1993).

In dynamic environments and organizations, the leadership competencies of managers have been recognized as crucial drivers of firm success (Chatzoglou et al., 2017; Yukl, 2008). Leading project teams, in particular, is considered more challenging due to the unique characteristics of projects (Podgórska & Pichlak, 2019). Project managers encounter frequent changes, time and cost pressures, and the need to establish relationships with newly formed teams for each project (Podgórska & Pichlak, 2019). Through effective leadership, project managers play a vital role in motivating individuals to

achieve project success (Ahmed & Anantatmula, 2017). Enhancing project performance requires not only the application of professional project management tools and techniques but also the development of leadership skills among project managers (Berg & Karlsen, 2016).

It is important to highlight that the leadership competencies of project managers differ from other competencies (Dulewicz & Higgs, 2003), as leadership competencies primarily focus on influencing followers. Therefore, the leadership competence of project managers encompasses a dynamic process of social influence, involving the integration of their ideas, knowledge, skills, and characteristics. This process employs performance methods such as leadership empowerment, motivation, and guidance to enable subordinates to reach their full potential and achieve organizational goals (Anantatmula & Thomas, 2010). Current research on project manager leadership competencies primarily concentrates on examining leadership styles and behaviors exhibited by project managers and their relationship with project performance. However, the underlying motivations and reasons remain unclear, and social information processing theory offers a potential explanatory framework for this.

2.5.3.2 Social Information Processing Process: Team Learning, Team Monitoring and Team Climate

The social information processing model, developed by Salancik and Pfeffer, encompasses an intermediary process of information processing. For instance, social information influences individual behavior through the process of social

learning, while the combination of social information and task environment characteristics affects individual attitudes through the process of perception and judgment. Additionally, attitudes influence behavior through the process of evaluating choices. In the context of this research conducted at the project team level, Marks et al.'s (2001) taxonomy of team processes is primarily utilized to explain the transmission of project manager leadership competencies. However, the social information processing model provides only a conceptual description of the intermediate information processing process and lacks specific intermediary factors. Therefore, it is crucial to further define and clarify the specific intermediary variables within this information processing process. In this study, team learning, team monitoring, and team climate are employed as the three processes of social information processing.

The previous section has already reviewed the research origins, research methods, and their connection to this study concerning team learning, team monitoring, and team climate. Therefore, these aspects will not be reiterated here.

2.5.3.3 Social Information Processing Results: Project Team Performance

In the theoretical framework of this study, which is based on social information processing theory, project team performance serves as the outcome of social information processing. Construction enterprises typically operate as project-oriented organizations, where their primary business activities rely on

temporary project teams. The performance level of project teams plays a crucial role in realizing project functions and values, thus influencing the long-term development of construction enterprises. Therefore, the evaluation of construction project team performance should encompass not only the project's success but also the long-term interests of the project-based enterprise. This can be achieved by enhancing the project team's abilities and promoting sustainable organizational development.

From the perspective of team theory, project team performance consists of two key components: team effectiveness and efficiency. Team effectiveness refers to the extent to which the project team accomplishes the organization's intended goals, while team efficiency pertains to the ability of the project team to achieve desired results with minimal time and effort (Wang et al., 2005). Regarding project team efficiency, the team's focus lies in project tasks and outcomes, with cost, schedule, and quality serving as fundamental criteria for evaluation. On the other hand, project team effectiveness entails achieving common goals with higher efficiency and improved performance through capacity building, growth, and development despite resource constraints. The extent to which capabilities are developed and the satisfaction of the project team, as an important stakeholder, reflect the effectiveness of the project team.

Building upon the previous literature review on project team performance, this study divides the outcomes of social information processing, specifically the evaluation of project team performance, into two significant aspects. Firstly, from the perspective of project team efficiency, the study incorporates the

traditional iron triangle - project schedule, cost, and quality - as measures of the project team's task completion. Secondly, considering the characteristics of this research, the study examines project team effectiveness by taking into account both project team satisfaction and project team learning and growth. From a psychological perspective, the study deeply explores the mechanisms through which knowledge-based team heterogeneity influences team performance.



CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter outlines the research methodology employed in this study, structured into several sections. The first section introduces the research paradigms that guide the study. Section 3.2 details the development of the research framework and the hypotheses. Section 3.3 explains the study design, including the sampling process and the criteria used to define the sample. Section 3.4 focuses on the development of the research instruments, describing how the variables were measured. Section 3.5 discusses the translation process of the instruments to ensure accuracy and cultural relevance. Section 3.6 covers the pilot study conducted to refine the research tools. Section 3.7 outlines the data collection procedure, followed by Section 3.8, which presents the data analysis methods employed in this study, including the steps taken to validate the model and test the hypotheses.

3.2 Research Paradigms

A paradigm is a fundamental belief system and theoretical framework based on assumptions about 1) ontology (the nature of reality), 2) epistemology (how knowledge is acquired), 3) methodology (the approach to inquiry), and 4) methods (specific techniques used) (Rehman & Alharthi, 2016). In social

science research, several paradigms exist, including positivism, interpretivism, critical theory, and pragmatism, each with its own assumptions about reality and knowledge creation.

This study adopts the positivist paradigm. Positivism assumes that reality exists independently of human perception and can be objectively measured and studied. In the positivist paradigm, there is a belief in a single, observable reality (ontology), and the researcher and the subject are considered independent entities (epistemology). This approach typically uses quantitative methodologies, focusing on hypothesis testing and statistical analysis. Methods often include experiments, surveys, and structured observations, which enable systematic data collection and analysis.

The choice of positivism for this study is driven by the nature of the research topics: project manager leadership competencies and team performance. While these constructs are complex, they can be operationalized and measured objectively. This approach aligns with the study's goal of identifying measurable relationships between variables and testing specific hypotheses about how leadership competencies influence team performance in construction projects.

It is important to recognize that different paradigms conceptualize research objects in varying ways. While this study focuses on objectively measurable aspects of leadership and performance, other paradigms might approach these topics differently. For instance, an interpretivist study might explore

subjective leadership experiences, or a critical theory approach might examine power dynamics within project teams. Although these alternative approaches are valid, they address different facets of the phenomena and are suited to different research questions.

In line with the positivist paradigm, this study will formulate hypotheses about the relationships between leadership competencies and team performance, which will be tested using quantitative analysis, as recommended by Guba & Lincoln(1994). This approach allows for the examination of cause-and-effect relationships and the generalization of findings, which aligns with the study's objective to provide practical, evidence-based insights for improving project management in the construction industry.

The specific methods and tools employed in this positivist approach—including the development of measurement instruments, data collection procedures, and statistical analysis techniques—will be discussed in the following sections. These methods have been carefully selected to ensure consistency with the positivist paradigm and to effectively address the research questions.

3.3 Research Design

In simple terms, the term "research" pertains to the advancement of new knowledge. Scientific research, on the other hand, involves a systematic, controlled, rigorous, empirical, and critical investigation of hypothetical

propositions to uncover solutions or unveil and explain new knowledge (Creswell, 2013).

In the context of this study, research design encompasses the plan for data collection, measurement, and analysis devised to address the research questions posed (Sekaran & Bougie, 2016). The present study aims to explore the relationship between project manager leadership competencies and project team performance in the construction industry. Additionally, it investigates the intermediary role of team learning, team monitoring, and team climate—three stages of team processes—between project manager leadership competencies and project team performance in the construction industry. This research entails the prediction, description, and validation of factors associated with project manager competencies, team processes, and team performance. Therefore, quantitative research appears to be an appropriate method to accomplish the research objectives.

This research plan adhered to the steps outlined in Figure, which presents the research flowchart for this study. The steps include a literature review, research design, data collection, quantitative data analysis, and research report.

The central purpose of this study is twofold. Firstly, it aims to provide empirical evidence to clarify the relationship between the independent variable of construction project manager leadership competencies and the dependent variable of team performance. Secondly, it examines the relationship between

the independent variable and the dependent variables of team learning, team monitoring, and team climate. Additionally, it investigates the mediating role of leadership competencies to explore the mechanism of the team process. This study is grounded in the theoretical framework of social information processing theory. It formulates hypothesis tests to examine the causal relationships among independent variables, dependent variables, and mediator variables using empirical evidence.

To gather the necessary data and information, the survey method is employed. In the survey method, individuals respond to specific questions about their behavior, attitudes, beliefs, or emotions. This method offers several advantages, as it is a simple and effective way to collect information from a large number of individuals. It provides flexibility to study various phenomena, including people's behavior, attitudes, beliefs, and emotions. The research questions can be tailored, and multiple formats and response options are available. Researchers can choose from different administration methods based on available resources, study type, and study population. Standardized closed-ended questions are used to facilitate quantifiable responses. Given the characteristics of the construction industry, such as a large workforce, widespread geographical distribution, and diverse project types, the survey method is particularly suitable for this study.

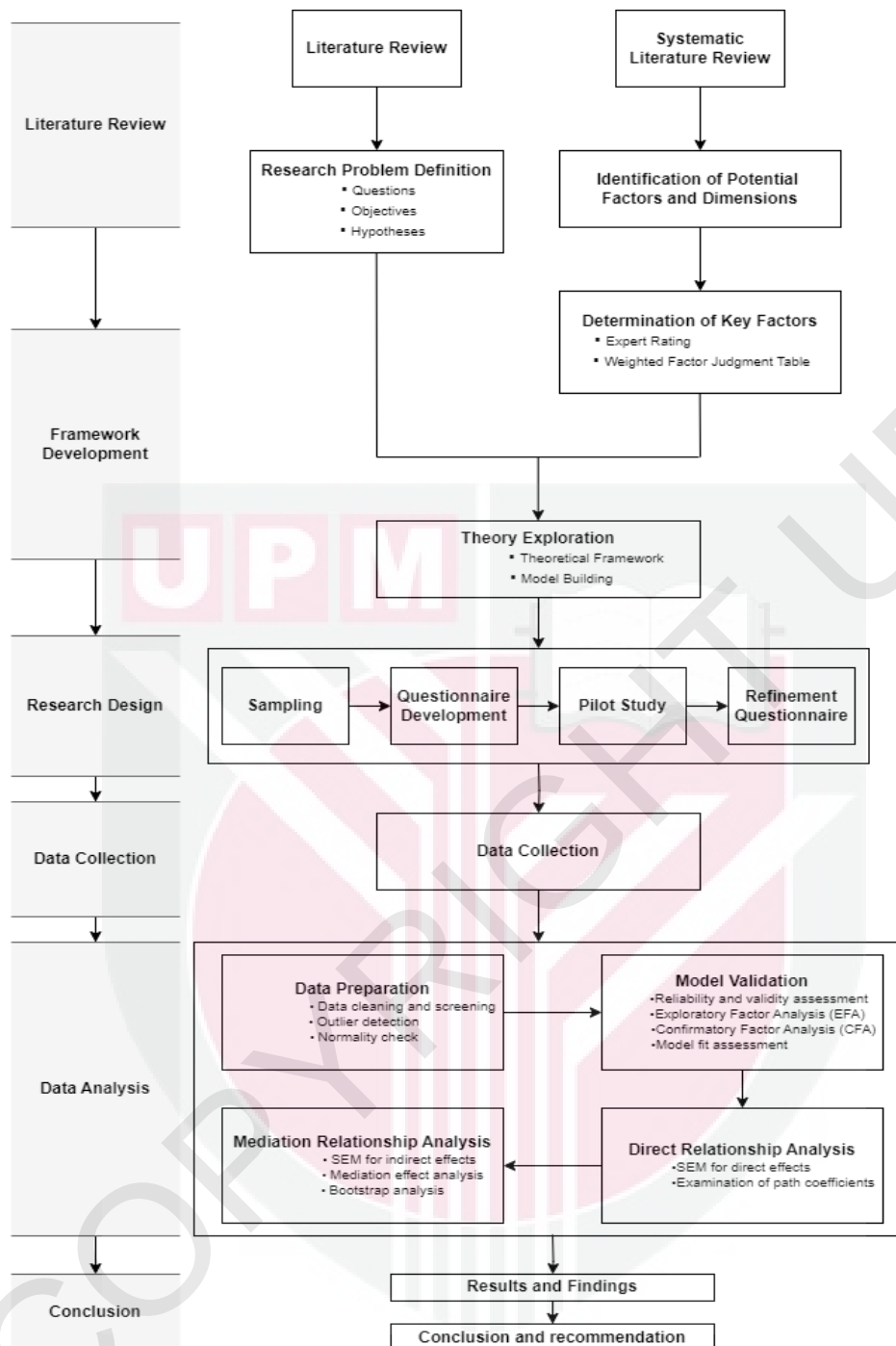


Figure 3.1: Research Process Flow Chart

3.4 Research Framework and Hypotheses Development

This section outlines the theoretical framework of the study and presents the hypotheses to be tested.

3.4.1 Development of Evaluation Criteria for Project Manager Leadership Competencies

This subsection describes the process of creating a comprehensive set of criteria to assess project manager leadership competencies.

3.4.1.1 Identification of Evaluation Dimensions

In this study, the iceberg competency model serves as the theoretical foundation for developing a leadership competency framework specifically for construction project managers. The choice of the iceberg competency model is justified by its comprehensive coverage of both visible and hidden aspects of competencies, aligning well with the complex and multifaceted nature of construction project management (Spencer & Spencer, 2008). This model offers a holistic framework that encompasses the diverse range of skills required in the construction industry, from technical expertise to interpersonal abilities and underlying personal attributes. Its widespread recognition and application across various fields of management and leadership studies provide a robust theoretical basis for our research (McClelland, 1973; McClelland & Boyatzis, 1982).

The iceberg model categorizes individual competencies into two segments: the observable "above the waterline" components and the concealed "below the waterline" components. The visible segment consists of core knowledge and skills, while the hidden segment includes social roles, self-image, personality traits, and motivations (Hsieh et al., 2012). This dual focus on

observable skills and underlying traits enables a more nuanced evaluation of leadership capabilities in the context of construction project management.

The literature review in Chapter 2 classifies the leadership competencies of construction project managers into three dimensions: task-related, people-related, and self-related competencies. This classification corresponds well with the structure of the iceberg model. The self-related dimension aligns with the "below the waterline" section of the iceberg model, while the task-related and people-related dimensions correspond to the "above the waterline" section. Task-related competencies encompass a leader's ability to manage and execute work tasks, such as goal setting, strategic planning, and resource management. People-related competencies reflect a leader's capacity to foster relationships and team dynamics through effective communication, teamwork, conflict resolution, and team development. Self-related competencies assess a leader's self-regulation skills, reflecting values like fairness, integrity, and resilience to stress.

In this study, the iceberg competency model forms the theoretical foundation for developing a leadership competency model specifically for construction project managers. The iceberg model categorizes individual competencies into two segments: the observable 'above the waterline' and the concealed 'below the waterline' components. The visible segment comprises core knowledge and skills, while the hidden segment encompasses social roles, self-image, personality traits, and motivations (Hsieh et al., 2012). Chapter 2's literature review classifies the leadership competencies of construction project

managers into three dimensions: Task-related, People-related, and Self-related competencies. The Self-related dimension aligns with the iceberg model's 'below the waterline' section, whereas the Task-related and People-related dimensions correspond to the 'above the waterline' part. Task-related competencies involve a leader's proficiency in managing and executing work tasks, including goal setting, strategic planning, and resource management. People-related competencies highlight a leader's ability in building relationships and team dynamics through effective communication, teamwork, conflict resolution, and team development. Self-management competencies assess a leader's self-regulation skills, reflecting values, fairness, integrity, and resilience to stress.

3.4.1.2 Selection and Determination of Competency Factors

3.4.1.2.3 Questionnaire Design and Data Collection

The preceding section identified the dimensions of leadership competencies for construction project managers and established competency element libraries for each dimension, as detailed in Chapter 2's systematic review. This section focuses on selecting pertinent competency elements from these libraries. A survey was conducted to enable an expert panel to identify relevant competency elements. The questionnaire was distributed in person to six senior experts from China's construction industry, with the researcher present to explain the content and scoring principles. These experts could ask questions and seek clarification from the researcher during the survey process.

The expert panel consisted of five senior managers and one government official in construction project management, all of whom had experience managing project managers in the Chinese construction industry. Their academic qualifications include two master's degrees and four bachelor's degrees. These experts were selected based on their extensive experience in the field and their senior positions in construction management.

The questionnaire, which is detailed in the Appendix, was designed to evaluate competency elements across three dimensions: Task-Related, People-Related, and Self-Related. Prior to scoring, the researcher provided clear explanations of these dimensions and the factors within each, ensuring that the experts had a comprehensive understanding of the survey's structure and content. This approach helped ensure that the respondents had a clear understanding of the questions being asked and that their feedback was reliable and reflective of their true opinions and knowledge.

The statistical analysis in Chapter 4 reveals a consensus among the expert panel regarding element selection. Adhering to the "majority rule," elements chosen more than three times were considered confirmed for the leadership competency framework. The anonymity of the responses was maintained to encourage honest and unbiased feedback.

3.4.1.2.4 Establishing Weights and the Model

Subsequent to the expert survey, the competency elements for the leadership model were established. The study employed a cost-effective and efficient weighting factor judgment table method to assign weights to these elements. The same six experts formed a panel to evaluate and score the elements through face-to-face scoring. Detailed in Chapter 4, this scoring process led to the weighted ranking of the competency elements. The finalized leadership competencies model for construction project managers emerged from this analysis, laying the groundwork for a subsequent quantitative research framework.

3.4.2 Research Framework and Hypotheses

Following the establishment of a leadership competency model for construction project managers via qualitative research, this study proceeds to develop the theoretical framework and quantitative model. This development is anchored in the previously established leadership competencies model. Meanwhile, in order to establish a comprehensive theoretical foundation and validate the proposed concepts of project manager leadership competencies, team learning, team monitoring, team climate, and project team performance, it is necessary to synthesize previous research findings from relevant literature both domestically and internationally. This section aims to delve into the process mechanisms and effect mechanisms of project manager leadership competencies, present theoretical hypotheses regarding the impact of project manager leadership competencies on project team performance, and

construct a model that encompasses two paths—direct impact and indirect impact—between the project manager's leadership competencies and project team performance. By integrating these elements, a coherent and comprehensive model of the hypothesis-action relationship can be obtained.

In leadership research, the independent variable typically comprises various types of leadership behaviors, while the dependent variable commonly entails measuring the impact on leadership, including team performance or subordinate satisfaction (Hughes, 1993). The framework of this study was developed based on relationships identified through a comprehensive literature review, which revealed that different authors have employed diverse methods to study similar sets of variables, and vice versa. The primary objective of the model is to investigate the influence of construction project manager leadership competencies on project team performance. Additionally, the framework proposes the mediating effects of team learning, team monitoring, and team climate on the relationship between project manager leadership competencies and project team performance.

Drawing upon social information processing theory, this study integrates the leadership competencies model proposed by Vaculik et al. (2014) and the taxonomy of team processes by Marks et al. (2001), combining various models to support the research framework. The specific model presented in this study incorporates some modifications compared to the model based on literature support. Notably, new mediator variables, namely team learning and team climate, have been included in the framework.

Based on the preceding analysis, this study proposes the following hypotheses:

Hypothesis 1 (H1): Project manager leadership competencies significantly influence project team performance.

Leadership competencies are expected to directly impact team performance through effective guidance, strategic decision-making, and the creation of a conducive work environment. Project managers with strong leadership skills can optimize resource allocation, foster team cohesion, and align team efforts with project goals, thereby enhancing overall performance. To examine this relationship, three dimensions of leadership competencies are considered:

H1a: Task-related competencies of project managers positively influence project team performance.

H1b: People-related competencies of project managers positively influence project team performance.

H1c: Self-related competencies of project managers positively influence project team performance.

Hypothesis 2 (H2): Project manager leadership competencies significantly influence team processes.

Leadership competencies are likely to shape how teams operate and interact, affecting key processes such as communication, collaboration, and problem-solving. Effective leaders facilitate smoother team operations, promote

knowledge sharing, and create an environment conducive to productive team dynamics. The following sub-hypotheses are proposed:

H2a: Task-related competencies of project managers positively influence team processes.

H2b: People-related competencies of project managers positively influence team processes.

H2c: Self-related competencies of project managers positively influence team processes.

Hypothesis 3 (H3): Team processes mediate the relationship between project manager leadership competencies and project team performance.

Leadership competencies may indirectly influence team performance by shaping team processes, which in turn impact performance. This mediating effect suggests that leaders influence team interactions and work methods, which ultimately affect team outcomes. To explore this mediating role, the study focuses on three key aspects of team processes:

H3a: Team learning mediates the relationship between project manager leadership competencies and project team performance.

H3b: Team monitoring mediates the relationship between project manager leadership competencies and project team performance.

H3c: Team climate mediates the relationship between project manager leadership competencies and project team performance.

Figure illustrates these hypotheses and the relationships among the research variables.

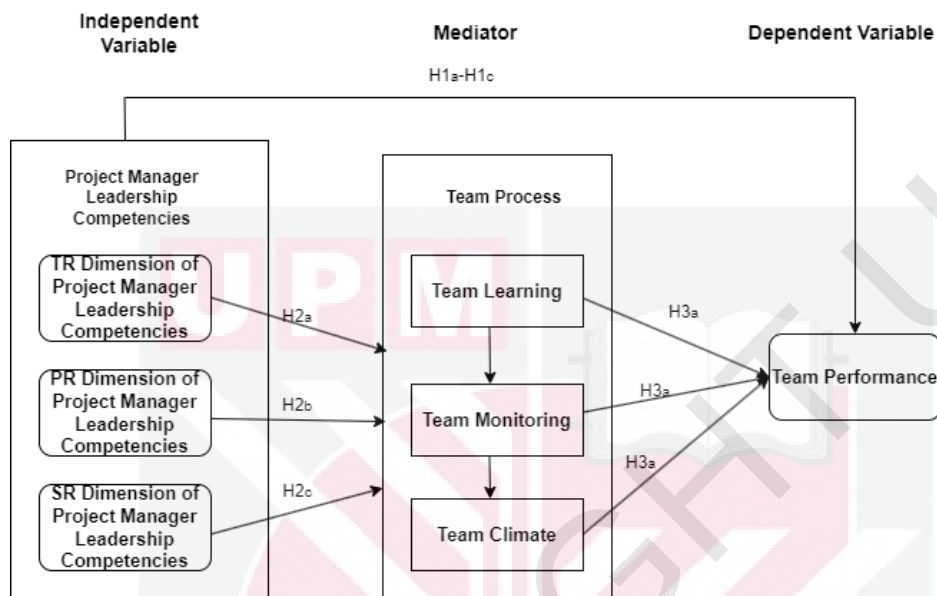


Figure 3.1: Research Framework and Hypothesis of The Study

3.5 Sampling

Sampling is a critical component of research in various fields, including social sciences and natural/physical sciences. The quality of the sample used in a study greatly influences the credibility of the researcher's conclusions. Experimental design and surveys are valuable tools for data collection and analysis to address research questions, but they can be counterproductive if the target population is not properly defined. In other words, conducting research without gathering data from relevant individuals, events, or objects that can provide accurate answers to research problems is futile. This section provides insights on determining the study population and sample, which is

divided into three parts: defining the population, selecting the sampling design, and determining an appropriate sample size.

