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Hungarian University of Agriculture and Life Sciences

Project Management Competencies and Performance: The Impact of Project Complexity in Hungarian Organizations

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CPM: Critical Path Methodology
CSFs: Critical Success Factors
EV: Earned Value
EVM: Earned Value Management
ICB: International Project Management Association Competence Baseline
IPMA: International Project Management Association
IT: Information Technology
KA: Knowledge Area
KPI: Key Performance Indicator
PC: Project Complexity
PM: Project Manager
PM: Project Management
PMBoK: Project Management Body of Knowledge
PMC: Project Management Competency
PP: Project Performance
PERT: Program Evaluation and Review Technique
PRINCE2: Projects in Controlled Environments
PG: Process Group
QMS: Quality Management System
R&D: Research and Development
SD: Standard Deviation
SPV: Standard Project Variance
WBS: Work Breakdown Structure

1. INTRODUCTION

The effective management of projects is critical for the success and growth of organizations, necessitating a deep understanding of the connection between project management competencies and project performance (Mainga, 2017). The significance of project complexity in project management is widely recognized for multiple reasons (Nicholas & Steyn, 2020) noted that research has shed light on the adverse effects of project complexity on project performance, including impacts on unit cost (Butler et al., 2020), project efficiency and effectiveness, and adherence to project budgets and schedules (Kerzner, 2022). Additionally, project complexity has been shown to exert negative influences on project outcomes, particularly on budgetary allocations and time constraints (Morcov et al., 2020). Consequently, project complexity has emerged as a pivotal area in project management literature, recognized as a significant determinant of project performance (Khan et al., 2020).

Numerous studies have consistently demonstrated the detrimental impact of project complexity on project performance. Given that project performance remains a primary objective for most organizations, understanding and mitigating project complexity are critical concerns for both researchers and practitioners in project management. For example, a study conducted by PricewaterhouseCoopers (PwC) analyzing over 10,640 projects found that only 2.5% of the companies surveyed completed successfully, all their projects as planned, with most failing to meet some initial goals or encountering budgetary and scheduling issues. Additionally, Kerzner (2022) highlighted the critical importance of cost-related metrics in evaluating project performance.

While significant research has been conducted on the connection between project complexity and project performance, emerging economies have received comparatively less attention. Researchers have called for more project management studies that focus on addressing the unique socioeconomic challenges faced by these regions. (Kermanshachi et al., 2020).

This research investigates the associations between the competencies of project manager and project success or performance, alongside the potential moderating influence of project complexity, within the emerging economy sector, specifically in Hungary. The aim is to enhance comprehension of the interconnectedness among PM competencies, project performance, and project complexity within the Hungarian economic context. By exploring potential determinants of project performance within the emerging economy sector, this study aims to provide valued insights for addressing socioeconomic development challenges in developing nations.

Current discussions in the project management field emphasize the difficulties associated with project complexity, encouraging additional research into the expertise and abilities required for project managers to handle these challenges effectively (Alaloul et al., 2020). These debates underscore the significance of exploring the interplay between PM competencies, project performance, and project complexity, laying the groundwork for the present study. The subsequent sections of this chapter will delve into the background, purpose, significance, research questions, definitions, design, study limitations, and assumptions made.

Project management serves as a crucial organizational framework aimed at achieving business objectives. It is often presumed that project management competencies have a positive impact on project performance. However, previous research indicates that additional factors may also influence outcomes. This study examines a model in which project complexity acts

as a mediator between management competencies and performance. Data was collected through a survey distributed to project managers who shared insights regarding recently completed projects. The survey included questions on project complexity, competencies, and performance, yielding 229 valid responses collected via reliable online platforms. The analysis utilized a hierarchical component partial least squares structural equation modeling approach. Pre-established instruments were employed to measure the latent variables of management competencies, complexity, and performance. Three structural models were developed to investigate the relationships between these variables, with results partially supporting the mediation hypotheses. The initial model assessed all dimensions of complexity, competencies, and performance, demonstrating evidence of mediation. Subsequent models focused on specific latent variables to address additional research questions, further underscoring the role of complexity as a mediator in the competencies-performance relationship. The diverse findings from this study highlight the necessity for further exploration to enhance project management theories and practices.