3.5.1 Population

A population refers to the complete set of cases that can be considered in a study, while a target population specifically represents the group from which a researcher gathers information for making inferences (Matthews & Ross, 2010). Sampling, on the other hand, involves the selection of a sufficient number of elements from the population (Sekaran & Bougie, 2016).

The objective of this study is to investigate the correlation between project manager leadership competencies and project team performance within the construction industry. Additionally, it examines the mediating role of team learning, team monitoring, and team climate (which represent the three stages of the team process) between project manager leadership competencies and project team performance in the construction industry.

Considering the definitions of population and the research objectives, the survey participants consist of front-line project managers working in construction projects, including project engineers, professional supervisors, professionals from various departments, and other members of the project team. Selecting project team members as the survey subjects is justified by their direct involvement in engineering projects, which allows for authentic evaluation of the project manager's leadership competencies. Moreover,

project team members have firsthand experience with the team process and performance outcomes, enabling them to provide practical and effective assessments of team learning, team monitoring, team climate, and project team performance.

According to the International Labor Organization, the construction industry employs over 100 million individuals worldwide. Consequently, accurately estimating the number of front-line project management personnel in construction projects is challenging. Taking China as an example, as of February 2020, there were approximately 1.7 million registered second-level construction engineers nationwide. Hence, the target population for this study is substantial.

This study focuses specifically on project team members within the Chinese construction industry, providing a clear and targeted research scope. This focused approach allows for a more in-depth analysis of the unique characteristics and dynamics present in this sector, ensuring research quality and relevance. The total number of target group members is approximately 1.7 million.

3.5.2 Sample Design

The sampling design is the second step in the sampling process for this study. It involves two primary types: probability sampling and non-probability sampling. In probability sampling, elements within the population have a

known, non-zero chance of being selected as sample subjects. Probability sampling designs are preferred when sample representativeness is crucial for broader generalizability. On the other hand, non-probability sampling does not assign predetermined probabilities to elements, and it is commonly used when time or other constraints are significant factors (Sekaran & Bougie, 2016).

This study examines the impact of project manager's leadership competencies on the project team, focusing on the construction project context in China. Due to the limited cooperation between construction companies and academia, the selected respondents often lack motivation to participate in research surveys (Zhang et al., 2018). Consequently, random sampling may result in a low response rate, compromising the reliability and validity of the findings. Furthermore, conducting large-scale random sampling directly is impractical due to the large population size and resource constraints.

Therefore, non-probability sampling is selected as a more feasible approach for this study. Non-probability sampling is widely utilized in project management research within the construction industry (Li et al., 2005; Low Sui Pheng & Yuquan, 2002; Wu et al., 2015). Since this study targets construction industry practitioners in China with project experience and does not impose any specific restrictions, a convenience sample will be employed. This approach enhances efficiency, improves questionnaire response rates and effectiveness, and yields meaningful results within the context of the Chinese construction industry.

3.5.3 Sample Size

After selecting the sampling method, the subsequent step involves determining the appropriate sample size. The sample size denotes the number of elements or sets of elements to be included in the study (Sekaran & Bougie, 2016). The choice of sample size significantly impacts the accuracy of research outcomes. A sample size that is too small can impede the detection of effects related to the phenomenon under investigation, leading to insignificant findings, whereas an excessively large sample may hinder the identification of weak relationships reaching the significance level. Thus, an optimal sample size is essential for the research project. In this study, various commonly used methods for estimating sample size were carefully considered when determining the required sample size (Sekaran & Bougie, 2016).

According to the (Krejcie & Morgan, 1970) table used to determine the sample size, as presented in Table below, a population of more than 100,000 requires a sample size of 384 to represent the population with 95% confidence level. Considering the statistics from the Chinese government, it is estimated that there will be 1.7 million individuals holding second-level construction engineer positions and registered in construction enterprises by 2023 (Ministry of Housing and Urban-Rural Development of the People's Republic of China, 2023). Given the substantial number of project management team members, it is evident that the population exceeds 100,000. Therefore, based on this sampling calculation method, this study requires a sample size of 384-500 employees.

Table 3.1: Krejcie and Morgan Table for Determining Sample Size

N	S	N	S	N	S
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	175	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	100000	384

(Source: Krejcie & Morgan, 1970)

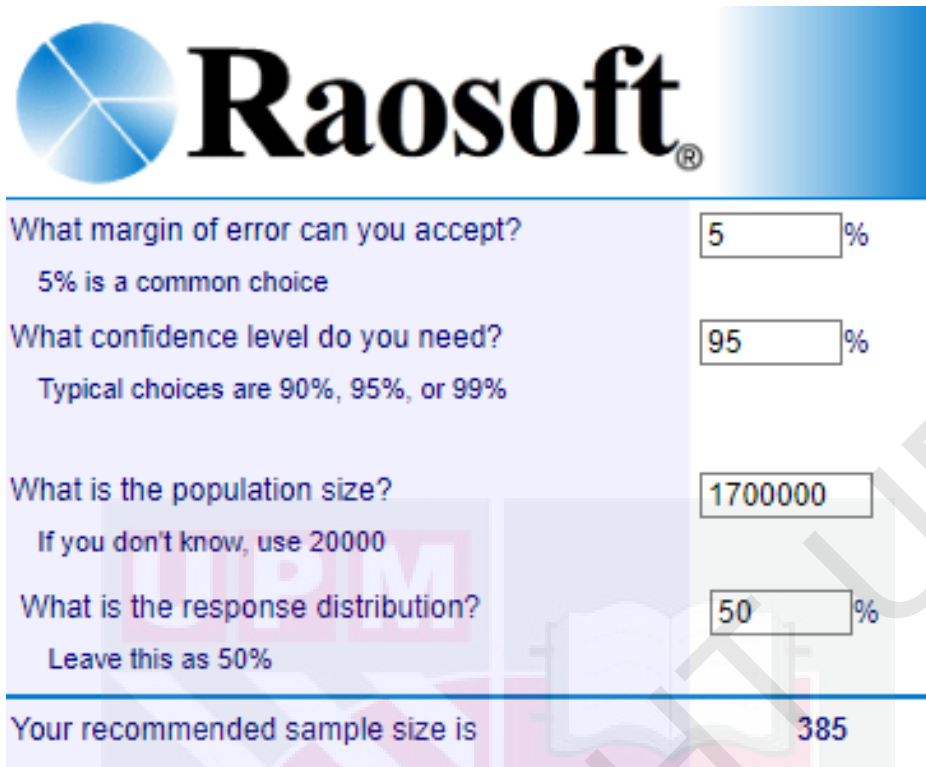
The data analysis in this study utilized SEM-AMOS. Structural Equation Modeling (SEM) encompasses two complementary schools of thought: a) covariance-based SEM, which requires large sample sizes for model validation due to its instability with small samples; b) component-based SEM, primarily used for fractional calculations and can be conducted with minimal sample size

(Tenenhaus, 2008). Given the emphasis on model validation in this study, covariance-based SEM was preferred, necessitating a larger sample size.

In SEM analysis, the sample size is determined by two factors: the estimation technique and model complexity. For maximum likelihood estimation, a recommended minimum sample size of 100 to 150 is required to obtain stable results, with an optimal sample size of 150 to 400. In SEM-AMOS analysis, the total number of samples to variables should exceed 10 times (Hair, 2009). Since this study involves 7 variables, the minimum sample size should be above 100, following this principle. Additionally, there is an upper limit to the sample size, considering the large sample frame, which makes calculating a specific value impractical and an excessively large sample size may lead to Type II errors. Therefore, following Roscoe's (1975) suggestion, the upper limit of the sample size in this study is set at 500 samples.

Based on the above analysis, the most appropriate sample size for this study falls within the range of 384 to 500.

For further validation, two online sample size calculators were utilized to re-evaluate the required sample size. The first calculator employed was Raosoft, which is readily available online (Raosoft, 2023). It suggested a sample size of 384 for a population of 1.7 million, as depicted in Figure. The calculation considered several standards: a margin of error of 5% and a confidence level of 95%.



The image shows the Raosoft Sample Size Calculator interface. It features a blue header with the Raosoft logo. Below the header, there are four input fields with corresponding labels and suggestions. The first field is for the margin of error, set to 5%. The second field is for the confidence level, set to 95%. The third field is for the population size, set to 1700000. The fourth field is for the response distribution, set to 50%. At the bottom, a blue bar displays the recommended sample size as 385.

Input	Value
What margin of error can you accept?	5%
What confidence level do you need?	95%
What is the population size?	1700000
What is the response distribution?	50%
Your recommended sample size is	385

Figure 3.3: Results from Raosoft Sample Size Calculator

The second calculation software used was the "Prior Sample Size Calculator for Structural Equation Model," specifically designed to determine the sample size for SEM-AMOS (Soper, 2023). This online software requires the input of relevant criteria for the study. For this research, the expected effect size was set to 0.3, the expected statistical power level to 0.95, the number of latent variables to 7, the number of observed variables to 35, and the probability level to 0.05, as illustrated in Figure. The final recommended sample size from this calculator was 400.

Anticipated effect size:	0.3	?
Desired statistical power level:	0.95	?
Number of latent variables:	5	?
Number of observed variables:	35	?
Probability level:	0.05	?
Calculate!		
Minimum sample size to detect effect: 223		
Minimum sample size for model structure: 400		
Recommended minimum sample size: 400		

Figure 3.4: Results from priori Sample Size Calculator for Structural Equation Models

After a careful evaluation of various sample size calculation methods and results from both software tools, the sample size for this study has been determined to be 400-500. This number of samples appears to be appropriate for the study's objectives as it satisfies all the aforementioned requirements.

3.6 Research Instrument Development

Instruments are the tools researchers use to gather information and data (Rahi, 2017). Various data collection methods include tests, questionnaires, interviews, classroom observations, and diaries. Qualitative research typically relies on interviews, diaries, and classroom observations, while quantitative research commonly employs open-ended and closed-ended questionnaires for data collection, analysis, and interpretation (Creswell & Creswell, 2017).

Following a quantitative approach, this study used a survey questionnaire as its primary research instrument. The questionnaire method offers several advantages, including broad coverage, speed, cost-effectiveness, objectivity, and flexibility in data collection. It is widely used in management and project management research. Since data on project managers' leadership competencies, team monitoring, team climate, and project team performance were not available in publicly accessible databases, the questionnaire survey method was adopted to collect empirical data, ensuring the survey's content was both authentic and reliable.

A survey's foundation lies in its questionnaire, and the study's results largely depend on the quality of the questions (Krosnick, 2018). To reduce response errors, questionnaires should be designed following best practices. Sekaran & Bougie (2016) highlight three key design principles: careful wording of questions, consideration of how variables will be categorized, scaled, and coded upon receiving responses, and the overall appearance of the questionnaire.

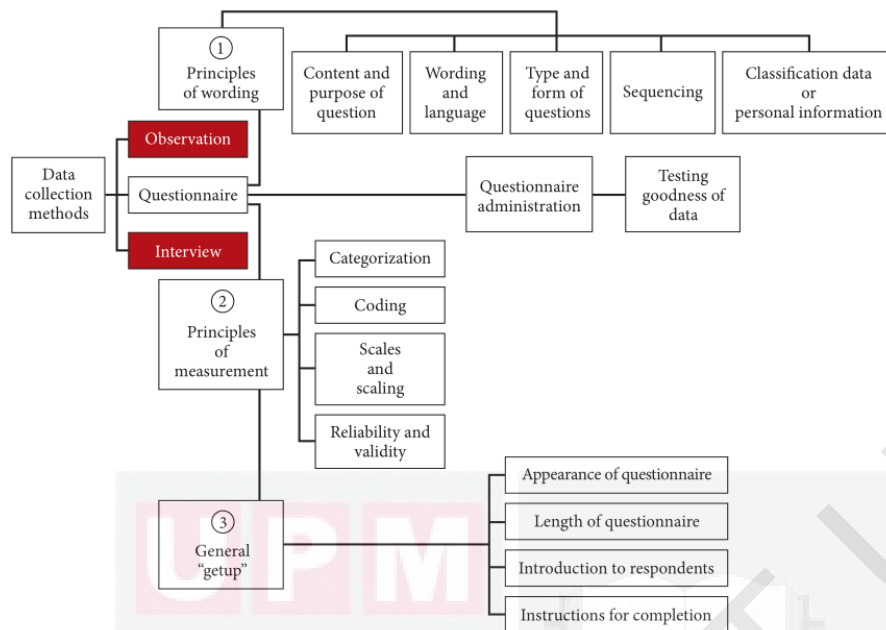


Figure 3.5: Principle of Questionnaire Design

Based on the three principles mentioned above, this study devised the following steps while consulting a significant number of literatures on questionnaire development and design. The initial step involves determining the measurement items based on published literature, followed by the second step of establishing the scale through discussions with an expert group. The third step entails conducting a pilot study, and finally, the questionnaire is revised based on the pilot study's results to create the formal version.

To begin, after identifying the research variables, relevant measurement scales that have been well-established and extensively applied in existing literature were sought. For variables with multiple sets of established scales, they were carefully screened in accordance with the research content of this study. For scales that had not been utilized in the context of construction project management, the expressions in the questionnaire design were revised

through discussions with frontline experts in the field of construction projects. This step aimed to ensure that the questionnaire's wording was more suitable for investigating construction projects, enhancing the questionnaire's professionalism, and ultimately improving the quality of responses. Following the completion of the second step, an initial questionnaire was formed.

Before distributing the formal questionnaire, a pilot study was carried out to assess the consistency of the questions and respondents' comprehension of the questionnaire. Based on the results of the pilot study, the questionnaire was refined and the final version was produced.

The scale utilized in this study is a compilation of scales obtained from an extensive review of previous literature. The questionnaire is structured into four sections. The first part serves as an introduction, briefly describing the study's purpose, with a particular focus on ensuring participant privacy. The second part aims to gather the demographic profile of the respondents, primarily focusing on aspects such as age, education level, work experience, and information about their current employer. The third part collects basic information about the projects the respondents are involved in, including project type, scale, and their positions within the project. Finally, the fourth part encompasses the measurement scales for the research variables, including the project managers' leadership competencies, team learning, team monitoring, team climate, and project team performance.

In measuring the variables, a five-point Likert scale is used. The number of response categories in Likert scales has been debated. While some researchers, like Dillman et al. (2014), suggest using four to five categories, others, like Fink (1995), recommend five to seven categories. However, the 7-point scale is associated with longer response times and may lead to respondent resistance, impatience, and potential data distortion. On the other hand, the 5-point scale provides a balance between reliability, discrimination, and accurate measurement of variables, reducing errors. Thus, this study adopts the Likert 5-point scale, where 1 represents "strongly disagree" and 5 represents "strongly agree."

3.6.1 Independent Variable

Leadership competencies measurement in project management frequently uses the LDQ scale developed by Dulewicz and Higgs (2005) as the preferred instrument (Ralf Müller & Turner, 2010; Tabassi et al., 2016). The LDQ scale consists of three dimensions: intellectual competencies, emotional competencies, and managerial competencies. However, the extensive original LDQ questionnaire (with 189 statements) was deemed impractical for this particular study. Furthermore, Henley Management College owns this tool, limiting its use. In general, research on measuring team leaders' leadership competencies remains limited. Apart from the aforementioned LDQ tools, Ahmed (2017) also performed empirical research, categorizing project managers' leadership competencies into five dimensions: defining roles and responsibilities, communicating expectations, adopting consistent processes,

communicating clearly, and building trust. Ahmed used 23 items to assess project managers' leadership skills via self-reported questionnaires. Other empirical research concentrates on one of the three LDQ dimensions. Wong & Law (2017) developed the context-specific WLEIS scale for China, comprising four dimensions: self-emotional appraisal, others' emotional appraisal, emotional utilization, and emotional regulation. Each dimension has 4 items, totaling 16 items overall. The scale demonstrates high reliability and validity (Wong et al., 2004) and widespread use in management research. Yeo (2006) developed a 27-item competency scale grounded in existing theory for his doctoral dissertation.

As discussed in Chapter 2, this study categorizes project managers' leadership competencies into three dimensions: task-related (TR), people-related (PR), and self-related (SR). In the study by Vaculik (2014), 14 total items across three dimensions were established to assess project managers' leadership competencies, such as "He/She was an example of diligence for others." and "He/She insisted that we finish the work we started." Lee et al. (2013) categorized leadership competencies into three dimensions: emotional intelligence competencies, cognitive intelligence competencies, and social intelligence competencies, with 5, 5, and 6 items, respectively, to measure each. This scale has been applied in the Asian context and demonstrates higher reliability and validity.

To address the issue of project selection, this study applies validated measures from the project manager competencies research reviewed in

Chapter 2. Additionally, the selection of measurement items in each dimension has been adapted to reflect the specific context and characteristics of construction project management. Building on the work of previous scholars, this study acknowledges the unique aspects of construction projects and specifies 20 items to assess project managers' leadership competencies. These include 7 items for task-related competencies, 7 for people-related competencies, and 6 for self-related competencies.

The items within each competency category (task-related, people-related, and self-related) are differentiated based on specific aspects of leadership skills and behaviors relevant to construction project management. For instance, in the task-related category, TR1 might focus on technical knowledge, while TR6 could emphasize problem-solving skills. Similarly, in the self-related category, SR3 might address self-awareness, while SR5 could focus on emotional intelligence. Each item is designed to measure a distinct aspect of the overall competency category, ensuring a comprehensive assessment of project managers' leadership abilities. Table 3.2 presents the dimensions, codings, items, and sources of measurement for project manager's leadership competencies, detailing these distinctions.

Table 3.2 outlines the dimensions, codes, items, and sources of measurement for project manager leadership competencies.

Table 3.2: Dimensions, Codings, Items and Sources of Measurement for Project Manager's Leadership Competencies

Dimensions	Coding	Items	Sources
Task-related Competencies (TR)	TR1	The project manager can effectively identify, analyze, and control risk factors.	(Vaculik, 2014; Lee et al., 2013; Dulewicz & Higgs, 2005; Wong & Law, 2017; Yeo, 2006)
	TR2	The project manager can effectively prevent and handle work conflicts and interpersonal conflicts.	
	TR3	The project manager is able to organize team members and coordinate various tasks.	
	TR4	The project manager possesses strong organizational and coordination abilities.	
	TR5	The project manager rewards individuals with outstanding job performance.	
	TR6	The project manager emphasizes the connection between goal achievement and rewards.	
	TR7	The project manager is able to foresee risks.	

Table 3.2: Continued

People-related Competencies (PR)	PR1	The project manager cares about team members and provides support and assistance for their work and personal difficulties.
	PR2	The project manager frequently appreciates team members who work hard and achieve exceptional results.
	PR3	The project manager supports team members' skill improvement and career development.
	PR4	The project manager believes that team members can handle complex tasks.
	PR5	The project manager actively seeks input and suggestions from subordinates when making decisions.
	PR6	The project manager allows us to complete tasks in our own way.
	PR7	The project manager holds high expectations when communicating with team members.

Table 3.2: Continued

Self-related Competencies (SR)	SR1	The project manager sets a disciplined example through their own actions.
	SR2	The project manager is highly responsible and willing to take on responsibilities.
	SR3	The project manager is sincere and values integrity.
	SR4	The project manager demonstrates self-control and restraint.
	SR5	The project manager is positive and optimistic, willing to face challenges.
	SR6	In complex situations, the project manager makes clear decisions using rationality and intuition.

3.6.2 Mediator Variable

Team learning in this study refers to the processes of learning by team members, which include information acquisition, information processing, and information storage and retrieval (Offenbeek, 2001; Woerkom & Croon, 2009). The measurement of team learning behavior utilizes the scale developed by Edmondson (1999), which has been widely used and proven successful in subsequent studies (Hirst et al., 2009). The scale consists of 7 items, such as "We regularly take time to figure out ways to improve our team" and "Team members go out and get all the information they possibly can from others—such as customers, or other." In the project management field, Savelsbergh et al. (2015) categorized the learning behavior of engineering project teams into 8 dimensions and a total of 28 measurement items, including "team members elaborate on the information and ideas they have with each other," which has a measurement validity as high as 0.94. From a knowledge learning perspective, Zhang & Ng (2012) designed a set of knowledge sharing behavior scales containing 4 measurement items, such as "I often share my technical skills with colleagues" and so on.

Edmondson (1999) conceptualized learning as a continuous process of reflection and action, involving asking questions, seeking feedback, experimenting, and reflecting on results. Drawing from the dimension division of Savelsbergh et al. (2015), the team learning process is summarized as problem discovery, communication, feedback, action, and innovation. By integrating the items from the three scales mentioned above, the team learning

scale used in this study was finally formed. The items are coded as TL1, TL2, etc., with each item representing a specific aspect of team learning behavior. Table 3.3 presents the codings, items, and sources of measurement for team learning.

Table 3.3: Codings, Items and Sources of Measurement for Team Learning

Mediator Variable	Coding	Items	Sources
Team Learning (TL)	TL1	Team members actively strive to identify new challenges in their work.	(Edmondson, 1999; Savelsbergh et al., 2015; Zhang & Ng, 2012)
	TL2	Team members openly engage in communication and discussion about relevant issues.	
	TL3	Team members frequently engage in discussions on enhancing teamwork.	
	TL4	Team members regularly consolidate their experiences and lessons learned.	
	TL5	Team members proactively experiment with novel ideas and solutions in their work.	

The mediating role of team monitoring between team learning goal orientation and team performance is crucial in understanding team dynamics. Team monitoring involves real-time supervision and inspection among team members during collaborative tasks, representing a fundamental team action process. A high level of team monitoring signifies the team's strong

commitment to achieving each member's goals and closely monitoring whether tasks are being performed as intended (Marks et al., 2001). Existing research has revealed a significant positive relationship between team monitoring and team performance (Marks & Panzer, 2004).

In the realm of existing research, there is a limited number of measuring instruments for team monitoring. One of the scales, developed by Jong & Elfring (2010), assesses team processes, including team reflection, team monitoring, and team effort, with 5 items in each dimension. Additionally, Pitariu (2007), in his master's thesis, divided team monitoring into Reactive monitoring and Proactive monitoring, creating 20 items for each dimension. For this study, the scale formation of Jong & Elfring (2010) is predominantly referred to. The items are coded as TM1, TM2, etc., with each item representing a specific aspect of team monitoring behavior. Table presents the codings, items, and sources of measurement for team monitoring.

Table 3.4: Codings, Items and Sources of Measurement for Team Monitoring

Mediator Variable	Coding	Items	Sources
Team Monitoring (TM)	TM1	In this team we check whether everyone meets their obligations to the team.	(De Jong & Elfring, 2010)
	TM2	In this team we watch whether everyone completes their work on time.	
	TM3	In this team we keep close track of whether everyone performs as expected.	
	TM4	In this team we check whether everyone is doing what is expected of him/her.	
	TM5	In this team we carefully monitor each other's progress on his/her work.	

The concept of organizational climate refers to the way each member perceives the environment within a specific organizational context. It plays a crucial role in influencing the motivation, attitudes, values, and beliefs of organizational members (Litwin, 1968). Teams, being a unique form of organization with shared tasks and goals, foster closer and more frequent communication and interaction among members. Consequently, it becomes easier for teams to develop a shared psychological perception of the environment. As a result, the impact of team atmosphere research holds greater concreteness and relevance (Anderson & West, 1998).

This study primarily focuses on the team process, examining how certain factors impact team dynamics. The sense of trust established within a team significantly influences the interaction among its members. Moreover, teams with a high degree of openness allow members to freely express their opinions.

Studies by Schweiger et al. (1989) have shown that techniques that tolerate disagreement and encourage open and honest discussion can induce task conflict. Additionally, research by Eisenhardt & Bourgeois (1988) has indicated that teams that foster open expression experience less mutual attack and covert political behavior compared to average teams. In light of this, the team climate in this study is measured using three dimensions: team trust (based on Rauniar (2005)'s scale), team openness, and team identification (both based on Anderson (1998)'s scale). Two items were developed for each dimension, resulting in a total of six items to assess the team atmosphere. The items are coded as TC1, TC2, etc., with each item representing a specific aspect of team climate. Table presents the codings, items, and sources of measurement for team climate.

Table 3.5: Codings, Items and Sources of Measurement for Team Climate

Mediator Variable	Coding	Items	Sources
Team Climate (TC)	TC1	Team members trust each other mutually.	(Rauniar, 2005; Anderson & West, 1998)
	TC2	Team members are willing to share sensitive information with each other.	
	TC3	Team members believe in each other's trustworthiness.	
	TC4	Team members are able to engage in (constructive) arguments when they have different opinions.	
	TC5	Different opinions among team members are taken seriously.	
	TC6	Team members have a strong sense of belonging to the team.	
	TC7	Team members perceive the team's difficulties as their own.	
	TC8	Team members feel like a part of the team family.	

3.6.3 Dependent Variable

Project performance involves the evaluation of engineering projects from the perspective of the construction party. Its primary purpose is to compare the actual project performance with predetermined goals and assess whether the project has successfully achieved its construction objectives, particularly focusing on aspects such as "progress-quality-cost."

On the other hand, team performance refers to the array of organizational activities and outputs undertaken by the project team to realize their goals within a specific project cycle. Therefore, the evaluation object for project team performance should naturally be the project team itself. The field of research on team performance measurement scales has significantly matured over time. In this study, the team performance measurement scales developed by Liu & Cross (2016) serve as a key reference. Their scale identifies three primary dimensions that reflect project team performance: team effectiveness, team efficiency, and team innovation, with each dimension appropriately measured.

For this research, the Efficiency dimension from Liu and Cross's scale is adopted to assess team performance. This dimension allows for individual-level measurement and consists of six items in total. Team members evaluate their project team's performance based on the actual situation they have experienced. The team performance scale used in this study, integrated with the context of the construction project, is detailed in Table. The items are

coded as TP1, TP2, etc., with each item representing a specific aspect of team performance in the construction project context.

Table 3.6: Codings, Items and Sources of Measurement for Team Performance

Mediator Variable	Coding	Items	Sources
Team Performance (TP)	TP1	The project team can achieve task objectives on time.	(Liu & Cross, 2016)
	TP2	The project team can control costs reasonably.	
	TP3	Our project progress aligns with expectations.	
	TP4	The project team can complete work in a time-saving manner.	
	TP5	The work processes in my team are efficient.	
	TP6	Team members are satisfied with the team's work.	
	TP7	Team members are able to utilize their expertise and abilities in teamwork.	
	TP8	Team members can quickly and effectively learn new methods and apply them to tasks.	

3.6.4 Control Variable

Owing to practical challenges in implementing experimental and quasi-experimental designs, the use of control variables assumes a crucial role in organizational research (Bernerth & Aguinis, 2016). The objective of this study is to explore the mechanism of project manager leadership competencies and

team performance, thus considering potential influences of certain team characteristics on the study variables. Previous research on teams has indicated that project type, team size, and team duration could impact the main variables of this study (Lorinkova & Bartol, 2021; Ralf Müller & Turner, 2010). Similarly, in prior studies on team performance, project type, team size, and team duration have been commonly used as control variables (Lorinkova & Bartol, 2021; Siddiquei et al., 2022). Consequently, this study includes these team characteristics as control variables. Project category is categorized based on engineering category (Ralf Müller & Turner, 2010), team size is measured by the total number of employees in the team, and team duration is represented by the project's duration (Lai et al., 2018).

The novelty of this study lies in its comprehensive integration and validation of these established control variables within the context of the Chinese construction industry. By incorporating project category, team size (measured by the number of employees), and team duration, this research aims to offer a more comprehensive analysis of their effects in this unique setting. This approach not only builds on the existing body of knowledge in team research but also allows for the discovery of context-specific nuances in Chinese construction projects.

3.6.5 Instrument Translation

The survey instruments employed in this study are derived from English literature, which refers to academic publications and research instruments

originally written and developed in the English language. Given that the survey will be administered in China, meticulous preparatory efforts have been undertaken to ensure the survey's rigor and efficacy. To establish English-Chinese linguistic equivalence, the back-translation method was adopted. (Sekaran, 1983). Initially, the questionnaire's content was translated into Chinese by the research team. Subsequently, three engineering management academic lecturers from Binzhou University were engaged to collaboratively refine the Chinese version, aiming to mitigate cultural biases and enhance precision. Given that the questionnaires would reach frontline practitioners in construction projects, alignment with questionnaire wording principles necessitated adjustments to the initial measurement items to better suit respondents' working environment, comprehension, and expression capabilities. This was to ensure suitability to the construction project context, including idiomatic expressions. To validate the intelligibility, appropriateness, and sensitivity of these items, feedback was sought from four experienced construction industry managers. Following this, a PhD candidate in linguistics from Ocean University of China performed a reverse translation of the Chinese version back into English.

3.6.6 Pilot Study

To ensure the reliability and validity of the questionnaire, a comprehensive pilot study was conducted prior to the main survey. The pilot study involved 100 practitioners from the construction industry who were recruited online through Credamo, a professional Chinese online survey platform. Credamo serves as

an integrated research platform, encompassing questionnaire design, online respondent recruitment, remuneration distribution, data cleaning, and statistical modeling within a single platform. The data quality adheres to the standards upheld by leading international academic journals and has garnered acceptance within prominent international journals spanning psychology, management, environmental science, sociology, and related disciplines (Cui & Zhong, 2023; Y. He et al., 2023; Lei, 2023.).

After the translation and initial refinement process, the questionnaire was distributed to the 100 participants through Credamo. Strict screening criteria were implemented to ensure participants had relevant experience in the construction industry, and quality control measures were built into the questionnaire to detect inattentive responses. Upon completion of the questionnaire, participants received compensation through the Credamo platform.

Following data collection, a comprehensive statistical analysis was performed. Reliability analysis was conducted using Cronbach's alpha, with a threshold of 0.7 considered acceptable. Item-total correlations were also examined, with values below 0.5 flagged for potential removal (Hair et al., 2010). Validity was assessed through exploratory factor analysis, using principal component analysis with varimax rotation (Tabachnick et al., 2013).

The pilot study results indicated generally good reliability and validity for most scales. However, some problematic items were identified. In the Task-related

Competencies scale, items TR2, TR8, and TR11 were removed due to cross-loading or low factor loadings. Minor refinements were made to the wording of a few items to improve clarity based on these statistical results.

Following the statistical analysis, the revised questionnaire was submitted back to the expert panel for further review and refinement. This panel, consisting of the three engineering management academic lecturers and four experienced construction industry managers previously involved, provided additional feedback. Their insights led to further minor adjustments to item wording and the overall questionnaire structure to ensure optimal clarity and relevance to the construction project context.

This iterative and rigorous pilot testing process, combining meticulous translation procedures, statistical analysis, and multiple rounds of expert review, helped ensure the final questionnaire was not only reliable and valid from a statistical standpoint but also culturally appropriate and practically relevant to the target respondents in the construction industry. The refined questionnaire resulting from this comprehensive pilot study was then deemed fit for purpose in the main study.

3.6.7 Development of the Formal Questionnaire

Following the examination of reliability and validity within a small sample, the investigation identified that measurement items TR2, TR8, and TR11 from the Task-related Competencies scale did not meet the reliability criteria and were

subsequently removed. All other items were retained. Upon a meticulous review of the questionnaire, certain items were observed to exhibit non-fundamental issues pertaining to their expression or format. Consequently, refinements were made to enhance the clarity and quality of these items. Moreover, the questionnaire's introduction emphasized the significance of standardized completion in relation to compensation distribution. These collective efforts culminated in the creation of the formal questionnaire for this study. For the questionnaire's content, please refer to Appendix 2.

3.7 Data Collection Procedure

Data plays a pivotal role in research endeavors. Irrespective of variations in research methodologies, the cornerstone of every study lies in the utilization of high-quality data, subsequently subjected to analysis and interpretation to yield valuable insights. Amongst the various data collection methods prevalent in social science research, the questionnaire method stands as the most widely employed. The soundness of data collection processes holds the key to employing samples for inferring broader characteristics, ultimately serving the purposes of hypothesis testing and fortifying the scientific rigor of the research model. Consequently, meticulous attention must be directed towards the data collection process to ensure the authenticity and reliability of the research findings, thereby underpinning the establishment of scientifically sound research conclusions.

This study is primarily concerned with investigating the relationship between leadership competencies and the team performance of project managers within the construction industry. Survey participants were drawn from individuals possessing practical experience in project management within the construction sector.

The survey component of this research was conducted online, aligning with contemporary research practices (Evans & Mathur, 2018). Online surveys offer several distinct advantages, encompassing the ability to create, disseminate, collect, store responses, and visualize survey results efficiently. They streamline the questionnaire preparation process, data collection, storage, visualization, and collaborative work. Online surveys are characterized by their cost-effectiveness and the agility with which they can be executed (Nayak & Narayan, 2019). Nevertheless, they encounter challenges, including potential sample bias inherent in online user groups, such as individuals with higher education and income levels. Unclear survey instructions can also undermine response quality. Importantly, the absence of personal interaction, diminished intimacy, and concerns related to privacy and security tend to diminish trust in online surveys, contributing to low response rates. While strides have been made to enhance online survey methodologies, these challenges persist, warranting ongoing refinement. Enhancing response rates, improving sample representativeness, and instilling participant trust remain primary challenges associated with online surveys.

The research questionnaire was administered through the Chinese online survey platform, Credamo. Credamo serves as an integrated research platform, encompassing questionnaire design, online respondent recruitment, remuneration distribution, data cleaning, and statistical modeling within a single platform. The data quality adheres to the standards upheld by leading international academic journals and has garnered acceptance within prominent international journals spanning psychology, management, environmental science, sociology, and related disciplines (Cui & Zhong, 2023; He et al., 2023; Lei, 2023.).

Two principal methods were employed to disseminate the questionnaires in this study. The first involved recruiting subjects from the Credamo platform's sample repository. Stringent criteria were imposed to ensure sample quality, with a specific focus on the construction industry, restricting responses solely to those within this domain. Identity verification was enforced via the platform's credit score system, guaranteeing the veracity of subject information. Additionally, to enhance sample randomness, IP address restrictions were enforced, permitting only one response within a 5-square-kilometer radius. The second method entailed the distribution of questionnaires through an online vocational training institution specializing in the construction industry. This institution predominantly provides training programs for various professional qualifications within China's construction sector. Its student body comprises employees of construction firms and active participants in construction projects. Given the online nature of this institution, its student populace is geographically diverse, ensuring a degree of randomness.

To ensure data quality, the questionnaire featured screening questions. Researchers conducted rigorous background data checks, including scrutinizing demographic and information outliers, to rectify discrepancies.

In addition, to incentivize subject participation, each participant received a specified reward upon completing the questionnaire. The introductory section of the questionnaire underscored the direct correlation between the quality of information provided and the receipt of this incentive.

3.8 Data Analysis Procedures

To enhance the implementation of research templates, this study adopted a four-step data processing and analysis approach, each step building upon the previous to achieve four research objectives. Step 1 entailed qualitative analysis, while Steps 2-4 focused on quantitative analyses. This section outlines the data analysis procedure across these steps.

3.8.1 Step 1: Identification and Analysis of Key Leadership Competencies

This study began by identifying the dimensions of leadership competencies for construction project managers through a systematic literature review, establishing competency element libraries for each dimension, as detailed in Chapter 2. Subsequently, the research focused on selecting relevant competency elements from these libraries. To this end, a survey questionnaire was designed to enable an expert panel to identify relevant competency

elements. This questionnaire was completed anonymously, with details provided in the appendix.

For this qualitative study, six senior experts from the Chinese construction industry were selected, including five senior managers and one government official in construction project management. Their academic backgrounds included two master's degrees and four bachelor's degrees. The selection of these experts ensured that the research could obtain in-depth insights from different perspectives within the industry.

Statistical analysis in Chapter 4 showed that the expert panel reached a consensus on element selection. The study adopted a "majority rule" to determine the elements to be included in the final leadership competency framework. Specifically, elements chosen by more than half of the experts (i.e., at least four experts) were confirmed as relevant and important competency elements. This method ensured that the selected elements had wide recognition and applicability.

After completing the expert survey, an initial set of competency elements for the leadership model was established. To further refine this model and assign weights to each element, the study employed a cost-effective weighting factor judgment table method. The same six experts participated again, evaluating and scoring each element through face-to-face scoring. This scoring process is described in detail in Chapter 4, with experts scoring based on the importance and relevance of each element in actual project management.

After scoring, the research team conducted statistical analysis on the collected data. The average score for each competency element was calculated, determining the relative weight of each element. This process not only considered the frequency of element selection but also reflected experts' judgments on their importance. Through this method, the study derived a weighted ranking of competency elements, forming a comprehensive and hierarchical leadership competencies model.

This final leadership competencies model became an important foundation for subsequent research. It not only reflected the unique leadership needs of the Chinese construction industry but also provided a solid theoretical basis for subsequent quantitative research frameworks. The research team used this model to design a broader questionnaire survey to validate and further explore the impact of these competencies in a larger sample.

3.8.2 Step 2: Model Validation and Direct Effects Analysis

Once data collection and cleaning are completed, the subsequent critical phase involves data analysis to derive valuable insights. Statistical procedures serve the dual purpose of substantiating the validity of a theoretical model and quantifying the extent of influence exerted by various explanatory variables on the dependent variable. In this study, a combination of descriptive and inferential analyses was utilized. Firstly, statistical analysis plays a pivotal role in effectively conveying results within reports and fostering an intuitive comprehension of observed phenomena. Secondly, it serves to scrutinize the

extent to which the collected data aligns with theory-based responses to the research inquiries. Ultimately, the application of statistical techniques in data organization furnishes a rational foundation for formulating sound conclusions.

Data analysis entailed the utilization of SPSS statistical software, version 27, which facilitated data reading and the computation of statistical measures including frequency, mean, standard deviation, and measurement reliability based on the preliminary data. This process also involved conducting reliability and validity analyses, including Cronbach's alpha calculations, construct reliability (CR), average variance extracted (AVE), and various validity tests. Subsequently, the AMOS program, version 27, was employed for the specification, estimation, evaluation, and presentation of the model delineating the hypothesized relationships among variables. The theoretical model was developed based on the leadership competencies identified in the previous step. Consequently, confirmatory factor analysis (CFA) and structural equation modeling (SEM) through AMOS were employed to empirically test the hypotheses posited in this study, including the assessment of model fit and the examination of direct effects between variables through path coefficient analysis.

3.8.2.1 Descriptive Analysis

Descriptive statistics constitutes a fundamental statistical method employed for the succinct summarization, systematic organization, and comprehensive depiction of sample data. It accomplishes this by employing various statistical

indicators to elucidate the distribution, central tendency, and extent of variability within the sample data (Katz et al., 1982). These specific indices encompass extreme values, means, medians, standard deviations, among others. The paramount role and significance of descriptive statistics lie in its capacity to provide an intuitive portrayal of the inherent attributes of the sample, investigate the fundamental tendencies of variables, and furnish a foundational platform for subsequent statistical inference and analysis. In contrast to the broader scope of inferential statistics, which encompasses overall inference and hypothesis testing, descriptive statistics primarily concentrates on the meticulous examination and concise summarization of the sample data itself. Through the utilization of descriptive statistics, researchers can gain a clear comprehension of the sample's comprehensive characteristics and deliver data-driven support for quantitative research endeavors. Furthermore, descriptive findings can be visually conveyed, enhancing the intuitive grasp of statistical data. In essence, descriptive statistics serves as the cornerstone of quantitative research, marking the inaugural step in the realm of statistical analysis. Its significance is pivotal in distilling sample characteristics and patterns, as well as in assessing the representativeness of research outcomes. In this study, descriptive techniques are harnessed to delineate the attributes of the research sample, facilitating the synthesis of sample characteristics and patterns.

3.8.2.2 Common Method Bias Analysis

Researchers occasionally express concerns about the potential bias in survey results arising from the manner in which questions are formulated and posed. One aspect of this concern involves the notion that the sequencing of questions might induce covariance among closely grouped items (Joseph F Hair, 2009). Furthermore, researchers frequently grapple with the challenge of mitigating potential common method bias. Common method bias occurs when identical survey methods are employed during data collection for different variables, and the survey participants remain the same. Such a scenario can engender phenomena like the halo effect, introducing biases into the data, thereby jeopardizing the scientific rigor and objectivity of research findings. This study adopts the approach of soliciting self-reports from employees, which, by its nature, could potentially contribute to common method bias. Consequently, once the questionnaires have been collected, it becomes imperative to employ rigorous statistical methods for control. Presently, scholars widely recognize Harman's Single-Factor Test as a suitable tool for detecting common method bias. This method consolidates all study variables into a single exploratory factor, evaluating the unrotated factor's explanatory power while examining the explanatory capability of the first factor vis-à-vis total variation, along with the number of factors boasting eigenvalues exceeding 1. If the explanatory power of the first factor falls below the critical threshold of 40%, it signifies that common method bias is not significantly pervasive, thus permitting subsequent analyses. Conversely, if the cumulative explanatory power of the first factor surpasses the 40% threshold, it serves as

an indicator of the presence of common method bias necessitating further scrutiny.

3.8.2.3 Reliability Analysis

Reliability, in the context of measurement, pertains to its internal consistency and stability, serving to validate the accuracy of collected data. It signifies the extent to which an instrument or technique exhibits freedom from random errors and consistently yields identical results upon repeated use. In simpler terms, reliability underscores an instrument's capacity to generate consistent outcomes devoid of measurement errors (Joseph F Hair, 2009). Importantly, reliability also signifies the degree to which a measurement model effectively gauges the underlying construct. Schumacker (2004) suggests that the assessment of a reliability measurement model can be predicated upon specific criteria, as detailed in Table.

Table 3.7: Criteria for Reliability and Level of Acceptance

Internal Reliability	Description	Level of Acceptance
Internal Reliability	To ensure the study is free from random error	Cronbach's Alpha $\geq$ 0.70
Construct Reliability	To measure the reliability and internal consistency of the measured variable representing a latent construct	CR $\geq$ 0.6
Average Variance Extracted	The average percentage of variation explained by the items in a construct	AVE $\geq$ 0.5

(Source: Schumacker, 2004)

Internal consistency, a key facet of reliability, safeguards against the intrusion of random errors within a study. To gauge internal consistency, Cronbach's coefficient α was employed. Reliability scores range from 0.00 to 1.00, with values exceeding 0.7 indicating commendable internal consistency in the measurement data, and those surpassing 0.8 representing an optimal level of internal consistency (Joseph F Hair, 2009). Accordingly, this study adheres to the criterion of a reliability score of 0.70 as the threshold for ensuring robust internal consistency.

Additionally, this study will assess construct reliability (CR) and average variance extracted (AVE) in accordance with the guidelines. Construct reliability (CR), akin to Cronbach's α , gauges the collective contributions of

each measurement item within the scale to the underlying construct. Typically, a CR value greater than 0.7 is indicative of robust convergent validity, with CR depending on the standardized load and measurement item error. Higher standardized load values and reduced measurement item error contribute to greater CR values.