1.1 Problem Background

This research examines the complex relationship between project management competencies, project complexity, and project performance, utilizing complexity theory as a guiding framework. Complexity theory, rooted in general system dynamics, emphasizes the interconnectedness and interdependencies of various project components. The study incorporates both standard and expanded project management models to analyze how project management competencies interact with project complexity to impact performance (Van Assche et al., 2019). While competencies in project management are essential for improving productivity and achieving desired outcomes, the increasing importance of project complexity presents challenges that warrant deeper exploration. Empirical evidence suggests that project complexity negatively impacts project performance, while project management competencies are associated with positive outcomes (Morcov et al., 2020). However, the intricate interplay between these variables and their combined effect on project performance remains underexplored in the existing literature.

The evolving landscape of project management underscores the importance of understanding and addressing project complexity to mitigate its adverse effects on project performance. As projects become increasingly complex, traditional deterministic approaches to project management prove ineffective, necessitating adaptability and collaboration (Ahmad & Karim, 2019). This study seeks to add to the ongoing conversation by examining how project management competencies and project complexity impact project performance, offering meaningful insights into effective practices for managing projects. By examining the dynamic interactions between these variables, the study seeks to offer practical guidance for project managers navigating complex project environments and advance scholarly understanding of project management in contemporary contexts.

1.2 Statement of the Problem

The research problem highlights a gap in understanding the connection between project management competencies and project performance, particularly in the context of complex projects. The current literature provides limited information on how PM competencies and project complexity influence project outcomes (Khan et al., 2020). PM competencies encompass a combination of related behaviors and information is important to know about project success. Mainga (2017) says that project managers can share their expertise to enhance performance, with both relationship-focused and task-oriented competencies strengthening

stakeholder collaboration and overall project success. Effective communication skills in project managers help create open, innovative environments. Theron & Roodt (2001) highlighted that procedural and personal skills in project managers foster team commitment, especially during crises. Their competency framework includes 33 aspects covering team leadership, technical knowledge, interpersonal abilities, project management techniques, and individual attributes. Likewise, Fernandes et al. (2019) found that trained project managers improve team unity. (Bjorvatn & Wald, 2018; Fernandes & Araújo, 2019).

Locatelli (2023) underscored project complexity as a critical research area in project management. Complexity, characterized by shifts from stability to disruption and back to stability, distinguishes itself from chaos (Locatelli et al., 2023). Rapid shifts, unattainable expectations, and changing demands are key factors driving project complexity. According to Locatelli (2023), complexity might be responsible for the failure of up to 70% of projects. Studies indicate that project managers frequently perceive complexity as a primary factor contributing to project failures. However, there is no universally accepted definition of project complexity within the project management discipline (Sonta-Draczkowska & Mrozewski, 2019).

According to Dartey-Baah (2022), project complexity encompasses both tangible elements, such as the size of the project and the number of stakeholders, and intangible aspects, such as the level of stakeholder involvement and the pressures of meeting deadlines. Utilizing this construct, he demonstrated that project managers adept at navigating interdependence experience success in complex projects. Sonta-Draczkowska & Mrozewski (2019) articulated dimensions of project complexity, including structural, sociopolitical, and emergent complexity.

While project performance traditionally revolves around cost, schedule, and scope, globalization and technological advancements have expanded its definition to encompass sustainability, resource efficiency, end-user satisfaction, team collaboration, societal impact, and project contingencies. Alves et al,. (2019) proposed a comprehensive factor-based model of project performance, encompassing various dimensions, and applied this model to investigate interdependence and project performance (Alves et al., 2019). Literature suggests that complexity negatively impacts project performance by introducing instability and disruptions. Empirical evidence from Sonta-Draczkowska et al. (2019) corroborated the detrimental effect of project complexity on project performance, while Alves et al. (2019) highlighted its adverse impact on project implementation.