Average variance extracted (AVE) quantifies the average extent to which latent constructs explain variance in qualitative indicators, signifying the mean impact of measurement items on the construct. An AVE value exceeding 0.5 signifies that the measurement possesses ample convergent validity, with the construct accounting for over half of the variance. AVE is closely linked to the standardized load, with higher standardized load values yielding greater AVE.

CR and AVE collectively serve as indicators of convergent validity within the scale. Compliance with the stipulated standards for both CR and AVE signifies that the measurement model enjoys adequate convergent and discriminant validity. Consequently, the calculation and inclusion of CR and AVE findings are imperative when working with structural equation models.

3.8.2.4 Validity Analysis

Validity in research assesses how effectively a measurement tool reflects the authenticity of sample data. In the realm of organizational management, content validity and structural validity are commonly employed to evaluate the validity of samples.

Content validity primarily concerns the alignment of measurement item content with the intended meaning of the measured scale (Haynes et al., 1995). It is often challenging to evaluate content validity through statistical analysis, necessitating a combination of semantic analysis and data source reliability during design.

Structural validity, on the other hand, pertains to the extent to which items within the research scale measure relevant constructs. Construct validity further divides into convergent validity and discriminant validity. Convergent validity, also known as convergent validity, gauges the extent to which various measurement items can measure the same latent variable. When measuring the same construct, these related measurement items should exhibit high correlations. Convergent validity is typically assessed via item factor loading values, factor loading average variance extraction (AVE), and composite reliability (CR). Generally, factor loading values exceeding 0.5, AVE values surpassing 0.5, and CR values exceeding 0.7 indicate robust convergent validity (Schumacker & Lomax, 2004).

Discriminant validity refers to the low correlation between latent variables corresponding to the items. Confirmatory factor analysis with statistical software often serves as the preferred method. All items from different constructs are merged into one construct, and the overall model's goodness of fit is evaluated. A significant drop in fit suggests distinctiveness among items. Alternatively, the square root of the average variance extracted (AVE) is compared with the correlation coefficient between it and other variables. If the

square root of AVE is greater than the correlation coefficient, discriminant validity is established.

Before commencing factor analysis, preliminary testing, including the Kaiser-Meyer-Olkin (KMO) sample test and Bartlett's sphericity test, is conducted to assess sample suitability for validity testing. In this study, since the measurement scales were adapted from existing literature and scales but required translation into Chinese, exploratory factor analysis was performed to validate construct validity. Reference to commonly used metrics, such as KMO values and cumulative variance explained, determined each variable's eligibility for factor analysis. Utilizing SPSS 27.0 statistical software, KMO and variance explained statistics were computed. A KMO exceeding 0.7, coupled with a cumulative variance explanation exceeding 50%, signified that each variable's items met the prerequisites for factor analysis, ensuring representativeness and sound structural validity (Joseph F Hair, 2009).

3.8.2.5 Model Fit Validation

The final step in model validation extends insights from initial correlation analyses to assess the fit of the newly developed theoretical model, illustrating the complex, dynamic relationship between project manager leadership, team processes, and team performance. Previously, the model's framework and constructs underwent validation through exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). This step focuses on assessing the model's explanatory ability by analyzing its goodness of fit. Goodness of fit evaluates

the concordance between the model's predicted values and the observed data, particularly in regression analysis, to determine the model's capacity to explain data. To determine this, various statistical measures are employed: Chi-square index (χ^2/df) below 3, Good Fit Index (GFI) above 0.85, Adjusted GFI (AGFI) above 0.85, Normed Fit Index (NFI) above 0.9, Incremental Fit Index (IFI) above 0.9, Tucker-Lewis Index (TLI) above 0.9, Root Mean Square Residual (RMR) below 0.08, and Root Mean Square Error of Approximation (RMSEA) below 0.08. (Schumacker & Lomax, 2004). These criteria rigorously validate the model's robustness and its ability to elucidate the phenomena under study.

3.8.2.6 Direct Effects Analysis

The third step, in line with RO3, after completing model validation and assessment, the next step is to examine the direct relationships between variables. This phase focuses on empirically testing and confirming the direct effects proposed in the measurement model.

The principle of verifying direct relationships is to establish causal links between variables without considering intervening factors. This process employs statistical techniques to quantify the strength and direction of these relationships. In Structural Equation Modeling (SEM), direct effects are depicted by single-headed arrows in path diagrams, indicating the immediate impact of one variable on another.

This stage is critical for solidifying the study's theoretical foundation by examining the direct relationships among key variables: project manager leadership competencies, team processes, and team performance. Validating these direct effects is a key milestone, providing empirical support for the proposed framework and reinforcing the model's theoretical and practical significance.

Direct effects refer to the influence of an independent variable on a dependent variable, without intermediaries. Understanding these effects is essential for analyzing variable relationships and developing theoretical models. Verifying direct relationships allows researchers to isolate the unique contributions of each predictor variable while controlling for other factors in the model.

The procedure for measuring direct effects includes several steps: first, defining the independent and dependent variables; second, constructing a structural equation model using AMOS software, which involves calculating path coefficients; third, executing the model, performing estimation and goodness-of-fit tests; and finally, interpreting the results, with attention to the magnitude and significance of the path coefficients to determine the strength and direction of the direct effects.

This methodology is vital not only for validating research hypotheses but also for gaining comprehensive insights into the complex relationships among variables—an essential aspect of SEM analysis. By systematically examining these direct effects, researchers can develop a more nuanced understanding

of the interactions within the model, providing a solid foundation for further analysis and theoretical advancement.

3.8.3 Step 3: Mediating Effects Analysis

In the concluding phase, addressing RO4, our study turns to an enhanced model refined from insights gained in previous analyses. This model is meticulously analyzed to understand the mediating and moderating effects within the leadership-performance context. Advanced statistical methods, such as hierarchical regression and Bootstrap analysis, are employed, utilizing SPSS 27.0 and AMOS 27.0 for these assessments. As outlined by Preacher & Hayes (2008), these methods are integral to our analysis.

Bootstrap analysis, fundamentally, is a technique of resampling. It simulates drawing multiple samples from a population, using existing samples as proxies. This process, which involves repeated sampling with replacement, generates numerous samples mirroring the original set. Bootstrap analysis is advantageous as it doesn't require a normally distributed mediation effect or specific data distribution knowledge. Instead, it assumes the sample accurately represents the population and is suitable for testing mediation models in smaller samples. This method, less restrictive than the stepwise or Sobel test methods, is supported by major statistical software packages, including SPSS, Lisrel, Mplus, Amos, and SmartPLS. The bias-corrected percentile Bootstrap method is renowned for its accuracy and robustness in assessing mediation effects (MacKinnon et al., 2004).

Originally, Baron & Kenny(1986) proposed a three-step approach for mediation effect testing, often limited by data constraints. Zhao et al. (2010) refined this approach, introducing a decision tree to determine mediating effects. The procedure analyzes the effect of the independent variable X on the dependent variable Y through the mediator M. A non-significant direct effect c' implies a complete mediation by M, whereas a non-significant indirect effect ab and direct effect c' suggest no functional relationship between X and Y.

Using structural equation modeling with Bootstrap, our study determines path coefficients and significance levels for the indirect and specific mediating effects of variable X on Y. This involves 5,000 resamplings with replacement (Preacher & Hayes, 2008) and a 95% confidence level bias-corrected Bootstrap confidence interval estimation. A confidence interval containing zero indicates an insignificant mediation effect.

This comprehensive data analysis procedure, integrating sophisticated statistical techniques, ensures a thorough examination of the research objectives. It enables a nuanced understanding of how project manager leadership impacts team processes and performance, significantly contributing to the literature on project management and leadership.

CHAPTER 4

DATA ANALYSIS AND DISCUSSION

4.1 Introduction

Building on the research methodology detailed in Chapter 3, this chapter begins by analyzing the data collected and presenting the results that address the research questions. The study utilizes both quantitative and qualitative methods, with the primary focus on quantitative analysis in the subsequent phases. This chapter is structured around two main types of statistical analysis: descriptive and inferential. Descriptive statistics summarize the demographic characteristics of the respondents using frequencies, percentages, means, and standard deviations. Inferential statistics are used to explore the relationships between variables, with correlations and structural equation modeling (SEM) employed to test the research hypotheses. The results of these analyses are presented, followed by an in-depth discussion of the findings in the context of the study's research objectives.

4.2 Results of Step 1: Identification and Analysis of Key Leadership Competencies

This section presents the findings from the first step of the research, focusing on identifying and analyzing the critical leadership competencies for construction project managers.

4.2.1 Determining the Factors of Leadership Competencies for Construction Project Managers

In the survey concerning the selection of competency elements for construction project management leadership, six questionnaires were distributed, and all were completed and returned by the experts, resulting in a 100% response rate. The statistical outcomes are presented in Table 4.1:

Frequency of Factors Selected by the Expert Panel.

Table 4.1: Frequency of Factors Selected by the Expert Panel

Dimension	Number	Factors	Frequency
TR	1	Technical skills	4
	2	Risk management	6
	3	Project experience	6
	4	Academic education level	2
	5	Strategic thinking	5
	6	Analytical abilities	5
	7	Task management	5
	8	Organizational coordination abilities	4
	9	Innovation	1
	10	Decision making	4
	11	Flexibility	6
	12	Interpersonal skills	6
	13	Negotiation	5
	14	Motivate team members	5
PR	15	Competency development and career guidance	4
	16	Get support from the team	4
	17	Get support from senior managers	3
	18	Responsible	5
SR	19	Confidence	4
	20	Initiative	4
	21	Work under pressure	6
	22	Behavioral consistency	5
	23	Adaptability	6
	24	Passion	1
	25	Self-control	3

The statistical analysis revealed a notable concentration in the expert group's opinions regarding element selection. Adhering to the “more than half” principle, elements selected more than three times were identified as the definitive competency elements for a construction project manager. For further details, refer to Table.

Table 4.2: Competency Factors of Project Manager Leadership Competencies

Dimension	Competency Factors
TR	Technical skills, Risk management, Project experience, Strategic thinking, Analytical abilities, Task management, Organizational coordination abilities, Decision making
PR	Flexibility, Interpersonal skills, Negotiation, Motivate team members, Competency development and career guidance, Get support from the team
SR	Responsible, Confidence, Initiative, Work under pressure, Behavioral consistency, Adaptability

4.2.2 Determining the Evaluation Model of Leadership Competencies for Construction Project Managers

This study utilized a rigorous scientific approach involving re-engagement of the six previously mentioned experts to complete weight factor judgment forms through in-person scoring. Researchers explained each competency factor to experts, who then assigned scores using the weight factor judgment table. Weight adjustments followed to finalize each factor's weight.

The five-point rating system compared row and column elements via pairwise comparisons. Experts independently assigned scores: 4 for very important, 3

for more important, 2 for equally important, 1 for less important, and 0 for very unimportant. By tallying judgment table scores, calculating and adjusting weights, each factor's weight was finalized. Details can be found in Table.

Table 4.3: Summary of Weight Factor Judgment by the Expert Panel

Competency Factor	Results of the Expert Panel's Scoring						TS	M	Weight (%)
	A	B	C	D	E	F			
Technical skills	22	26	26	29	33	18	154	25.67	3
Risk management	38	42	41	38	39	35	233	38.83	5
Project experience	37	38	38	38	38	39	228	38.00	5
Strategic thinking	42	47	47	45	45	37	263	43.83	6
Analytical abilities	27	28	30	29	28	28	170	28.33	4
Task management	41	43	43	42	43	42	254	42.33	6
Organizational coordination abilities	47	43	43	43	42	65	283	47.17	6
Decision making	47	47	42	45	46	39	266	44.33	6
Flexibility	40	37	38	34	36	38	223	37.17	5
Interpersonal skills	44	45	44	42	44	57	276	46.00	6
Negotiation	42	42	41	41	44	43	253	42.17	6
Motivate team members	43	43	43	42	43	40	254	42.44	6
Competency development and career guidance	45	44	44	43	46	40	262	43.67	6

Table 4.3: Continued

Get support from the team	31	29	34	42	31	38	205	34.17	4
Responsible	40	40	41	41	40	37	239	39.83	5
Confidence	43	39	39	38	39	40	238	39.67	5
Initiative	43	43	43	42	43	42	256	42.67	6
Work under pressure	36	37	37	37	36	40	223	37.17	5
Behavioral consistency	28	29	26	26	25	29	163	27.17	3
Adaptability	24	18	20	23	19	13	117	19.50	2
Total	760	760	760	760	760	760	4560	760	100

Note:

A, B, C, D, E, F represent individual experts on the panel.

TS: Total Score (sum of scores from all experts)

M: Mean Score (average score across all experts)

Subsequently, using the established weights from the expert group's weight factor judgment summary, the weights of competency elements within the same dimension were aggregated to calculate the weights of each dimension, culminating in the establishment of the construction industry project manager leadership competency model. For further details, refer to Table.

Table 4.4: Evaluation Dimensions and Factors Weights of Project Managers' Leadership Competencies

Evaluation Dimensions	Dimension Average Weights	Competency Factors	Factors Weights
TR	5.125	Technical skills	3
		Risk management	5
		Project experience	5
		Strategic thinking	6
		Analytical abilities	4
		Task management	6
		Organizational coordination abilities	6
		Decision making	6
		Flexibility	5
		Interpersonal skills	6
		Negotiation	6
		Motivate team members	6
PR	5.5	Competency development and career guidance	6
		Get support from the team	4
		Responsible	5
		Confidence	5
SR	4.33	Initiative	6
		Work under pressure	5
		Behavioral consistency	3
		Adaptability	2

4.3 Results of Phase 2: Model Validation and Direct Effects Analysis

This section presents the outcomes of the second phase of the research, focusing on validating the proposed model and analyzing the direct effects between variables.

4.3.1 Data Collection and Examination

As outlined in Chapter 3, data collection for this study occurred through two primary channels: recruitment from Credamo's sample database and outreach via social media by a construction industry training institution to its trainees. The data collection period spanned from August 2, 2023, to September 29, 2023, during which the target demographic received consistent reminders. A total of 508 individuals from the construction industry completed the survey, with online recruitment providing 600 quotas. This resulted in a response rate of 84.67%.

Rigorous measures were implemented to ensure data quality. A screening question was embedded to automatically disqualify respondents with incorrect answers, verifying their basic knowledge of the construction industry based on established standards. In addition, individuals who answered "No" to the question "Have you ever had any project experience?" in the demographic survey were excluded. Samples with abnormal demographic information were carefully removed, and suspicious response patterns were identified and discarded. Following the recommendations of Hair et al. (2017a), respondents who displayed a "straight pattern," consistently selecting the same response (predominantly 1 or 7), were removed. Diagonal alignments and extreme response patterns were also closely examined. After thorough data screening, 25 invalid responses were discarded, leaving 483 valid questionnaires and yielding a questionnaire validity rate of 95.08%.

4.3.2 Descriptive Analysis

This section presents a comprehensive overview of the survey data, providing insights into the characteristics of the respondents and the distribution of responses across various variables.

4.3.2.1 Demographic Background of the Respondents

Upon analyzing the 483 valid samples, descriptive statistics were conducted employing SPSS 27.0 statistical software. The sample distribution centered on respondents' basic characteristics (such as age, education level, work experience, and the nature of their employing organization) and pertinent project attributes (including project type, contract amount, and the respondent's position within the project). The demographic profile of the respondents is as follows: in terms of gender distribution, male respondents significantly outnumbered females, constituting 61.1% compared to 38.9% of females. Regarding age distribution, the majority fell within the 31-40 age bracket, comprising 39.3% of the sample, followed by those aged 25-30, constituting 35.4%. Respondents in other age groups were notably fewer. Concerning education level, the majority held a bachelor's degree, accounting for 62.5%, while 23.2% possessed junior college qualifications, and only 14.3% held master's or doctorate degrees. Work experience analysis revealed that individuals with 3-5 years of experience and those with less than 3 years were predominant, comprising 40.0% and 38.1% respectively. Respondents with other experience levels were comparatively rare. Regarding the nature of their

employing organizations, private enterprises constituted the largest group at 54.7%, followed by local state-owned enterprises at 27.7%. Respondents from central state-owned enterprises and other organizational types were in the minority. In summary, the surveyed professionals in the construction industry were predominantly male, most fell within the 31-40 age range, possessed bachelor's degrees, had 3-5 years of work experience, and were primarily employed in private enterprises. This demographic profile closely mirrors the current composition of the construction industry.

Table 4.5: The Distribution of Respondents' Demographic Characteristics

Variable	Level	Frequency	Percentage (%)
Gender	Male	295	61.1
	Female	188	38.9
Age	<24	53	11.0
	25-30	171	35.4
	31-40	190	39.3
	41-50	60	12.4
	51 and above	9	1.9
	Diploma	112	23.2
	Bachelor's	302	62.5
Qualification	Masters	60	12.4
	PhD	9	1.9
	Less than 3 years	184	38.1
Work Experience	3~5 years	193	40.0
	6~8 years	58	12.0
	More than 8 years	48	9.9
	Central enterprise	31	6.4
Nature of current work unit	Local state-owned enterprise	134	27.7
	Private enterprise	254	54.7
	Other	54	11.2

Upon examining the projects in which the respondents were involved, railway projects constituted the largest share, accounting for 31.3%, succeeded by construction projects at 27.5%, with highway and municipal projects trailing at 18.0% and 17.0% respectively; other project types had a notably smaller representation. Regarding project contract values, the majority of respondents were engaged in projects ranging from 1 million to 50 million yuan, constituting 42.2%, followed by projects spanning 5 million to 100 million yuan, making up 18.2% of the sample. When considering the respondents' roles within the projects, technical supervisors were the most common, constituting 24.2%, whereas ordinary employees accounted for 53.0%. Management-level roles were less frequent. In terms of team size, a significant 59.9% of respondents participated in projects involving teams ranging from 6 to 50 members, while projects with larger or smaller teams had fewer participants. Regarding project duration, the majority of respondents, totaling 51.3%, were engaged in projects lasting between 1 and 3 years, followed by 29.0% for projects spanning 3 to 5 years. Projects of other durations were represented by fewer respondents. Analyzing this project-related data reveals that the types and scopes of the projects the respondents participated in are reasonably representative, offering insights into the overall landscape of the construction industry projects. This robust dataset forms the basis for subsequent model analyses.

Table 4.6: Distribution of Project Information from Respondents

Variable	Level	Frequency	Percentage (%)
Project Type	Building construction project	133	27.5
	Railway project	151	31.3
	Highway project	87	18.0
	Municipal project	82	17.0
	Others	30	6.2
Contract Value of the Project	Less than 50 million yuan	74	15.3
	50 million to 100 million yuan	90	18.6
	100 million to 500 million yuan	204	42.2
	500 million to 1 billion yuan	88	18.2
	More than 1 billion yuan	27	5.6
Position Title on the Project	Project Engineer	22	4.6
	Project Department Manager/Deputy Manager	88	18.2
	Technical Supervisor	117	24.2
	General Staff	256	53.0
Size of Project Team	15 members or fewer	117	24.2
	6-50 members	285	54.9
	51 members and above	101	20.9
Duration of the Project	Less than 1 year	34	7.0
	1-3 years	248	21.3
	3-5 years	140	29.0
	5 years and above	61	12.6

4.3.2.2 Descriptive Analysis of Variables

This study assessed the normality of the data by computing the kurtosis and skewness for each measurement item and main variable. Kline (2023) established criteria where an absolute skewness value below 3 and an absolute kurtosis value below 10 are considered acceptable. Examination of Table reveals that the highest absolute skewness value for each main variable is 0.451, and the highest absolute kurtosis value is 1.273. With kurtosis ranging between -2 and +2, and skewness between -1 and +1, the main variable data can be considered to approximately follow a normal distribution.

Analysis of the mean scores provides insights into how construction project team members perceive their project managers' competencies, team dynamics, and overall performance. The Task-Related (TR) competencies of project managers show an average score of 3.47, with scores ranging from 3.40 to 3.53. People-Related (PR) competencies have a slightly higher average of 3.51, with scores between 3.41 and 3.60. Self-Related (SR) competencies demonstrate the highest average at 3.54, ranging from 3.46 to 3.58. These scores suggest that team members generally view their project managers as competent across all areas, with a slight edge in self-related skills.

Regarding team dynamics, Team Learning (TL) shows a relatively high average of 3.57, indicating that team members perceive a strong learning culture within their projects. Team Monitoring (TM) also demonstrates a high average of 3.54, suggesting that team members recognize effective oversight

and assessment practices in their teams. Team Climate (TC) has a slightly lower average of 3.45, ranging from 3.38 to 3.55, which still indicates a generally positive team atmosphere, albeit with some room for improvement. Team Performance (TP) shows an average of 3.49, reflecting a generally positive assessment of overall team outcomes by the members.

The distribution characteristics provide further insights. The negative skewness values (ranging from -0.154 to -0.451) indicate that responses are slightly skewed towards higher scores, suggesting that team members tend to rate their project managers and team dynamics more positively. The negative kurtosis values (ranging from -0.806 to -1.273) indicate that the distribution is slightly flatter than a normal distribution, implying a wider spread of opinions across the scale.

These distribution characteristics, while within acceptable ranges for normality, suggest that construction project team members generally view their project managers' competencies, team learning processes, monitoring practices, team climate, and overall performance positively, but with some diversity in opinions. This pattern provides a solid foundation for further statistical analyses, as the data closely approximates a normal distribution while still reflecting real-world variability in perceptions within construction project teams. The generally positive scores across all dimensions indicate a healthy project management environment in the surveyed construction projects, with potential areas for improvement particularly in team climate and some aspects of task-related competencies.