Given these findings, there is a need for empirical research that integrates project management competencies, project complexity, and project performance. While existing literature underscores the positive influence of project management competencies on project performance, it also highlights the negative impact of project complexity. However, there is a gap in understanding the combined influence of project management competencies and project complexity on project performance.

1.3 Objectives to be Achieved

The main objective of this research is to examine how project management competencies and project complexity influence project performance in Hungarian organizations. While earlier studies have focused mainly on identifying the causes of complexity, fewer have integrated competencies, complexity, and performance within a single framework (Kocsir & Varga, 2020). This study applies a quantitative, non-experimental design to test how project complexity mediates the relationship between competencies and performance, using validated

tools such as the PMCQ, CAT, and PSQ. By focusing on certified project management professionals (PMPs) and their equivalents, the research aims to provide evidence that contributes both to theory and to practice in complex project environments (Maylor & Turner, 2017; Sugden et al., 2021).

The objective of this doctoral research is to contribute to the deeper understanding of how project management competencies and project complexity jointly influence project performance in Hungarian organizations. Although project management literature has matured considerably in recent decades, most studies have concentrated either on identifying the causes of project complexity or on assessing the role of competencies in isolation. What has remained underexplored is the integrated examination of competencies, complexity, and performance, and more specifically, how complexity mediates the impact of competencies on outcomes. This research seeks to fill that gap by developing and empirically testing an extended model grounded in complexity theory and competency frameworks.

The study pursues several interrelated objectives. First, it aims to clarify the role of project management competencies in achieving project success. Competencies are conceptualized as a combination of knowledge, technical expertise, and behavioral capabilities that enable project managers to plan, lead, and deliver effectively. By adopting the Project Management Competencies Questionnaire (PMCQ), the study ensures a structured and validated measurement of this construct, providing insights into which competencies are most critical in complex project environments.

Second, the study seeks to analyze the multidimensional nature of project complexity**.** Building on Dartey-Baah's (2022) three-factor model, complexity is approached as a construct with structural, socio-political, and emergent dimensions. Each of these dimensions poses distinct challenges to project managers: structural complexity relates to size and interdependencies; socio-political complexity arises from stakeholder interests and external environments; and emergent complexity reflects unpredictability and change. The Complexity Assessment Tool (CAT) is employed to capture these nuances and ensure that complexity is not treated as a monolithic factor but as a dynamic influence on competencies and performance.

Third, the study aims to validate the mediating role of project complexity between competencies and performance. While competencies are generally assumed to enhance performance, this study tests whether and how complexity modifies this relationship. For instance, does rising complexity strengthen the importance of competencies, or does it hinder their effective application? By addressing this question empirically, the research contributes to ongoing debates in project management scholarship and extends the theoretical framework suggested by Geraldi (2021) and Maylor & Turner (2017).

Fourth, the study seeks to measure project performance beyond the traditional "iron triangle" of time, cost, and scope**.** The Project Performance Questionnaire (PSQ) allows the study to consider broader performance outcomes, including communication effectiveness, stakeholder engagement, and sustainability (Fabbro & Tonchia, 2021). This holistic approach reflects the evolving understanding of success in project management, aligning with global standards and practitioner concerns.

Finally, the research aims to generate context-specific insights for Hungary, where empirical studies on project complexity and competencies remain limited. By focusing on certified project management professionals (PMPs) and their equivalents, the study ensures that findings are grounded in the practices of individuals with recognized expertise, thereby enhancing both validity and practical relevance.

In summary, the overarching objective of this research is not merely to test statistical relationships but to develop a comprehensive, theory-informed, and empirically validated model that explains how competencies and complexity interact to shape project performance. The findings are expected to enrich theoretical discourse, refine measurement tools, and provide actionable recommendations for practitioners seeking to improve performance in increasingly complex project environments.