Table 4.7: Normality Test Results

Variables	Mean	Standard Deviation	Skewness	Kurtosis
TR	3.47	0.935	-0.332	-0.839
PR	3.51	0.936	-0.343	-0.806
SR	3.54	0.958	-0.399	-0.832
TL	3.57	0.937	-0.451	-0.841
TM	3.54	0.939	-0.397	-0.849
TC	3.45	0.933	-0.281	-0.912
TP	3.49	0.918	-0.329	-0.881

4.3.3 Common Method Bias Test

Common method bias occurs when data is collected for different variables using the same survey methods and the same survey subjects. This can introduce issues such as the leniency bias, potentially biasing the data and compromising the scientific rigor and objectivity of research findings. Given that the data in this study is derived from respondents rating each item based on their own judgment, there is a possibility of common method bias. Therefore, it is essential to apply statistical control methods. Currently, scholars commonly employ Harman's single-factor test to assess common method bias. This method aggregates all study variables into a single exploratory factor, evaluates the explanatory power of unrotated factors, and examines the contribution of the first factor to the overall variance, considering the number of factors with eigenvalues greater than 1. When the explanatory power of the first factor falls below the critical threshold of 40%, it suggests that common method bias is not significant, allowing for subsequent analysis. Conversely, if the cumulative explanatory power of the first factor exceeds 40%, it indicates the presence of common method bias (Podsakoff et al., 2003).

In this study, as demonstrated in Table, Harman's single-factor test was conducted using SPSS 27.0 software. The analysis revealed that all variable items collectively extracted seven factors with eigenvalues greater than 1, contributing to a cumulative variance of 69.369%. Furthermore, the initial explanatory power of the unrotated first factor was 38.846%, which is below the critical threshold of 40%. This suggests that the level of common method bias falls within an acceptable range, allowing for further research.

Table 4.8: Results of Common Method Bias Analysis

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)
1	20.588	38.846	38.846	20.588	38.846	38.846
2	3.267	6.164	45.009	3.267	6.164	45.009
3	3.172	5.986	50.995	3.172	5.986	50.995
4	2.822	5.324	56.319	2.822	5.324	56.319
5	2.699	5.092	61.411	2.699	5.092	61.411
6	2.390	4.509	65.920	2.390	4.509	65.920
7	1.828	3.449	69.369	1.828	3.449	69.369

4.3.4 Reliability Analysis

After completing the formal data collection through questionnaires, this study proceeded to assess the reliability of the scales using internal consistency. Utilizing SPSS 27.0, Cronbach's alpha coefficients were computed for all variables under study to evaluate their reliability, as indicated in Table. The analysis demonstrated robust internal consistency, with overall Cronbach's alpha coefficients for task-related leadership competencies, people-related leadership competencies, self-related leadership competencies, team learning, team monitoring, team climate, and team performance measuring 0.948, 0.933, 0.915, 0.892, 0.893, 0.940, and 0.951, respectively. These coefficients exceeded the 0.8 threshold, indicating high reliability (Joseph Hair, 2009). Additionally, the Corrected Item-Total Correlation (CITC) values for all items surpassed 0.7, confirming their strong correlation with the total score. Remarkably, removing any item did not significantly enhance the alpha value, further corroborating the stability of the scales in the formal questionnaire. These results indicate that the measurement scales used in this study are highly reliable and consistent, providing a solid foundation for further statistical analyses and interpretations of the data collected from construction project team members.

Table 4.9: Results of Reliability Analysis

Variables	TR	PR	SR	TL	TM	TC	TP
Cronbach's Alpha	0.948	0.933	0.915	0.892	0.893	0.940	0.951

4.3.5 Validity Analysis

Validity analysis is a crucial step in research to ensure measurements accurately represent the intended concepts. It involves checking if the measuring tool effectively measures the desired variables. This analysis is important because, even if measurements are reliable, they might not be valid.

4.3.5.1 Content Validity

Content validity, as defined by Haynes et al. (1995), pertains to the alignment between the expression of measurement items and the underlying meaning of the measured scale. Testing semantic expressions for content validity often proves challenging, necessitating a blend of semantic analysis and scrutiny of source data during the design phase. In this study, a meticulous approach was adopted. Initially, the conceptual dimensions of all variables were rigorously delineated through an extensive review of relevant literature, clarifying the associated concepts. During the scale development, existing research and established scales were consulted, ensuring a comprehensive foundation. Subsequently, a rigorous design process ensued. Prior to disseminating the measurement questionnaire, intensive consultations were held with three project management lecturers and an English Ph.D., fostering fruitful discussions. Additionally, an expert panel comprising senior managers from enterprises was convened to dissect item contents and offer insights, facilitating iterative modifications for questionnaire enhancement. To further bolster the questionnaire's robustness, a preliminary survey was conducted, yielding data that underwent statistical analysis, including Corrected Item-Total

Correlation (CITC) values and Cronbach's Alpha coefficients. These analyses informed targeted refinements, enhancing the scales' reliability significantly. Through these meticulous measures, the content validity of the questionnaire was effectively established.

4.3.5.2 Structural Validity

Structural validity assesses how well the items in the research scale measure the intended constructs. Preliminary to factor analysis, it is imperative to conduct the Kaiser-Meyer-Olkin (KMO) sample adequacy test and Bartlett's sphericity test to ascertain the suitability of the sample for validity testing. Despite employing measurement scales directly borrowed from established foreign instruments, challenges like inaccurate translation and localization applicability necessitated a rigorous evaluation of structural validity through exploratory factor analysis.

Utilizing SPSS 27.0 statistical software, KMO and variance interpretation rate analyses were performed (refer to Table). Notably, all variable dimensions exhibited KMO values ranging from 0.879 to 0.971, surpassing the 0.7 threshold, and Bartlett's sphericity test significance probabilities were all below 0.05. These outcomes affirm that the data met the prerequisites for factor analysis. The high KMO values indicate excellent sampling adequacy, suggesting that the patterns of correlations are relatively compact and factor analysis should yield distinct and reliable factors.

Subsequently, factor analysis was executed for each scale using the principal component analysis method and maximum variance rotation technique. Notably, all seven variables revealed a single common factor, which supports the unidimensionality of each construct. Cumulative variance interpretation demonstrated Task-related Competencies at 68.091%, People-related Competencies at 68.190%, Self-related Competencies at 70.232%, Team learning at 69.823%, Team monitoring at 70.004%, Team climate at 70.497%, and Team performance at 66.981%. These high percentages of variance explained (all above 65%) indicate that the extracted factors account for a substantial amount of the variability in the original variables, supporting the validity of the measurement model.

Furthermore, all measurement items displayed factor loadings surpassing 0.7, reinforcing the robust structural validity of the questionnaire. The high factor loadings suggest strong correlations between the items and their respective constructs, providing evidence that the items are good indicators of the latent variables they are intended to measure.

Table 4.10: Structural Validity Analysis Results

Variables	KMO	Bartlett's Test of Sphericity	Cumulative Variance Explained
TR	0.967	P < 0.0001	68.09%
PR	0.952	P < 0.0001	68.19%
SR	0.924	P < 0.0001	70.23%
TL	0.879	P < 0.001	69.82%
TM	0.887	P < 0.001	70.00%
TC	0.958	P < 0.0001	70.50%
TP	0.971	P < 0.0001	66.98%

4.3.5.3 Convergent Validity

Convergent validity, an essential aspect of construct validity, evaluates whether items intended to measure a specific construct converge by sharing a high proportion of variance. This study employed several key indicators to assess convergent validity: factor loadings from Confirmatory Factor Analysis (CFA), Average Variance Extracted (AVE), and Composite Reliability (CR). Based on the criteria proposed by Hair et al. (2013), it was determined that standardized factor loadings should exceed 0.70, AVE should be greater than 0.50, and CR should surpass 0.70 to establish strong convergent validity.

CFA was conducted using AMOS 27.0 for the primary constructs: task-related competencies, people-related competencies, self-related competencies, team learning, team monitoring, team climate, and team performance. The results, summarized in Table, provide substantial evidence of convergent validity for all constructs. Standardized factor loadings ranged from 0.741 to 0.843, exceeding the 0.70 threshold, indicating strong associations between items and their respective constructs. AVE values ranged from 0.623 to 0.663, surpassing the recommended 0.50 threshold, suggesting that the latent constructs explain more than 50% of the variance in their indicators. CR values were well above the 0.70 threshold, ranging from 0.892 to 0.951, demonstrating high internal consistency.

Additionally, various model fit indices were evaluated for each CFA model. Chi-square/df ratios were consistently below 2 (except for team learning, which

was below 5), indicating good model fit. RMSEA values were below 0.05 for most constructs (and below 0.08 for team learning), suggesting a close fit with the data. GFI, AGFI, CFI, NFI, and IFI all exceeded 0.90 across all constructs, demonstrating excellent model fit.

The convergent validity analysis offers compelling evidence that the measurement items accurately capture the intended constructs. The high factor loadings reflect strong relationships between the items and their respective constructs, while AVE values above 0.50 indicate that the constructs explain a substantial portion of variance in their indicators. The high CR values further confirm the internal consistency of the measures. These consistent results across all major constructs, from leadership competencies to team processes and performance, strengthen confidence in the overall measurement model.

This robust convergent validity has significant implications for the study. It provides a strong foundation for further analyses, such as testing the hypothesized relationships between variables. It enhances confidence that the observed relationships (or lack thereof) in the data reflect true relationships between constructs, rather than being due to measurement errors. Additionally, it supports the generalizability of the findings, as well-validated measures are more likely to perform consistently across different samples and contexts within construction project management.

Table 4.11: Summary of Convergent Validity Analysis Result

Variables	Factor Loading	AVE	CR	Model Fit Indices
TR	0.646	0.948	0.767-0.842	$\chi^2/df < 2$, RMSEA < 0.05, GFI, AGFI, CFI, NFI, IFI > 0.9
PR	0.636	0.933	0.741-0.826	$\chi^2/df < 2$, RMSEA < 0.05, GFI, AGFI, CFI, NFI, IFI > 0.9
SR	0.643	0.915	0.769-0.825	$\chi^2/df < 2$, RMSEA < 0.05, GFI, AGFI, CFI, NFI, IFI > 0.9
TL	0.623	0.892	0.771-0.823	$\chi^2/df < 5$, RMSEA < 0.08, CFI, NFI, IFI, GFI, AGFI > 0.9
TM	0.626	0.893	0.757-0.806	$\chi^2/df < 2$, RMSEA < 0.05, CFI, AGFI, NFI, IFI > 0.9
TC	0.663	0.94	0.783-0.843	$\chi^2/df < 2$, RMSEA < 0.05, GFI, AGFI, CFI, NFI, IFI > 0.9
TP	0.637	0.951	0.773-0.816	$\chi^2/df < 2$, RMSEA < 0.05, GFI, AGFI, CFI, NFI, IFI > 0.9

4.3.5.4 Discriminant Validity

Discriminant validity, a crucial aspect of construct validity, serves to establish distinctions between various constructs. Its purpose is to confirm that constructs, which should theoretically be unrelated, indeed exhibit low correlations, demonstrating their conceptual distinctiveness. The primary criteria for evaluating discriminant validity include the correlation matrix

method, where correlations between different constructs must remain low, and the Average Variance Extracted (AVE) method. According to Hair (2019), discriminant validity is upheld if the AVE value of each construct exceeds its squared correlation coefficient with other constructs. Specifically, the squared correlation coefficient between a construct and other constructs in the scale should be smaller than the AVE of that construct. This criterion ensures effective differentiation between constructs, enhancing their relevance to themselves. If the squared correlation coefficient between two constructs surpasses the AVE of either construct, it implies excessive closeness and a lack of effective differentiation, thus failing the test of discriminant validity. This validation is especially pertinent in the presence of irrelevant variables. Table presents the results supporting the discriminant validity of the measurement model.

Table 4.12: Discriminant Validity of Construct

	TP	TC	TM	TL	SR	PR	TR
TP	0.798						
TC	0.572***	0.814					
TM	0.528***	0.458***	0.791				
TL	0.504***	0.467***	0.517***	0.789			
SR	0.526***	0.519***	0.420***	0.521***	0.802		
PR	0.526***	0.528***	0.457***	0.444***	0.500***	0.798	
TR	0.578***	0.535***	0.509***	0.487***	0.518***	0.535***	0.804

4.3.6 Verification of Model Fit Goodness

Utilizing Amos software to scrutinize the measurement model, the output results revealed positive error variances, R^2 values below 1, and an absence of nonpositive definite matrices warnings. The highest standardized coefficient observed was 0.844, comfortably below the 0.95 threshold. Standard errors ranged from 0.024 to 0.064, with no outliers. In essence, these outcomes indicate no estimative violations in the model, enabling a deeper investigation into goodness of fit (Byrne, 2013; Joseph Hair, 2009).

The assessment of the model's overall goodness of fit serves as a crucial gauge of the model's quality. A higher goodness of fit implies a stronger alignment between the measurement model and the sample data. This evaluation necessitates a comprehensive analysis utilizing three indicators: absolute fit indices, relative fit indices, and parsimonious fit indices (Bagozzi & Yi, 1988).

The first set of indices falls under absolute fit measures, evaluating the alignment between the theoretical model and sample data. These indices, including chi-square (χ^2), normed chi-square (χ^2/df), root mean square residual (RMR), standardized root mean square residual (SRMR), root mean square error of approximation (RMSEA), goodness of fit index (GFI), and adjusted goodness of fit index (AGFI), are paramount. The χ^2 value, although sensitive to sample size and data distribution, is mitigated by χ^2/df , which, between 1 and 2, indicates a robust model fit.

RMR, SRMR, and RMSEA, derived from fitting residuals, offer deeper insights. RMR values less than 0.05 suggest excellent fit, with SRMR values ideally below 0.05. RMSEA, less influenced by sample size, between 0.05 and 0.08 indicates reasonable fit and less than 0.05 suggests outstanding fit. GFI and AGFI, signifying the model's explanatory power, should ideally surpass 0.90, with values in the [0.8, 0.89] range still acceptable (Doll et al., 1994).

The second category comprises relative fit indices, comparing the theoretical model with a null model. Normed fit index (NFI), incremental fit index (IFI), Tucker-Lewis index (TLI), and comparative fit index (CFI) values approaching 1 indicate superior fit, with values exceeding 0.90 signifying acceptable fit. CFI, less affected by sample size, is particularly robust.

The third group, parsimonious fit indices, incorporates both absolute and relative fit measures. Akaike information criterion (AIC), consistent Akaike information criterion (CAIC), expected cross-validation index (ECVI), parsimony normed fit index (PNFI), and parsimony goodness of fit index (PGFI) are essential. Smaller AIC and CAIC values, relative to the saturated and independence models, denote better fit, provided the sample size exceeds 200 and data conforms to normal distribution. ECVI is suitable for diverse sample sizes and indicates better fit with lower values. PNFI and PGFI values exceeding 0.50 signify acceptable model parsimony. The fit indices and evaluation criteria for the measurement model are shown in Table.

Table 4.13: Comparison of Measurement Model Fit Indices

Fit Category	Fit Indices	Measurement Model Fit Index	Standard Criteria
Absolute Fit Indices	χ^2	1776.446	Smaller is preferable
	χ^2/df	1.224	$1 < \chi^2/df < 3$ (Stricter: $1 < \chi^2/df < 2$)
	RMR	0.042	RMR < 0.05
	SRMR	0.031	SRMR < 0.05
	RMSEA	0.022	RMSEA < 0.05 (Excellent fit) RMSEA < 0.08 (Reasonable fit)
Relative Fit Indices	GFI	0.882	GFI > 0.90 (Tolerant: GFI > 0.80)
	AGFI	0.871	AGFI > 0.90 (Tolerant: AGFI > 0.80)
	NFI	0.913	NFI > 0.90
	IFI	0.983	IFI > 0.90
	TLI	0.982	TLI > 0.90
Parsimonious Fit Indices	CFI	0.983	CFI > 0.90
	AIC	2066.446	Theoretical model's value smaller than that of the saturated and independent models
	CAIC	2817.549	Theoretical model's value smaller than that of the saturated and independent models
	ECVI	4.287	Theoretical model's value smaller than that of the saturated and independent models
	PNFI	0.860	PNFI > 0.50
	PGFI	0.926	PGFI > 0.50

The measurement model's goodness of fit was evaluated using the Amos software, yielding the following absolute fitness index results: $\chi^2=1776.446$, $df=1451$, $\chi^2/df=1.224$, $RMR=0.042$, $SRMR=0.031$, $RMSEA=0.022$, $GFI=0.882$, $AGFI=0.871$. Notably, the χ^2/df value, falling below 2, adheres to the strict discrimination criterion. Additionally, the $RMSEA$ value, less than 0.08, indicates reasonable model adaptation. Both GFI and $AGFI$, exceeding 0.80 and nearing 0.90, signify strong model adaptability. RMR and $SRMR$, both below the critical 0.05, further confirm the model's excellent absolute fitness.

Relative fitness indices provided by Amos include $NFI=0.913$, $IFI=0.983$, $TLI=0.982$, and $CFI=0.983$. While NFI , sensitive to factors like sample size, shouldn't solely determine model fitness, the IFI , TLI , and CFI values, surpassing 0.90, indicate a robust model fit.

Amos's report on the theoretical model's parsimonious fitness index presents $PNFI=0.860$, $PFGI=0.926$, $AIC=1776.446$ (saturated model $AIC=2068.670$; independent model $AIC=3163.004$), $CAIC=2817.549$ (saturated model $CAIC=2853.897$; independent model $CAIC=3163.004$), and $ECVI=4.287$ (saturated model $ECVI=4.292$; independent model $ECVI=6.562$). Remarkably, the AIC , $CAIC$, and $ECVI$ values, all surpassing the corresponding saturated model values, underscore the model's outstanding goodness of fit.

In summary, the measurement model satisfies the test standards for absolute, relative, and parsimonious fitness indices. The model demonstrates a robust fit with the sample data, validating its external characteristics.

4.3.7 Direct Effects Analysis

In the previous sections, analyses evaluating the model's reliability, validity, and goodness of fit have provided substantial support for the measurement model's credibility and the data's integrity. Consequently, this section will apply the measurement model to examine the direct relationships between the variables in the theoretical framework.

A structural equation model was meticulously crafted to scrutinize the impact of project managers' competencies on team performance and team processes. Within this model, three latent exogenous variables—task-related competencies, people-related competencies, and self-related competencies—were incorporated, alongside three control variables: project type, size of the project team, and project duration. The model encompassed four latent endogenous variables: team learning, team monitoring, team climate, and team performance. To account for the inherent imperfections in the observed variables and ensure a precise model-data fit, 53 error variables (e1-e53) were assigned to the manifest variables, along with four error variables (e54-e57) for the endogenous latent variables.

Utilizing Amos 21.0 software, the initial structural equation model was rigorously tested to validate the hypothesized relationships among project managers' task-related competencies, people-related competencies, self-related competencies, team learning, team monitoring, team climate, and team

performance. The outcomes, including coefficients and significance levels for each structural path, are illustrated in Figure.

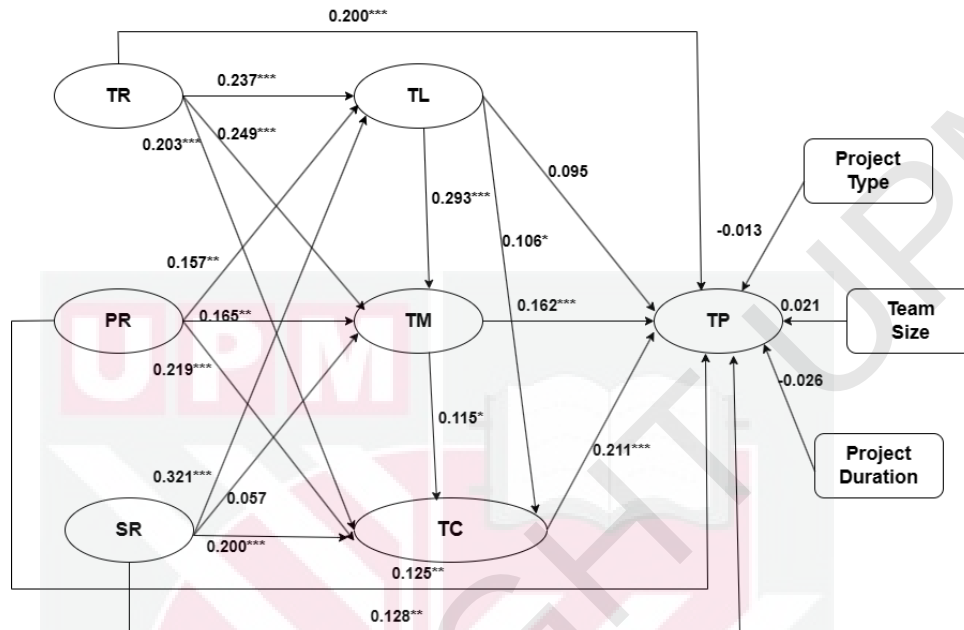


Figure 4.1: Results of Direct Effects Model

Note: * indicates $p < 0.05$; ** indicates $p < 0.01$; *** indicates $p < 0.001$

Figure 4.1 illustrates the outcomes of the path analysis, where the significance levels of path coefficients in the structural model determine the strength and direction of relationships between variables. Regarding the control variables, namely project type, size of the project team, and project duration, their impact on project team performance was found to be statistically non-significant. Consequently, these variables were excluded from subsequent model analyses.

The results reveal significant positive relationships between project manager competencies and team performance. Task-related competencies showed a significant positive effect on team performance with a coefficient of 0.200

($p < 0.001$). People-related competencies also demonstrated a positive influence on team performance with a standardized path coefficient of 0.125 ($p < 0.001$). Similarly, self-related competencies positively affected team performance with a standardized path coefficient of 0.128 ($p < 0.001$).

Examining the relationships between project manager competencies and team processes, all three competency types showed significant positive effects on team learning. Task-related competencies had a significant coefficient of 0.237 ($p < 0.001$), people-related competencies showed a standardized coefficient of 0.157 ($p < 0.01$), and self-related competencies demonstrated a standardized path coefficient of 0.321 ($p < 0.001$) on team learning.