1.4 Significance of the Study

This study makes a valuable contribution to the literature related to project management by examining the impact of PM competencies on project performance, with a particular focus on the mediating effect of project complexity. While an integrated project management theory is absent, this research integrates complexity theory with established competency models to provide deeper insights. Complexity theory sheds light on how abstruseness and uncertainties arising from external and internal project interactions can disrupt processes, leading to the emergence of new stable patterns (Byrne & Callaghan, 2022; Turner & Baker, 2019).

Using standard and extended models of project management as analytical frameworks, the study explores the interplay between PM competencies, complexity, and performance outcomes. The standard model asserts that PM competencies improve performance through the implementation of best practices, while the extended model highlights the adverse impact of project complexity on performance by introducing disruptions (Miguel et al., 2019). The research expands the application of complexity theory within different sectors in Hungary, offering valuable insights into managing complex projects effectively.

Beyond its academic value, this study provides practical insights for the project management community. Despite advances in project management tools and techniques, complexity remains a persistent challenge, especially in sociopolitical contexts. Project managers often identify complexity as a significant barrier to achieving project success. Considering the importance of project management competencies in navigating complexity, further exploration of their applicability across different dimensions of complexity is crucial (Andreev et al., 2022). This study highlights the skill sets necessary for managing complex projects effectively, offering valuable insights for professional training and education in the field of project management.

1.5 Research Question

In line with the research problem and objectives aimed at addressing the current gap, the following research question was formulated to empirically investigate the predictive role of PM competencies in project performance and the mediating role of project complexity:

The Primary Research Question (Q1) of the study is: *How does project complexity act as a mediator in the relationship between project management competencies, as they, and project performance, as the endogenous variable?*

There are Secondary Research Questions (Q2, Q3) with their sub-questions to help investigate the different layers of the problem.

The detailed Research Questions are summarized in Table 3 and 4, while the conceptual framework guiding this research question and related hypothesis is illustrated in Figure 4 (see Chapter 3).

1.6 Methodological Approach

The nonexperimental research model is used to explore the interrelationships among three variables. The chosen research design aligns with previous studies that have investigated PM competencies, project complexity, and project performance.

The research aimed to investigate the associations between project management competencies and project performance, as well as the mediating effect of project complexity. Data collection utilized Sugden et al.'s (2021) Project Management Competencies Questionnaire to assess project management competencies, Fabbro & Tonchia's (2021) Complexity Assessment Tool (CAT) to gauge project complexity, and Project Performance Questionnaire (PSQ) to evaluate project performance levels.

A quantitative research approach was employed due to the existence of theory and established variable measurements. Furthermore, this approach was deemed suitable for gaining insights into the relationships among the variables through rigorous measurement, analysis, and examination. The research was aimed at inspecting the level to which PM competencies directly and project complexity indirectly affect project performance. The randomization techniques were employed to mitigate discrimination (Saharan et al., 2020).

Multiple linear regression analysis was selected for this study, given its widespread application in evaluating the strength and direction of relationships between continuous exogenous variables (predictors) and a single continuous endogenous variable (criterion). This statistical technique enables the simultaneous consideration of multiple predictors, making it particularly suitable for examining how various aspects of project management competencies and project complexity collectively influence project performance. By employing this robust method, the research was able to quantify the unique and combined effects of the predictor variables, providing a clearer understanding of their relative contributions to project outcomes (Montgomery et al., 2021).

1.7 Assumptions

Every research endeavor involves methodological assumptions (Verma & Abdel-Salam, 2019). In this study, we considered general methodological, theoretical, and measurement assumptions. The research design was guided by ontological, epistemological, axiological, and methodological considerations.

Ontologically, this research relied on scientific and statistical methods for knowledge acquisition, given the availability of tools to measure and analyze the three variables under investigation. Epistemologically, the study derived its findings from reliable and validated instruments. Axiologically, the research was driven by the objective of bridging a gap in the existing literature, aligning with the value of advancing expertise. Methodologically, the focus was on examining the relationships between PM competencies and project performance with the mediation effect of project complexity. Thereby providing meaningful contributions to the project management field.