Regarding team monitoring, task-related and people-related competencies showed significant positive effects with path coefficients of 0.249 ($p < 0.001$) and 0.165 ($p < 0.01$) respectively. However, the relationship between self-related competencies and team monitoring was not significant (coefficient: 0.057, $p > 0.05$).

All three competency types significantly influenced team climate. Task-related competencies showed a path coefficient of 0.203 ($p < 0.001$), people-related competencies demonstrated a standardized coefficient of 0.219 ($p < 0.001$), and self-related competencies had a standardized coefficient of 0.200 ($p < 0.001$).

Interestingly, the direct effect of team learning on team performance was not significant, with a path coefficient of 0.095 ($p > 0.05$). This suggests that team learning might influence performance through indirect mechanisms rather than directly. In contrast, team monitoring showed a significant positive effect on performance with a path coefficient of 0.162 ($p < 0.001$). Team climate also demonstrated a significant positive impact on performance with a path coefficient of 0.211 ($p < 0.001$).

The model also revealed significant relationships among team processes. Team learning positively influenced team monitoring (coefficient: 0.293, $p < 0.001$) and team climate (coefficient: 0.106, $p < 0.05$). Additionally, team monitoring showed a positive effect on team climate (coefficient: 0.115, $p < 0.05$).

These results highlight the complex interplay between project manager competencies, team processes, and team performance. They suggest that project managers' competencies not only directly influence team performance but also play crucial roles in shaping team processes such as learning, monitoring, and climate. The findings underscore the importance of developing a well-rounded set of competencies in project managers to enhance both team processes and overall performance.

The results for the direct effects are summarized in Table.

Table 4.14: Summary of Direct Effects in the Structural Model

Path	Estimate β	SE	CR.	P	Results*
TR→TP	0.2	0.046	3.98	***	Supported
PR→TP	0.125	0.05	2.599	0.009	Supported
SR→TP	0.128	0.048	2.552	0.011	Supported
TR→TL	0.237	0.047	4.334	***	Supported
PR→TL	0.157	0.052	2.907	0.004	Supported
SR→TL	0.321	0.049	5.801	***	Supported
TR→TM	0.249	0.049	4.465	***	Supported
PR→TM	0.165	0.052	3.066	0.002	Supported
SR→TM	0.057	0.05	1.025	0.305	Unsupported
TR→TC	0.203	0.055	3.874	***	Supported
PR→TC	0.219	0.059	4.323	***	Supported
SR→TC	0.2	0.056	3.851	***	Supported
TL→TC	0.095	0.054	1.904	0.057	Unsupported
TM→TP	0.162	0.052	3.322	***	Supported
TC→TP	0.211	0.044	4.306	***	Supported
TL→TM	0.293	0.057	5.181	***	Supported
TL→TC	0.106	0.064	2.014	0.044	Supported
TM→TC	0.115	0.061	2.237	0.025	Supported

Note: * indicates $p < 0.05$; ** indicates $p < 0.01$; *** indicates $p < 0.001$

4.4 Results of Phase 3: Mediating Effects Analysis

In the previous section, the preliminary model was examined to assess the direct effect relationships, revealing that 16 paths were supported while 2 were not. As a result, in preparation for analyzing mediation effects, the structural equation model was refined by removing non-significant paths. Before conducting path analysis, it was necessary to evaluate the fit of the refined model.

After eliminating the non-significant paths, the model's fit indices showed slight improvements compared to the measurement model. The χ^2/df ratio (1.184) fell within the stricter standard range of 1 to 2, indicating an excellent fit. Both RMR (0.044) and SRMR (0.031) were below 0.05, suggesting good fit. The RMSEA value of 0.022 indicated excellent fit. While GFI (0.887) and AGFI (0.876) were slightly below the ideal threshold of 0.90, they remained within the acceptable range above 0.80. All relative fit indices (NFI, IFI, TLI, CFI) exceeded 0.90, further confirming the model's good fit. These results demonstrate the refinement's effectiveness in improving the overall fit and reliability of the model.

The outcomes of the refined model are depicted in Figur, where all pathways now exhibit statistical significance. This section explores the mediating influences of three variables: team learning, team monitoring, and team climate, based on the refined model. Notably, the analysis includes all possible mediation pathways, including those involving sequential mediation chains among the three variables.

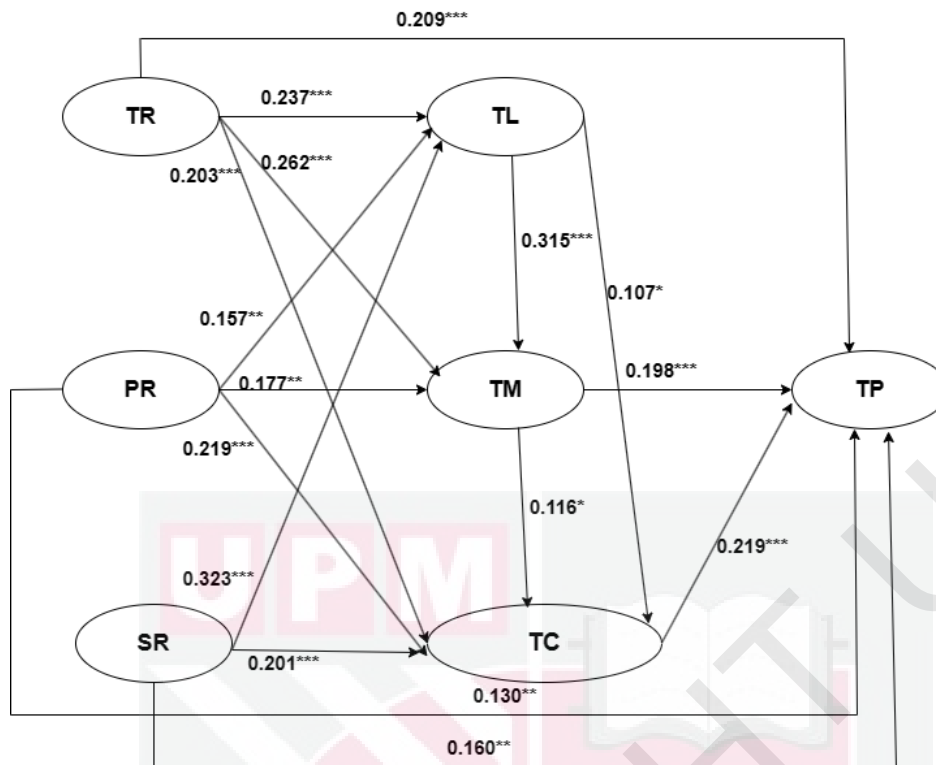


Figure 4.2: Refined Structural Model with Path Coefficients

Note: * indicates $p < 0.05$; ** indicates $p < 0.01$; *** indicates $p < 0.001$

Using AMOS 27 statistical software, coefficients and significance levels were calculated for the overall indirect effect of the independent variable (X) on the dependent variable (Y), as well as for the specific mediation effects through the proposed mediators. This was conducted via bootstrap-based structural equation modeling with 5000 resamples, as recommended by Preacher (2008). A bias-corrected bootstrap confidence interval at the 95% confidence level was applied to ensure robustness. If the confidence interval includes zero, the mediation effect is considered non-significant. The results of the mediation effect analysis are presented in Table.

The analysis revealed that the direct effect of team learning on team performance was not significant, leading to the removal of the path from team

learning to team performance in the refined model. However, serial mediation effects involving team learning and the other two mediators were still examined.

The total indirect effect of project managers' task-related competencies (TR) on team performance (TP) was 0.125 (bootstrap CI: 0.085 to 0.175), indicating a significant mediating effect, which accounted for 38.07% of the total effect. Six significant mediation paths were identified: TR→TM→TP (0.052, 15.57%), TR→TC→TP (0.044, 13.17%), TR→TL→TM→TP (0.015, 4.49%), TR→TL→TC→TP (0.006, 1.80%), TR→TM→TC→TP (0.007, 2.10%), and TR→TL→TM→TC→TP (0.002, 0.60%).

For people-related competencies (PR), the total indirect effect on team performance was 0.102 (bootstrap CI: 0.069 to 0.145), representing 43.97% of the total effect. Six significant mediation paths were identified: PR→TM→TP (0.035, 15.09%), PR→TC→TP (0.048, 20.69%), PR→TL→TM→TP (0.01, 4.31%), PR→TL→TC→TP (0.004, 1.72%), PR→TM→TC→TP (0.004, 1.72%), and PR→TL→TM→TC→TP (0.001, 0.43%).

The total indirect effect of self-related competencies (SR) on team performance was 0.074 (bootstrap CI: 0.047 to 0.110), accounting for 31.62% of the total effect. Four significant mediation paths were identified: SR→TC→TP (0.044, 12.94%), SR→TL→TM→TP (0.02, 5.88%), SR→TL→TC→TP (0.008, 2.35%), and SR→TL→TM→TC→TP (0.003, 0.88%).

These findings reveal the complex mediation mechanisms through which project managers' competencies influence team performance. Although team learning does not directly impact performance, it plays a key role in serial mediation, affecting both team monitoring and team climate. Team monitoring and team climate consistently emerge as significant mediators across all competency dimensions, underscoring their importance in translating managerial competencies into team performance.

The results indicate that project managers' competencies influence team performance both directly and indirectly through various team processes. The multiple significant mediation paths highlight the intricate relationships between managerial competencies, team dynamics, and performance outcomes. This complexity underscores the importance of a holistic approach to project management, where managers must develop a broad range of competencies and cultivate positive team processes to enhance performance.

Table 4.15: Results of Mediating Effect Test

Paths	Effect type	Effect	Boot SE	Boot LLC	Boot ULC	Ratio of	
						Indirect to Total Effect	Indirect to Direct Effect
TR→TP	Total effect	0.334	0.054	0.243	0.421		
	Direct effect	0.209	0.058	0.11	0.305	62.57%	
	Total indirect effect	0.125	0.027	0.085	0.175	38.07%	
	Indirect effect	0.052	0.016	0.03	0.083	15.57%	41.27%
TR→TM→TP							
TR→TC→TP							
TR→TL→TM→TP							
TR→TL→TC→TP							
TR→TM→TC→TP							
TR→TL→TM→TC→TP							
PR→TP	Total effect	0.232	0.052	0.141	0.312		
	Direct effect	0.13	0.053	0.041	0.216	56.03%	
	Total indirect effect	0.102	0.023	0.069	0.145	43.97%	
	Indirect effect	0.035	0.014	0.016	0.065	15.09%	34.31%
PR→TM→TP							
PR→TC→TP		0.048	0.017	0.025	0.081	20.69%	47.06%

Table 4.15: Continued

PR→TL→TM→TP	0.01	0.005	0.004	0.021	4.31%	9.80%
PR→TL→TC→TP	0.004	0.003	0.001	0.011	1.72%	3.92%
PR→TM→TC→TP	0.004	0.003	0.001	0.011	1.72%	3.92%
PR→TL→TM→TC→TP	0.001	0.001	0	0.003	0.43%	0.98%
SR→TP						
Total effect	0.234	0.052	0.151	0.321		
Direct effect	0.16	0.052	0.077	0.248	68.38%	
Total indirect effect	0.074	0.019	0.047	0.11	31.62%	
Indirect effect	0.044	0.016	0.022	0.075	12.94%	59.46%
SR→TC→TP						
SR→TL→TM→TP	0.02	0.008	0.011	0.036	5.88%	27.03%
SR→TL→TC→TP	0.008	0.005	0.001	0.018	2.35%	10.81%
SR→TL→TM→TC→TP					0.88%	4.05%

4.5 Discussion of Results

The model testing results, while not supporting all proposed hypotheses, offer valuable insights into the relationships among the research variables. Overall, the empirical findings are largely consistent with the theoretical expectations regarding the impact of project manager leadership competencies on project team performance. This section provides a more detailed analysis of both the direct and indirect effects, expanding on the results discussed in the previous section.

4.5.1 Main Findings and Hypothesis Testing Results

This study aimed to identify and analyze the key leadership competencies necessary for successful project management in the Chinese construction industry and to examine how these competencies influence project team performance. Grounded in the social information processing perspective, the study categorized project managers' leadership competencies into three dimensions: task-related, people-related, and self-related competencies. To investigate the mechanisms through which these competencies affect project outcomes, the study introduced three critical team processes: team learning, team monitoring, and team climate. These processes were incorporated into the research framework to explore their mediating role between leadership competencies and team performance.

In alignment with the first research objective (RO1), the study identified and analyzed the essential leadership competencies for successful project management through a qualitative analysis of expert surveys, leading to the development of a leadership competencies evaluation model using the weight factor judgment table method. The second objective (RO2) focused on developing and validating a theoretical model illustrating the direct relationships between project managers' leadership competencies, team processes, and team performance. The third objective (RO3) explored the mechanisms by which leadership competencies affect project outcomes, specifically testing the mediating effects of team processes. The hypothesis testing results are summarized in Table 4.16, with detailed findings for each research objective discussed in the following sections.

Table 4.16: Summary of Hypothesis Testing

Hypothesis	Results
H1a: Task-related competencies of project managers positively influence project team performance.	Supported
H1b: People-related competencies of project managers positively influence project team performance.	Supported
H1c: Self-related competencies of project managers positively influence project team performance.	Supported
H2a: Task-related competencies of project managers positively influence team processes.	Supported
H2b: People-related competencies of project managers positively influence team processes.	Supported
H2c: Self-related competencies of project managers positively influence team processes.	Partially Supported
H3a: Team learning mediates the relationship between project manager leadership competencies and project team performance.	Conditionally supported
H3b: Team monitoring mediates the relationship between project manager leadership competencies and project team performance.	Partially Supported
H3c: Team climate mediates the relationship between project manager leadership competencies and project team performance.	Supported

Note: Conditionally Supported refers to cases where the hypothesized relationship is not directly supported by the data but is affirmed through indirect effects or other mediating variables.

Partially Supported refers to cases where only some paths within the hypothesized relationship are supported, while others are not.

The hypothesis testing confirmed that project managers' leadership competencies have a significant positive impact on project team performance.

Specifically, task-related, people-related, and self-related competencies were found to have direct positive effects on project team performance, providing empirical support for Hypothesis 1 (H1). These results suggest that project managers' ability to manage tasks, interactions with people, and self-

regulation directly contribute to the improvement of team performance in a project context. Additionally, the study also found that all three dimensions of leadership competencies—task-related, people-related, and self-related—had a significant positive influence on critical team processes, including team learning, team monitoring, and team climate, supporting Hypothesis 2 (H2). This highlights the importance of leadership competencies not only in directly affecting performance but also in shaping the internal dynamics and processes of the project team.

The mediation analysis (H3) revealed that team learning, team monitoring, and team climate play varying mediating roles in the relationship between leadership competencies and project team performance. Team monitoring was found to successfully mediate the effects of task-related and people-related competencies on project team performance, but it did not mediate the relationship between self-related competencies and performance. This suggests that the ability of project managers to monitor and guide team activities is particularly tied to their task and people management skills, rather than their self-regulation competencies. In contrast, team climate emerged as a significant mediator across all three leadership competency dimensions, indicating that a positive and conducive team atmosphere facilitates the translation of project managers' competencies into improved team performance. Team learning, while also a mediator, exhibited a more complex pattern of mediation, successfully mediating most of the relationships but showing non-significant mediation for certain paths. This indicates that while

learning processes within the team are generally important, their role as a mediator may depend on specific contexts or competency types.

The findings of the study underscore the critical role of project managers' leadership competencies—task-related, people-related, and self-related—in enhancing project team performance. These competencies not only contribute directly to performance but also influence essential team processes, which in turn mediate the relationship between leadership competencies and performance outcomes. The results provide both theoretical and practical insights for the field of project management. Theoretically, they expand the understanding of how leadership competencies operate through team processes to impact performance. Practically, they offer guidance for project managers and organizations on how to develop and apply leadership skills to optimize team dynamics and improve project outcomes. Specifically, understanding the role of team climate as a consistent mediator suggests that fostering a positive team environment may be an effective strategy for leveraging leadership competencies to achieve better team performance.

4.5.2 Key Leadership Competencies in Chinese Construction Project Management

The qualitative research conducted in Phase 1 not only established a foundation for subsequent quantitative model development but also provided crucial insights into the leadership competencies essential for successful project management in the Chinese construction industry.

Our findings revealed a comprehensive set of 20 key competencies, categorized into three dimensions: 8 task-related (TR), 6 people-related (PR), and 6 self-related (SR) competencies. This tripartite structure underscores the multifaceted nature of leadership in construction project management, aligning with previous research on leadership competencies (Müller & Turner, 2010; Zhang et al., 2013).

In the task-related dimension, strategic thinking, organizational coordination, and decision-making emerged as the most critical competencies. This emphasis reflects the unique challenges faced by project managers in the Chinese construction industry, where rapid urbanization and large-scale infrastructure projects demand a strategic outlook, effective coordination of diverse stakeholders, and decisive action in complex, often ambiguous situations.

Interestingly, our study revealed an unexpected finding regarding the perception of formal education in the Chinese construction industry. Despite the general emphasis on educational qualifications in China, industry experts did not highly prioritize academic degrees or formal education in their assessment of essential leadership competencies. This surprising result may be attributed to the rapid and unique development trajectory of China's construction sector, where practical experience and on-the-job learning have often taken precedence over formal education. This finding contrasts with some Western studies that emphasize the importance of formal education in

project management (Bredillet et al., 2015), highlighting a potential cultural difference in leadership development approaches.

The people-related dimension highlighted communication skills, team motivation, and career development as key competencies. This focus on interpersonal skills is particularly relevant in the Chinese context, where concepts of *guanxi* (relationships) and *mianzi* (face) play significant roles in business interactions. The findings in this dimension align with previous research emphasizing the importance of relationship management in Chinese business contexts (Chen & Partington, 2004).

In the self-related dimension, initiative and adaptability were highly valued, alongside responsibility and confidence. These competencies reflect the dynamic nature of the Chinese construction industry, where rapid changes in technology, regulations, and market conditions necessitate continuous learning and flexibility. This emphasis on adaptability and lifelong learning echoes findings from global studies on project management competencies (Crawford, 2006).

The relative weighting of these dimensions, with task-related competencies receiving the highest importance, followed by people-related and then self-related competencies, offers valuable insights into the priorities of the Chinese construction industry. This hierarchy is consistent with some previous studies in the construction sector (Dainty et al., 2005), but contrasts with others that place greater emphasis on emotional and social competencies (Zhang et al.,

2013), suggesting potential areas for future research and industry development.

The project manager leadership competency model developed in this study (Table 4.4) provides a culturally relevant framework for Chinese construction firms to select, develop, and evaluate project managers. It reflects the unique blend of technical, interpersonal, and personal qualities required to succeed in the complex and rapidly evolving Chinese construction landscape.

This model also highlights areas for potential improvement in the industry. For instance, while self-related competencies received the lowest weighting, their importance in driving long-term success and innovation should not be underestimated. This finding aligns with global trends emphasizing the growing importance of emotional intelligence and self-management in leadership roles (Goleman et al., 2013).

Moreover, the identified competencies provide a roadmap for educational institutions and professional bodies in China to align their curricula and training programs with industry needs. This alignment could help address the skills gap often reported in the sector and prepare the next generation of construction project managers for the challenges they will face.

4.5.3 Direct Relationships: Leadership, Team Processes, and Performance

The second research objective (RO2) of this study is to develop and validate a theoretical model illustrating the direct relationships between project manager leadership competencies, team processes, and team performance in complex engineering projects. This investigation examines the interplay among these three key elements, focusing on the direct relationships between individual variables and dimensions. The measurement model primarily investigates these direct relationships, providing a clear understanding of the operational mechanisms within project teams.

4.5.3.1 Project Manager Leadership Competencies and Project Team Performance

Prior research consistently underscores the profound link between project manager leadership and project team performance (Crawford, 2007). Leadership competencies represent pivotal situational variables that significantly influence team outcomes. Gaining insights into leadership styles and developing key competencies stand as imperative strategies for project success (Muller & Turner, 2010).

This study classifies leadership competencies into three fundamental dimensions. Task-related competencies encompass the accomplishment of objectives. Guiding teams to achieve goals constitutes a central leadership responsibility (Kaiser et al., 2008). These competencies directly forecast goal

attainment and team performance (Vaculik et al., 2014). People-related competencies signify leaders' capacity to connect with employees, a factor intricately linked with satisfaction and motivation (Anderson, 2012; Reave, 2005). Self-related competencies, such as integrity, foster trust among employees, enhancing motivation and commitment (Bennis & Thomas, 2002; Ones et al., 1993; Wang & Hsieh, 2013).

This well-established competency model and its dimensions are applied to assess project manager leadership and its impact on team performance. Empirical findings affirm the aforementioned relationship hypotheses. Task-related competencies, people-related competencies, and self-related competencies all exert a significant positive influence on project team performance. In engineering project teams, the primary objective lies in completing various project tasks and achieving project goals. Task-related competencies manifest in defining task objectives, delegating project tasks, devising plans, and overseeing implementation, serving as vital prerequisites for project teams to fulfill their duties and collaborate effectively. Task-related competencies also encompass a project manager's ability to influence and persuade team members. Through clear communication and persuasive arguments, project managers can guide and motivate the team effectively, ensuring alignment with project goals.

People-related competencies encompass providing support, recognizing achievements, facilitating team building, nurturing employee development, and authorizing consultations. In contrast to task-related competencies,

people-related competencies enable project managers to foster robust team relationships, cultivate a collaborative atmosphere, support team members, enhance their enthusiasm and initiative, and bolster understanding and communication within the team. These competencies facilitate conflict resolution and personal growth among team members, thereby augmenting team efficiency, member capabilities, and the project manager's standing within the team. Strategic use of interpersonal skills empowers project managers to coordinate and motivate the team effectively, directly enhancing team performance.

A project manager's self-related competencies, characterized by self-discipline, leading by example, high accountability, honesty, confidence, tenacity, and optimism, are pivotal for influencing subordinates. These competencies enable project managers to maintain a focused and responsible work ethic, inspire the team through personal conduct, and cultivate mutual respect and trust. Furthermore, they enhance the project manager's ability to handle pressure, distill experiences, and improve team execution. Additionally, these competencies enhance a project manager's interpersonal skills, fostering effective collaboration and elevating overall team performance.