The study employed systematic data collection and applied scientific methods to evaluate the predictive relationships between project management competencies, project complexity, and project performance (Li et al., 2019). Multiple linear regression analysis was used because it's a common method to examine how several predictor variables relate to a single outcome. It allowed the study to assess how different aspects of project management competencies and project complexity together influence project performance.

The theoretical foundation of the research was anchored in the standard model of project management, emphasizing the utilization of optimal competencies to manage budget, scope, and schedule constraints for enhanced project outcomes. Furthermore, the integration of complex adaptive systems theory expanded the standard model to include five dimensions of complexity as predictor variables for empirical analysis. Joseph (2017) simplified these dimensions into structural, sociopolitical, and emergent complexities, further highlighting the critical role of project management competencies in addressing them.

It was assumed that Joseph's (2017) three-dimensional model of complexity comprising structural, sociopolitical, and emergent dimensions sufficiently captures the essence of project complexity and provides a solid framework for the investigation. Additionally, complexity characterized by ambiguity, dynamic demands, and virtualization was anticipated to increase in significance soon (Institute, 2017).

Evidence suggests that project management competencies positively influence project performance, whereas project complexity has a negative impact. Accordingly, the relationships among these constructs were presumed to be linear. Since these constructs are latent and not directly observable, instruments were validated first and reliable to determine their indicators and ensure the accuracy of the analysis (van Bork et al., 2021).

Nevertheless, a notable limitation of the research design is the potential presence of systematic bias, which remains uncontrolled and can affect the reliability of research outcomes (Fischer et al., 2023). The study design relied on self-reported data from project managers based on a recently completed project. Self-reported surveys are commonly used in correlational research but may introduce biases (Durmaz et al., 2020). Project managers might unintentionally conflate their self-assessments of individual competencies with their evaluations of project complexity and performance.

The definitions used in this study may not fully reflect the nuanced understanding developed through recent research (Akanle et al., 2020). However, the study adopted the most comprehensive and reliable definitions available in existing literature.

Another limitation is the nonexperimental nature of the research design, which prevents the establishment of causal relationships. The evidence obtained from the study indicates associations among the variables but does not demonstrate causality. As a result, the findings are limited to exploring relationships rather than determining cause-and-effect dynamics.

2. LITERATURE REVIEW

Extensive literature is accessible across various research databases, delving into the competencies of project managers and their correlation with project performance and performance across diverse industries and geographic contexts. A comprehensive literature review was conducted to identify any existing research gaps. The competencies of project managers encompass personal, technical, organizational, and human factors (Ribeiro et al., 2013). While prior research has predominantly focused on enhancing technical and organizational project management competencies through training and experience, certain fundamental personal competencies have received comparatively less attention. This literature review addresses this gap by delving into the discussion of these essential personal competencies.

Some of the basic personal competencies are rarely discussed in the previous research but the technical and organizational PM competencies are improved through training and experience. Some of the basic personal competencies are discussed here from the literature available.

Effectively managing complexity is essential for achieving success in construction projects, as poor handling of complexity can result in unfavorable outcomes (Walker, 2015). Research has consistently highlighted a negative relationship between project complexity and performance. The substantial impact of complexity on cost overruns and schedule delays has garnered significant attention from scholars (Loufrani-Fedida & Missonier, 2015). As a primary source of uncertainty, project complexity contributes to additional expenses and hampers performance if not addressed during the early stages of the project lifecycle (Chang, 2015).

For instance, Moradi et al. (2020) highlight its role in affecting cost and schedule performance during project selection, while De Rezende and Blackwell (2019) identify it as a critical factor in project failures. However, Walker (2015) emphasized the need for further exploration into the relationship between project complexity, risk, and overall project outcome. Delivering favorable project outcomes for all stakeholders requires a deep understanding and effective management of project complexity (Turner, 2016). As Silvius and Schipper (2014) characterized, the construction industry is inherently dynamic, risky, and challenging, frequently struggling to mitigate complexities and deliver desired outcomes.