4.5.3.2 Project Manager Leadership Competencies and Team Process

According to analyses conducted by Carmeli et al. (2013) and Fedor et al., (2003), project managers, serving as leaders and information hubs within teams, play pivotal roles in shaping team behaviors, fostering reflective

communication among members, and cultivating an environment conducive to team learning. Advancements in various dimensions of project managers' leadership significantly enhance team learning outcomes. Leveraging project managers' leadership skills carries positive implications for augmenting teams' learning abilities, both theoretically and practically. Our empirical findings corroborate prior research, indicating that task-related competencies, people-related competencies, and project managers' self-related competencies all exert substantial positive effects on team learning, aligning with previous scholarly investigations.

Furthermore, from the perspectives of Dickinson & McIntyre (1997) and (Marks et al. (2001), project managers, as team leaders, directly influence trust-building among team members, guide and standardize team monitoring behaviors, and drive various monitoring activities. Enhancements in diverse dimensions of project managers' leadership effectively regulate and guide team monitoring behaviors, improving the quality and effectiveness of team monitoring, thereby positively impacting project progress. Consequently, project managers' leadership emerges as a pivotal prerequisite for determining and enhancing the effectiveness of team monitoring. Our sample validation indicates that among the three competencies of project managers, task-related competencies and people-related competencies significantly influence team monitoring. In contrast, the impact of project managers' self-related competencies on team monitoring is not significant. These self-related competencies, encompassing traits such as self-discipline, leading by example, high responsibility, honesty, confidence, and optimism, serve as social

information sources perceived by team members, influencing the team. However, unlike task-related competencies and people-related competencies, these effects are not directly linked to task execution, leader-member exchanges, or the team interaction atmosphere. Instead, they primarily influence team monitoring through the intermediary bridge of team learning, an integral part of the team process.

Lastly, drawing from Anderson & West (1998) research, project managers, as team leaders, directly shape team climate through their interaction styles, support, trust, and encouragement of innovation among team members. Effective leadership nurtures an open, secure, and inspiring team environment, fostering collaboration and enhancing information processing capabilities among team members. Consequently, project managers' leadership skills emerge as critical factors in fostering a positive team climate, ultimately enhancing team performance and cohesion.

4.5.3.3 Team Process and Team Performance

This study explores the intricate mechanisms underlying the influence of project manager leadership competencies within project teams using Marks and Panzer's (2004) conceptual framework of team processes. Following Marks's categorization into transition processes, action processes, and interpersonal processes, the variables of team learning, team monitoring, and team climate are measured, respectively.

The role of team learning within teams has stirred debates. While some argue that team learning drives improvements in team performance (Rumsey, 2013), others contend that excessive emphasis on it in stable environments can disrupt normal team operations, impairing performance (Bunderson & Sutcliffe, 2003). In project contexts, team learning does not directly impact project team performance. Complex engineering projects necessitate internal knowledge flow within teams, enabling rapid problem-solving for intricate issues beyond individual capacities. Although team learning enhances knowledge value by creating new insights based on existing knowledge exchange, its practical value in project problem-solving requires implementation by other teams. Focusing solely on team learning in transition processes does not directly influence project team performance.

Team monitoring, a well-established concept in team performance research (Marks & Panzer, 2004; Jentsch et al., 2005), involves mutual performance monitoring, where team members evaluate each other's behaviors. This mutual supervision ensures procedural compliance and work quality (McIntyre & Salas, 1995). In dynamic work environments, especially with high interdependence, team monitoring is vital. It acts as a crucial coordination mechanism, enabling behavioral adjustments based on expectations, thus enhancing overall performance (Burtscher et al., 2011; Rico et al., 2008). Empirical analyses in our study confirm team monitoring's significant positive impact on team performance. Evaluating each other's work behaviors not only ensures compliance but also fosters mutual accountability, enhancing team effectiveness and efficiency. Representing the action phase in team processes,

team monitoring enables effective behavioral adjustments, ensuring timely task completion.

Team climate profoundly influences team performance, reflecting team members' shared perceptions about working methods and practices (Acuña et al., 2008). It encompasses team attributes and is crucial for internal relationships. Positive team climate fosters communication, teamwork, and productivity, while negativity can cause conflicts and reduced productivity. In our empirical study with construction project managers, team climate demonstrated a significant positive impact on team performance. In the transition and action processes, knowledge, rules, and team behaviors determine competitive advantage. Team performance relies on the quantity and integration of team knowledge, along with knowledge sharing and application. As part of interpersonal processes, team climate integrates knowledge, rules, and behaviors, providing an optimal space for knowledge application and creation. Organizations must foster integration capabilities, enabling knowledge combination and new structural knowledge creation. Positive team climate encourages knowledge sharing, leading to innovation through knowledge combination. Team climate profoundly influences innovative performance, depending on contributed knowledge and the team's capability to combine it. A climate encouraging knowledge sharing and rational integration significantly impacts innovative performance.

4.5.3.4 The Relationship between Team Learning, Team Monitoring and Team Climate

Team learning, team monitoring, and team climate represent vital internal processes within a team. Among these, team learning holds particular significance as it enables teams to adapt effectively and enhance their knowledge base (Mathieu et al., 2008). Its influence is profound, not only shaping subsequent processes like team monitoring and team climate but also guiding teams in evaluating and planning activities between performance episodes, aligning taskwork toward collective goals. Team monitoring, conversely, is an action-oriented process that involves observing teammates, monitoring their performance, and providing assistance, thereby directly impacting the relationships among team members (Langfred, 2004). The positive effects of team monitoring inevitably extend to the interpersonal dynamics of team climate.

In the empirical analysis conducted in this study, the substantial positive impact of team learning on both team monitoring and team climate is evident. Team monitoring also exerts a significant positive influence on team climate. It becomes clear that team learning serves as a driving force, bringing both team monitoring and team climate into play. Team monitoring, through real-time assessment and assistance, actively shapes interactions among team members, with its influence on team climate being undeniable. As an interpersonal process, team climate is molded by both team learning and team monitoring. Team learning opens avenues for flexibility and knowledge accumulation, while team monitoring actively engages during critical work

stages, promoting collaboration and providing immediate support among team members. These intertwined processes synergistically foster a positive team climate, encouraging enhanced cooperation, learning, and adaptation among team members, thereby elevating overall team performance. The interactions among team learning, team monitoring, and team climate serve as crucial pillars supporting team collaboration and development, enabling teams to effectively achieve shared objectives.

4.5.4 Mediating Effects of Team Processes

In preceding sections, the relationships between the three dimensions of project manager leadership competencies and team processes—including team learning, team monitoring, and team climate—were explored in relation to project team performance. In the model assumptions of this study, team learning, team monitoring, and team climate are viewed as social information processing mechanisms. This section delves into the roles of these team processes in mediating the connection between project manager leadership competencies and project team performance. Furthermore, the interactions among these team processes are explicitly delineated, providing robust support for an in-depth understanding of the chain mediation model, consisting of team learning, team monitoring, and team climate.

Due to the temporary nature of project teams, spontaneous team learning among project members is typically limited. Thus, it becomes crucial to promote team learning behaviors through the leadership role of project

managers to enhance team performance. Previous empirical research has substantiated the mediating role of team learning in the relationship between team leadership and team performance (Choi et al., 2016; Lee et al., 2010). Our empirical findings corroborate this, confirming the impact of leadership competencies on team learning behaviors. Consequently, the mediating role of team learning in the relationship between project manager leadership competencies and team performance is explored. Since the direct impact of team learning on team performance is not significant, the isolated mediating effect of team learning does not stand. The mediation effect of team learning on project manager leadership competencies and team performance primarily manifests within the chain mediation composed of team learning, team monitoring, and team climate, representing a partial mediation effect. In these chain mediation models, team learning primarily acts as a mediator through its influence on team monitoring. Among the three dimensions of project manager leadership competencies, team learning and team monitoring exert the most substantial indirect effects on the relationship between project manager's self-related competencies and team performance. Although team learning does not exhibit a more direct mediating effect, it, as a transition process in team processes, links leadership with performance through its influence on the other two team processes, providing an effective platform for learning and growth within the team, thereby enhancing project team performance.

Team monitoring constitutes a typical action process within teams. In our empirical verification, team monitoring demonstrates significant mediating effects on task-related competencies, people-related competencies, and team

performance, indicating partial mediation effects. To ensure the realization of long-term team goals and the development of team members' skills, team members mutually assess their work abilities and actual performances, inspecting and comparing task completion with team expectations. It is evident that task-related competencies promote team monitoring, which, in turn, further enhances team performance. Team monitoring not only focuses on individual performance levels but also involves mutual comparison and supervision, mitigating free-riding phenomena within the team. Objectively, it urges all team members to concentrate on task accomplishment. Additionally, people-related competencies foster the personal growth of team members and the deepening of relationships, contributing to the enhancement of team monitoring capabilities and effects among members. Team monitoring facilitates mutual understanding of each other's actions and task completion, objectively encouraging the contributions of team members, ultimately leading to improved team performance.

As an interpersonal process within team dynamics, team climate arises from interactions among members and between members and the environment during team work. Team climate enhances professionals' information processing abilities (Açıkgöz et al., 2014) and fosters a sense of security. When members are encouraged to express opinions and experiment with new ideas or methods without fearing negative consequences, this sense of security allows them to make mistakes, positively impacting the entire team (Weiss et al., 2011). From the empirical analysis results of this study, team climate plays a partial mediating role between the three dimensions of project

manager leadership competencies—task-related competencies, people-related competencies, and self-related competencies—and team performance. Specifically, effective leadership competencies emphasize team interactions and socialization processes. By encouraging active participation of employees in team activities, team connections and a sense of belonging are strengthened, thus positively influencing team climate. This behavior and atmosphere construction reinforce the connections among team members, enhance relationship quality, and contribute to the improvement of project team performance. Finally, team climate mediates the relationship between project manager leadership competencies and team performance. This indicates that team climate is a crucial intermediary through which project manager leadership competencies are transmitted as social information sources. At the team level, project managers demonstrating care for team members' growth and competence development trigger the team's emotional mechanism, improve the team's work status, and consequently enhance project team performance. Therefore, team climate serves not only as an emotional state but also as a vital link between project manager leadership competencies and team performance, playing a positive role in the overall team operational process and work status.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a comprehensive overview of the study's conclusions and implications. The second section revisits the key research objectives and summarizes the main findings in relation to these objectives. The third section discusses the contributions of the research, highlighting its significance for academia, industry, and policy-making. Finally, the chapter critically addresses the limitations of the study and offers recommendations for future research, aiming to enhance the understanding and application of leadership competencies in construction project management.

5.2 Conclusion

This section presents the conclusions drawn from the study, demonstrating how the research objectives and questions have been systematically addressed. The study aimed to explore the relationships between project manager leadership competencies, team processes, and project team performance within the Chinese construction industry. By integrating both theoretical and empirical approaches, the study has provided valuable insights into the mechanisms through which leadership competencies influence project outcomes.

The first research objective (RO1)—to identify and analyze the key leadership competencies required for successful project management in the Chinese construction industry—was achieved through a rigorous process of literature review, expert consultation, and empirical validation. The study identified three core dimensions of project manager leadership competencies: task-related, people-related, and self-related. These dimensions reflect the multifaceted nature of leadership in construction, where technical proficiency, interpersonal skills, and personal integrity are all critical for effective project management. Task-related competencies, such as goal-setting, task delegation, and project oversight, were found to be particularly important in the context of the Chinese construction industry, where the complexity and scale of projects demand strong organizational and planning skills. People-related competencies, which include relationship-building, motivation, and conflict resolution, are equally essential, as they contribute to creating a cohesive and motivated project team. Finally, self-related competencies, such as integrity, self-discipline, and resilience, were shown to foster trust and respect within the team, although their direct impact on certain team processes—such as team monitoring—was found to be less pronounced.

The second research objective (RO2)—to develop and validate a theoretical model illustrating the direct relationships between project manager leadership competencies, team processes, and team performance—was addressed through the application of Structural Equation Modeling (SEM). The validated model confirmed that project manager leadership competencies significantly and positively influence project team performance. Specifically, the study

found that task-related, people-related, and self-related competencies all have a direct impact on performance, with task-related competencies exerting the strongest influence. These findings are consistent with existing literature, which underscores the importance of effective leadership for achieving project success. Moreover, the study demonstrated that these competencies not only affect performance directly but also shape the internal team dynamics that contribute to team effectiveness.

The third research objective (RO3)—to explore the mechanisms through which project manager leadership competencies impact project outcomes by testing an improved model with mediating effects—was achieved by examining the role of team processes as mediators in the relationship between leadership competencies and team performance. The study identified three key team processes: team learning, team monitoring, and team climate, and explored their mediating roles. The findings confirmed that team processes play a crucial role in translating leadership competencies into performance outcomes. Team learning, while not directly linked to performance, was found to facilitate other team processes—particularly team monitoring and team climate—which in turn positively influenced team performance. This suggests that effective leadership promotes a culture of continuous learning and improvement, which enhances the team's ability to monitor progress and maintain a positive working environment. The study also found that team climate, as a reflection of the shared perceptions and interactions within the team, was a particularly strong mediator, reinforcing the idea that a supportive and collaborative team environment is essential for high performance.

The empirical results also provided evidence for the sequential mediation of team processes. It was observed that team learning initiates improvements in team monitoring, which then fosters a positive team climate, ultimately enhancing team performance. This sequential mediation highlights the interconnectedness of team processes and emphasizes the importance of leadership in fostering an environment where learning, monitoring, and collaboration are encouraged. The study's findings thus extend the understanding of how leadership competencies influence not only the immediate outcomes of team performance but also the underlying processes that drive team success.

In addressing the research hypotheses, the study has provided comprehensive evidence supporting the view that project manager leadership competencies have both direct and indirect effects on project team performance. Task-related competencies were shown to directly improve performance by enhancing team monitoring and clarifying project goals. People-related competencies, on the other hand, were found to strengthen team relationships and create a positive team climate, which indirectly contributes to performance. Although self-related competencies had a less direct impact on team processes, they were nonetheless important in fostering trust and accountability within the team, which are critical for long-term project success.

The research also addressed the study's key research questions. The first research question, which sought to identify the critical leadership

competencies for project managers in the Chinese construction industry, was answered through the identification of 20 specific competencies across the three core dimensions. The second research question, which aimed to develop a theoretical model linking leadership competencies to team processes and performance, was addressed through the validation of the SEM model, which demonstrated a strong fit with the empirical data. The third research question, focused on the direct effects of leadership competencies on team performance and dynamics, was resolved through analysis of the measurement model. The fourth research question, which examined the mediating role of team processes in the relationship between leadership competencies and performance, was answered through the analysis of the enhanced model, which confirmed the mediating effects of team learning, monitoring, and climate.

Furthermore, the study highlights the importance of fostering a positive team climate and promoting continuous learning and monitoring within teams. These processes not only enhance team performance but also create a more resilient and adaptive project environment. In the context of the Chinese construction industry, where projects are often large-scale and complex, these findings underscore the need for project managers to cultivate leadership competencies that go beyond technical expertise, focusing on building strong, collaborative teams that can navigate the challenges of modern construction projects. Ultimately, the study provides a robust foundation for future research and offers practical guidelines for improving leadership development and team management in the construction sector.

5.3 Contributions

This study illuminates the impact of project manager leadership competencies on project team performance within the Chinese construction industry, providing an in-depth examination of how these competencies influence team dynamics and outcomes. The research contributes to both the theoretical understanding of leadership in project management and its practical applications. By addressing gaps in current knowledge and offering a nuanced analysis of the relationships among leadership competencies, team processes, and team performance, this study yields significant insights beneficial to both academic inquiry and industry practice.

5.3.1 Theoretical Contributions

Enhancing project performance has long been a central focus of project management research, with recent studies highlighting the importance of leadership competencies as critical determinants of project success. However, much of the prior research, while acknowledging the relevance of leadership, has tended to focus on general leadership styles or specific competencies without exploring their effects on team processes and subsequent project performance. This study makes a vital contribution by systematically analyzing how project manager leadership competencies—categorized into task-related, people-related, and self-related dimensions—affect team performance through mediating team processes such as learning, monitoring, and climate.

A key theoretical contribution of this study lies in its expansion of the traditional understanding of project manager leadership competencies, particularly within the Chinese construction industry. By introducing a three-dimensional framework of leadership competencies, the study moves beyond simplistic identifications and provides a detailed examination of how each dimension interacts with team processes at various stages of the project cycle. This nuanced perspective enhances understanding of how leadership competencies serve not only as determinants of performance outcomes but also as active agents that shape the internal dynamics of project teams. The empirical validation of this three-factor model—comprising task-related, people-related, and self-related competencies—bolsters the theoretical framework and confirms its applicability to the construction industry. The findings underscore that different types of leadership competencies have varying impacts on team processes, with task-related competencies being particularly influential in effective team monitoring and performance, while people-related competencies significantly contribute to fostering a positive team climate.

Moreover, this research offers an innovative theoretical contribution by applying the social information processing model to the context of construction project management. By conceptualizing the project manager as a key source of social information that shapes team behavior and performance, the study links leadership competencies to team outcomes through intermediary processes. Identifying team learning, team monitoring, and team climate as mediating factors provides a theoretical framework that explains how

leadership competencies influence project performance and uncovers the mechanisms through which these effects are transmitted. This application enriches the understanding of leadership in project management by emphasizing the role of information flow and team dynamics in mediating the leadership-performance relationship. The study thus extends existing leadership theories by integrating insights from organizational behavior and social psychology, offering a comprehensive lens to view the leadership-performance nexus in project management.

Finally, the study clarifies the differential effects of various leadership competencies on team processes and outcomes. While previous research has recognized the importance of leadership in project success, consensus on how different competencies influence specific team processes has been limited. This study addresses that gap by providing empirical evidence that task-related competencies have a more direct impact on team monitoring and performance, while people-related competencies are essential for cultivating a positive team climate, which is critical for long-term project success. Additionally, self-related competencies, including personal integrity and resilience, were found to play a more indirect role, fostering trust and accountability within the team. These insights contribute to the broader theoretical discourse on leadership in construction project management, offering a structured framework for understanding the multifaceted role of leadership competencies in shaping team performance.

5.3.2 Practical Contributions

Beyond its theoretical contributions, this study offers valuable practical insights that can be applied to the construction industry, particularly in the realm of project management. The integration of project manager leadership competencies into the study's framework provides a useful model for industry practitioners, offering clear guidance on how to enhance project team performance through effective leadership. Given the critical role that project managers play in overseeing construction projects, this research provides actionable recommendations for improving recruitment, training, and management practices in the industry.

First, this study has significant implications for the recruitment and development of project managers within the construction sector. By identifying the specific competencies that are most closely linked to project success, the study offers a practical framework for assessing and selecting project managers who possess the leadership skills necessary to drive team performance. The leadership competencies index model developed in this study can serve as a valuable benchmark for construction companies, helping them to identify the key attributes that are essential for successful project management. Furthermore, the model can be used to design targeted training programs that focus on developing task-related, people-related, and self-related competencies. By equipping project managers with a balanced set of leadership skills, construction firms can enhance the overall performance of their project teams and improve their competitiveness in the industry.

From a corporate perspective, this study's findings on the mechanisms through which leadership competencies influence team performance offer important insights for improving project team management. While the competencies of project managers are undoubtedly critical, the study emphasizes that team performance is also shaped by the processes that occur within the team. Effective project managers not only lead by example but also foster a collaborative environment in which team members can thrive. By promoting team learning, encouraging regular monitoring, and cultivating a positive team climate, project managers can significantly enhance the efficiency and cohesiveness of their teams. This study provides practical guidelines for construction companies on how to support project managers in their efforts to build high-performing teams. For example, encouraging open communication between managers and team members, promoting a culture of continuous learning, and facilitating regular feedback sessions can help to foster a more engaged and productive workforce. These practices, in turn, can lead to improved project outcomes and increased client satisfaction.

For project managers themselves, this study offers a roadmap for personal and professional development. By highlighting the importance of task-related, people-related, and self-related competencies, the research provides project managers with a clear understanding of the leadership attributes they need to cultivate in order to be effective. Self-awareness of one's leadership strengths and weaknesses is critical for personal growth, and this study offers project managers the tools to reflect on their own competencies and identify areas for improvement. By focusing on enhancing their leadership skills, project

managers can become more adept at managing complex projects, leading their teams more effectively, and achieving better overall project outcomes. The study's findings on the mediating role of team processes also offer practical insights for project managers seeking to optimize team performance. Understanding how team learning, monitoring, and climate contribute to success allows project managers to proactively address potential challenges and create a more supportive and productive team environment.

5.4 Limitations of the Study

This study provides a comprehensive investigation into the influence of project manager leadership competencies on project team performance within the construction industry, yielding valuable insights into the mechanisms that mediate this relationship. By integrating theoretical analysis with empirical research, substantial progress is made in understanding how leadership competencies impact team processes and outcomes. Additionally, the study offers practical recommendations for project managers and construction companies, aiming to guide the development of stronger leadership capabilities and improved team management practices. However, certain limitations must be acknowledged to present a balanced view of the findings and to inform future research directions.

One primary limitation of this study is its scope. While it focused on the internal dynamics of construction project teams and examined how project manager leadership competencies affect team processes and performance, it did not

address the broader external environment in which project teams operate. Interactions between project teams and external stakeholders, such as clients, contractors, and regulatory bodies, were beyond the scope of this research. Project managers often engage in cross-organizational activities that extend beyond their immediate teams, and their leadership competencies may be crucial in managing these external relationships. The exclusion of these factors presents a circumscribed view of leadership influence, concentrating solely on internal team processes. Future research should expand the scope to include external dimensions of project management, investigating how project manager leadership competencies affect interactions with stakeholders and cross-boundary collaborations, which are vital for the overall success of construction projects.

Another limitation relates to the content and contextual aspects of the research. Although the study empirically validated the direct and indirect effects of leadership competencies on team performance through mediating processes, it did not incorporate contextual variables that could influence these relationships. Construction projects are inherently complex, characterized by varying degrees of uncertainty, complexity, and external pressures, which can alter team dynamics and modify the impact of leadership competencies. For instance, changes in project scope, deadlines, or unexpected challenges could influence how team learning, monitoring, and climate evolve under a project manager's leadership. While the developed model provides a robust foundation for understanding leadership influences, it does not account for these situational variables, which may introduce variations in the strength or

direction of observed effects. Consequently, future research should include contextual factors, such as project complexity, urgency, and environmental volatility, to offer a more comprehensive understanding of when and how leadership competencies exert their influence in dynamic project environments.

The research design also presents limitations that may affect the generalizability of the findings. The study relied on self-reported survey data, which, while useful for capturing subjective perceptions of leadership and team performance, may introduce common method bias. Although efforts were made to minimize this bias through careful questionnaire design and statistical controls, reliance on a single method of data collection remains a potential weakness. Furthermore, the scales used to measure leadership competencies and team processes were adapted from existing literature, which may not fully capture the complexity of these constructs. While the measures were rigorously validated and translated for accuracy, they primarily focused on core dimensions, potentially overlooking nuanced elements of leadership competencies or team dynamics that could influence project performance. Future research should incorporate data from multiple sources, such as interviews, observational studies, or feedback from external stakeholders, to triangulate findings and reduce potential biases. Additionally, expanding the sample size and exploring diverse project settings could enhance the robustness of results and increase their applicability across different types of construction projects.

5.5 Recommendation

This study enhances the understanding of how project manager leadership competencies influence team dynamics and performance. However, its findings are constrained by certain limitations, as previously noted. Future research should address these constraints and expand the framework to further investigate leadership in the construction industry.

One key area for future exploration is the broadening of the research scope and content. This study primarily focused on internal processes within project teams, analyzing how project manager leadership competencies affect team learning, monitoring, and climate. However, construction projects exist within a larger organizational and environmental context, where external factors such as organizational culture, information technology support, and the overarching organizational system significantly impact team performance. Moreover, elements such as project complexity, project type, and organizational structure may mediate the relationship between leadership competencies and team dynamics. These external and contextual variables were not extensively addressed in this study, yet they are essential for a holistic understanding of leadership in construction projects. Future research should integrate these factors into the framework, examining how they interact with project manager leadership competencies to influence both team performance and the feedback loops that occur when team performance affects the broader project environment. Successful project outcomes can enhance trust among team members, foster a positive project culture, and improve overall team cohesion,

while project failures may undermine morale and disrupt dynamics. Thus, future studies should adopt a systemic perspective, analyzing the reciprocal relationships between leadership, team performance, and the broader project context.

In addition to expanding the research scope, future studies should address limitations related to the research design. The current research relied on survey data collected within a specific region and context, which may limit the universality of the findings due to geographic and cultural factors. Leadership in the construction industry likely varies across regions, influenced by cultural differences that affect leadership styles, team dynamics, and organizational structures. Future research should incorporate data from a more diverse range of settings, with cross-cultural comparisons enriching the understanding of how leadership competencies are perceived and applied in different contexts. By collecting data from global construction projects and comparing results across regions, future studies could provide valuable insights into the cultural nuances that impact leadership effectiveness in project management, facilitating a comparison of universal versus context-specific competencies.

Moreover, future research should adopt a dynamic approach that accounts for the evolving nature of project teams throughout a project's lifecycle. Construction projects are rarely static and require constant adaptation as they progress through various stages, from planning and design to execution and completion. Project managers must adjust their leadership behaviors in response to changing project conditions, team dynamics, and external

pressures. This study offers a snapshot of leadership competencies' influence on team performance at a specific point in time but does not capture the dynamic nature of leadership over a project's lifecycle. Future research should consider longitudinal studies that track the impact of leadership competencies across different stages of project implementation. Such studies could provide a detailed understanding of how project managers' leadership styles evolve in response to milestones, challenges, and changes in team composition. For example, case studies or empirical research utilizing longitudinal data could investigate how leadership behaviors shift from the early stages of team formation, where establishing trust and cohesion is critical, to later stages, where task execution and problem-solving become paramount. This approach would yield a richer exploration of the temporal dynamics of leadership and offer a nuanced understanding of how project managers can adjust their strategies to optimize team performance as the project progresses.

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APPENDICES

Appendix A



Questionnaire on Selecting Competency Factors for Construction Project Manager Leadership Competencies

Dear Expert in the Construction Industry,

We extend our greetings to you. This survey is conducted anonymously and exclusively for academic research purposes. We encourage you to respond candidly and with assurance.

Enclosed is a list of potential competency factors pertinent to construction project manager leadership. Kindly select the competency factors you deem most essential for construction project managers or those that significantly influence project team performance. Please indicate your selections by marking "√" in the provided boxes. We appreciate your valuable input.

Dimensions	Potential Competency Factors
Task-Related Competencies	1. Technical skills ☐ 2. Risk management ☐ 3. Project experience ☐ 4. Education ☐ 5. Strategic thinking ☐ 6. Analytical abilities ☐ 7. Task management ☐ 8. Organizational coordination abilities ☐ 9. Innovation ☐ 10. Decision making ☐

People-Related Competencies	1.Flexibility ☐ 2.Interpersonal skills ☐ 3.Negotiation ☐ 4.Motivate team members ☐ 5.Competency development and career guidance ☐ 6.Get support from the team ☐ 7.Get support from senior managers ☐
Self-Related Competencies	1.Responsible ☐ 2.Confidence ☐ 3.Initiative ☐ 4.Work under pressure ☐ 5.Behavioral consistency ☐ 6.Adaptability ☐ 7.Passion ☐ 8.Self-control ☐



providing essential theoretical guidance for project managers. Your participation is highly appreciated.

Your responses will be treated as STRICTLY CONFIDENTIAL, and individual answers will remain anonymous.

If uncertain about an answer, please provide your best estimate. There are no right or wrong answers.

I DEMOGRAPHIC INFORMATION

1. Gender:

Male _____

Female _____

2. Age:

<24 _____

25-30 _____

31-40 _____

41-50 _____

51 and

above _____

3. Qualification:

Diploma _____

Beachelor's _____

Masters _____

PhD. _____

3. Your working years are:

Less than 3 years _____

3~5 years _____

6~8 years _____

More than 8 years _____

4. Nature of your current work unit: ☐☐

Central enterprise _____ Local state-owned enterprise _____

Private enterprise _____ Other _____ ☐☐

5. Previous Construction Project Experience:

Yes _____

No _____



Please choose an impressive project you are currently participating in or have participated in, and answer the following questions.

Note: Please answer all of the following questions based on the same project.

II Information of the project

1. Project Type:

Building construction project _____ Railway project _____

Highway project _____ Municipal project _____

Others _____

2. Contract Value of the Project:

Less than 50 million _____ 50 million to 100 million yuan _____

100 million to 500 million yuan _____ 500 million to 1 billion yuan _____

More than 1 billion yuan _____

3. Your Position Title on the Project:

Project Engineer _____

Project Department Manager/Deputy

Manager _____

Technical Supervisor _____

General Staff _____

4. Size of Project Team:

15 members or fewer _____ 16-50 members _____

51 members and above _____

5. Duration of the project:

Less than 1 year _____ 1-3 years _____ 3-5 years _____ 5 years
and above

Note: The answer to the question is on a 5-point scale, where 1 means strongly disagree, 2 means somewhat disagree, 3 means neither agree nor disagree, 4 means somewhat agree, and 5 means strongly agree.

There is only ONE answer to each question.

III PROJECT MANAGER'S LEADERSHIP COMPETENCIES

The upcoming questions aim to assess the leadership competencies of project managers. We kindly request that you evaluate these competencies from an objective standpoint and select the response that aligns most accurately with your opinion, considering the real-life context.

Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
1	2	3	4	5

TR					
My project manager has a clear understanding of the project processes and related technologies.	1	2	3	4	5
My project manager possesses extensive engineering knowledge and relevant expertise.	1	2	3	4	5
My project manager has extensive experience and skills in engineering projects.	1	2	3	4	5
My project manager can effectively identify, analyze, and control risk factors.	1	2	3	4	5
My project manager can effectively prevent and handle work conflicts and interpersonal conflicts.	1	2	3	4	5
My project manager is able to organize team members and coordinate various tasks.	1	2	3	4	5
My project manager rewards individuals with outstanding job performance.	1	2	3	4	5
My project manager emphasizes the connection between goal achievement and rewards.	1	2	3	4	5
My project manager focuses more on team members with strong abilities and high levels of expertise.	1	2	3	4	5
My project manager can deeply and accurately analyze problems and solve difficult issues effortlessly.	1	2	3	4	5

PR					
The project manager cares about team members and provides support and assistance for their work and personal difficulties.	1	2	3	4	5
The project manager frequently appreciates team members who work hard and achieve exceptional results.	1	2	3	4	5
The project manager supports team members' skill improvement and career development.	1	2	3	4	5
The project manager believes that team members can handle complex tasks.	1	2	3	4	5
The project manager actively seeks input and suggestions from subordinates when making decisions.	1	2	3	4	5
The project manager allows us to complete tasks in our own way.					
The project manager delegates appropriate authority to subordinates.					
The project manager holds high expectations when communicating with team members.					
SR					
The project manager sets a disciplined example through their own actions.	1	2	3	4	5
The project manager is highly responsible and willing to take on responsibilities.	1	2	3	4	5
The project manager is sincere and values integrity.	1	2	3	4	5

The project manager demonstrates self-control and restraint.	1	2	3	4	5
The project manager is positive and optimistic, willing to face challenges.	1	2	3	4	5
In complex situations, the project manager makes clear decisions using rationality and intuition.	1	2	3	4	5

IV TEAM PROCESS

The forthcoming questions outline three processes through which project team members assimilate the information derived from the project manager's leadership competencies. We kindly ask that you evaluate these processes objectively and select the response that most accurately reflects your viewpoint, taking into consideration the actual circumstances.

Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
1	2	3	4	5

Team Learning					
Team members actively strive to identify new challenges in their work.	1	2	3	4	5
Team members openly engage in communication and discussion about relevant issues.	1	2	3	4	5
Team members frequently engage in discussions on enhancing teamwork.	1	2	3	4	5

Team members regularly consolidate their experiences and lessons learned.	1	2	3	4	5
Team members proactively experiment with novel ideas and solutions in their work.	1	2	3	4	5
Team Monitoring					
In this team we check whether everyone meets their obligations to the team.	1	2	3	4	5
In this team we watch whether everyone completes their work on time.	1	2	3	4	5
In this team we keep close track of whether everyone performs as expected.	1	2	3	4	5
In this team we check whether everyone is doing what is expected of him/her.	1	2	3	4	5
In this team we carefully monitor each other's progress on his/her work.	1	2	3	4	5
Team Climate					
Team members trust each other mutually.	1	2	3	4	5
Team members are willing to share sensitive information with each other.	1	2	3	4	5
Team members believe in each other's trustworthiness.	1	2	3	4	5
Team members are able to engage in (constructive) arguments when they have different opinions.	1	2	3	4	5
Different opinions among team members are taken seriously.	1	2	3	4	5

Team members have a strong sense of belonging to the team.	1	2	3	4	5
Team members perceive the team's difficulties as their own.	1	2	3	4	5
Team members feel like a part of the team family.	1	2	3	4	5

IV PROJEVT TEAM PERFORMANCE

The ensuing questions focus on gauging the performance of the project team. We kindly request that you assess this performance from an objective standpoint and select the response that aligns most closely with your opinion, considering the actual circumstances.

Strongly Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Strongly Agree
1	2	3	4	5

The project team can meet project schedule deadlines.	1	2	3	4	5
The project team rarely experiences rework and delays.	1	2	3	4	5
The project team's cost control is within a reasonable range.	1	2	3	4	5
The project's durability and appearance meet the requirements.	1	2	3	4	5
In the project department, I fully utilize my professional expertise.	1	2	3	4	5
In the project department, my work results are commensurate with the rewards I receive.	1	2	3	4	5

In the project department, my work is acknowledged and praised by leadership.	1	2	3	4	5
In the project department, my work is respected by colleagues and peers.	1	2	3	4	5
In the project department, team members maintain stable work efficiency.	1	2	3	4	5
When facing problems, team members consistently find creative solutions.	1	2	3	4	5
Team members can propose innovative construction and management methods in the project department.	1	2	3	4	5

This is the end of the questionnaire, please check carefully whether there are any missing answers.

Thank you again!

Appendix C

Table : Summary of selected studies

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
1	Edum-Fotwe & McCaffer(2000)	IJPM	Interview/Survey questionnaire	UK	Project managers in the UK construction industry	170
2	Miller et al.(2000)	JME	Case study	US		
3	El-Sabaa(2001)	IJPM	Interview/Survey questionnaire	US	Project managers and functional managers	220
4	Ogunlana et al(2002)	IJPM	Survey questionnaire	Thailand	Top ranking project managers in Bangkok construction companies	36
5	Odusami(2002)	JME	Survey questionnaire	Nigeria	Project leader in Nigeria construction industry	120
6	Shohet & Frydman(2003)	JCEM	Structured questionnaires	Israel	Building and residential projects team in Israel	30
7	Keegan & Den Hartog(2004)	IJPM	Questionnaire	Netherlands	Employees of a large technical and logistics-	

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
					oriented department of a government organisation	
8	Crawford(2005)	IJPM	Questionnaire	Australia, UK and USA	Project management practitioners in four application areas	208
9	Zwikael et al.(2005)	IJPM	Questionnaire	Israel/ Japan	Project managers of engineering, software, communications and services project	337
10	Turner & Müller(2005)	PMJ	Literature review			
11	Fisher et al.(2005)	JCEM	Survey questionnaire/oral interview	Mexico	Project managers	35
12	Dainty et al.(2005)	JME	Behavioural event inter-views	UK	A range of construction managers	60

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
13	Skipper & Bell(2006a)	JME	Questionnaire	USA	Project managers from a US construction company	68
14	Ralf Müller & Turner(2007)	IJPM	Semi-structured interview/ Questionnaire	Worldwide	Members of professional organizations in project management	400
15	Chen & Lee(2007)	IJPM	Qualitative research/Case study	Taiwan		
16	Dolfi & Andrews(2007)	IJPM	Questionnaire	US	Project management practitioners	858
17	Gehring, (2007)	PMJ	Qualitative research/ Questionnaire	Worldwide	Members of professional project management organizations	53
18	Sunindijo et al.(2007)	JME	Questionnaire	Thailand	Ongoing projects in the Bangkok metropolis	30

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
19	Ahadzie et al.(2008)	JCEM	Questionnaire	Ghana	Project manager registered in the Ghana Real Estate Developers Association	69
20	Geoghegan & Dulewicz(2008)	PMJ	Questionnaire	UK	Project managers and project sponsors from a financial services company	52
21	Henderson(2008)	PMJ	Questionnaire	Worldwide	Project team members	564
22	Ahadzie et al.(2008a)	IJPM	Questionnaire	Ghana	Project manager registered in the Ghana Real Estate Developers Association	57
23	Yasin et al.(2009)	PMJ	Questionnaire	Portuguese	Public-sector officials with project management experience	102
24	Skulmoski & Hartman(2010)	PMJ	Qualitative interview	Canada	IS project managers and business leaders	22

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
25	Arditi & Balci(2009)	JCEM	Questionnaire	USA	Project managers employed by private construction companies	63
26	Ralf Müller & Turner(2010)	IJPM	Questionnaire	Worldwide	Members of professional organizations in project management	400
27	Stevenson & Starkweather(2010)	IJPM	Questionnaire	USA	IT project managers	84
20	Geoghegan & Dulewicz(2008)	PMJ	Questionnaire	UK	Project managers and project sponsors from a financial services company	52
21	Henderson(2008)	PMJ	Questionnaire	Worldwide	Project team members	564
22	Ahadzie et al.(2008a)	IJPM	Questionnaire	Ghana	Project manager registered in the Ghana Real Estate Developers Association	57

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
23	Yasin et al.(2009)	PMJ	Questionnaire	Portuguese	Public-sector officials with project management experience	102
24	Skulmoski & Hartman(2010)	PMJ	Qualitative interview	Canada	IS project managers and business leaders	22
25	Arditi & Balci(2009)	JCEM	Questionnaire	USA	Project managers employed by private construction companies	63
26	Ralf Müller & Turner(2010)	IJPM	Questionnaire	Worldwide	Members of professional organizations in project management	400
27	Stevenson & Starkweather(2010)	IJPM	Questionnaire	USA	IT project managers	84
28	Darrell et al.(2010)	PMJ	Questionnaire survey	Australian	Project managers within the Western Australian public sector	46

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
29	Clarke(2010)	PMJ	Questionnaire	UK	UK project managers	67
30	Lloyd-Walker & Walker(2011)	IJPM	Model research/Case study/Interview	Australian	experienced alliance project leaders and unit managers	13
31	Yang et al.(2011)	IJPM	Questionnaire	Taiwan	Project directors, project planners, and project superintendents.	213
32	E. Fisher(2011)	IJPM	Face to face interviews/ Focus group meeting	Czech	Project managers worked in the Telecommunications, Banking, Consultancy and Engineering industries	10
33	Davis(2011)	PMJ	observational quasi- experiment		Project managers, project sponsors, project team members, project stakeholders, and project participants.	75

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
34	Rashidi et al.(2011)	JCEM	Fuzzy model	Iran		
35	Verburg et al.(2013)	IJPM	Interview/ End-Chain method Means- (MEC)	Europe	Experienced managers in leading global virtual projects	30
36	Zhang et al.(2013)	IJPM	Questionnaire	China	Construction managers	275
37	Hwang & Ng(2013)	IJPM	Questionnaire	Singapore	green construction managers	30
38	Ortiz-Marcos et al.(2013)	PMJ	Qualitative interview		experts in international cooperation project management and experts from organisations in this sector	166
39	Creasy & Anantatmula(2013)	PMJ	Literature review			

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
40	Tysen et al.(2014)	PMJ	Model qualitative research/ study			
41	Cohen et al.(2013)	PMJ	Questionnaire	Israel	Project managers in a variety of business areas	280
42	González et al.(2013)	PMJ	semi-structured in-depth interviews	Colombia	Project managers or workers	153
43	Ahsan et al.(2013)	PMJ	Qualitative analysis/ Content Analysis	Australia	Job advertisements	795
44	Chou et al.(2013)	JCEM	Survey questionnaire	Taiwan, Indonesia, and Vietnam	Professional engineers, project managers, stakeholders, or project team members in the construction industries	294

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
45	Rojas(2013)	JME	Focus groups and interviews	USA	Construction industry practitioners	52
46	Ahadzie et al.(2014)	IJPM	Questionnaire	Ghana	Project manager registered in the Ghana Real Estate Developers Association	61
47	Tyssen et al.(2013)	PMJ	Literature review			
48	Atalah(2014)	JME	Survey questionnaire	USA	Experienced applicants for construction management positions	102
49	Riza Yosia Sunindijo & Hadikusumo(2014)	JME	Survey questionnaire	Thailand	Project managers and engineers	34
50	Briere et al.(2015)	IJPM	Semi-structured interviews	Canada	Project managers in international NGOs	28
51	Mazur et al.(2014)	IJPM	Survey questionnaire	Australia	Project managers in Australian defence industry	373
52	Dillon & Taylor(2015)	PMJ	Interview	New Zealand	Project managers	12

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
53	Medina & Francis(2015)	PMJ	Interview	Sweden	Project team members from the soft-ware development section at Sony Mobile	15
54	Ling & Loo(2015)	JME	Structured questionnaire	Singapore	Construction project managers	32
55	Larsson et al.(2015)	JME	Questionnaire survey	Sweden	Project managers employed by the public infrastructure client	162
56	Bredillet et al.(2015)	IJPM	Qualitative study			
57	Ramazani & Jergeas(2015)	IJPM	Interview	Canada	Project managers and project engineers working in the oil and gas sector	29
58	Wang et al.(2016)	IJPM	Semi-structured interview/ questionnaire survey	China	Project managers in the Chinese construction industry.	246

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
59	Rezvani et al.(2016)	IJPM	Survey questionnaire	Australia	Project managers in Australian defence industry	373
60	Hodgson & Paton(2016)	IJPM	Semi-structured interview	UK	Project managers in defence industry	39
61	Hanna et al.(2016)	JCEM	Data-driven mathematical model/quantitative study	USA	PM supervisors in construction industry	62
62	Ramos et al.(2016)	IJPM	Survey questionnaire	Brazil	Project management practitioners	129
63	Pinto et al.(2017)	IJPM	Survey questionnaire	USA/Canada	Project managers, executives, team members, and resource/support individuals currently involved in projects	278
64	Ko & Kirsch(2017)	IJPM	Questionnaire	USA	information systems project managers	108

No.	Author/Year	Journal	Methods	Country/ Region	Respondent	Sample size
65	Meng & Boyd(2017)	IJPM	Questionnaire survey	UK	Construction project managers	73
66	D. Wang et al.(2017)	JCEM	Questionnaire survey	China	Construction project managers	101
67	R Müller et al.(2018)	IJPM	Case study/Semi-structured interviews	Worldwide	Project participants	166
68	(H. L. Chen & Lin, 2018)		Survey questionnaire	Taiwan	Auditing project managers from 50 financial service companies	320
69	Silvius & Schipper(2020)		structured interviews	Netherlands	Project participants	49
70	Zhu et al.(2021)		Survey questionnaire	China	Construction project managers	380

Note: IJPM stands for International Journal of Project Management;
 PMJ stands for Project Management Journal;
 JCEM stands for Journal of Construction Engineering and Management;
 JME stands for Journal of Management in Engineering

LIST OF PUBLICATIONS

Peng, W., Haron, N.A., Alias, A.H., and Law, T.H., 2022. Leadership in Construction: A Scientometric Review. *Buildings*, 12 (11), 1825.

Peng, W., Haron, N. A., Alias, A. H., & Law, T. H., 2023. Knowledge Map of Climate Change and Transportation: A Bibliometric Analysis Based on CiteSpace. *Atmosphere*, 14(3), 434.