2.1 Search Methods

The literature review for this study was conducted through an extensive and structured search of various academic databases and peer-reviewed journals to ensure the inclusion of relevant and up-to-date scholarly materials. Key databases utilized included, Google Scholar, Science Direct, ProQuest Central, EBSCOhost, and SAGE Journals Online, providing access to a wide array of multidisciplinary research (Iroaganachi & Izuagbe, 2018). In addition to these general databases, specialized resources such as the Psychology Database and journals like the Project Management Journal (PMJ) and the International Journal of Project Management (IJPM) were also consulted. The search was limited to articles published in the past five years to focus on recent developments and current discussions within the span of project management.

The search strategy was built around keyword-based queries, both with and without the term “project management,” to capture a broad spectrum of literature. The keywords used in the search process included “project management theory,” “general systems theory,” “contingency theory,” “chaos theory,” “complexity theory,” “standard project management

model," "expanded project management model," "project management competencies," "project complexity," "project performance," and "project success." These search terms were specifically selected to address various aspects of project management, its underlying theories, and the variables under investigation in this study (Li et al., 2019). Daily search updates were performed to identify any new publications or relevant studies, ensuring that the literature review was comprehensive and reflective of the most recent research trends.

2.2 Theoretical Frameworks followed

This research is grounded in complexity theory, which emphasizes how ambiguity and unpredictability arise from internal and external relationships in projects, leading to chaotic behavior (Derakhshan et al., 2019). Due to this randomness, complexity theory is considered an appropriate framework for analyzing project behavior, as recommended by Derakhshan et al. (2019). This study adopts both the standard model of project management and its extended standard models (Wolff et al., 2017). The standard model posits that PM competencies can increase project performance and the complexity of the project is another consideration (Geraldi & Söderlund, 2018). Despite the extensive literature on project management, there remains no unified theory in the field, and the need for alternative theoretical approaches, as suggested by Wolff (2017), becomes apparent in projects that behave unpredictably.

To understand the theoretical foundations of this study, it is important to begin with general systems theory. Projects can be viewed as interactions among people, inputs, and outputs, forming an open system where various components relate internally and externally (Edmondson & Harvey, 2018).

The projects integrate related parts, behaving as holistic entities (Koolwijk et al., 2018). These components, such as stakeholders and project teams, are interrelated, which causes problems and, ultimately, complexity. Koolwijk et al. (2018) suggested that interdependence in projects generates uncertainty and ambiguity, making management more difficult. Complexity theory explains how this instability reorganizes into new stable patterns over time. In essence, the unpredictable nature of project components results in nonlinear behavior and complexity (Ehsani et al., 2017).

Complexity theory aligns both the predictability of contingency theory and the unpredictability of chaos theory. It suggests that projects, being complex systems, need to adopt flexible and adaptive approaches to manage uncertainty and variability (Cleden, 2017). Cleden proposed that complexity can be categorized into three dimensions: emergent, sociopolitical, and structural. Structural complexity relates to measurable aspects like project size and team members, while sociopolitical complexity arises from relationships and motivations within the project (Monk & Ogolsky, 2019). Emergency complexity refers to the dynamic unpredictability that surfaces throughout the project lifecycle.

In managing complexity, creativity and innovation play crucial roles, particularly when the project approaches what complexity theorists describe as the "edge of chaos" a state where the system is on the verge of reorganizing into a new stable form Geraldi (2021). By leveraging the best competencies and fostering collaboration among project stakeholders, managers can navigate this chaotic state and restore stability. The standard model of project management helps managers apply competencies gained through experience, integrating tools, processes, and methodologies to guide project execution (Fabbro & Tonchia, 2021).

However, complexity introduces challenges to traditional project management competencies, which are often linear and deterministic. Nonlinear behaviors caused by complexity make these approaches less effective (Ehsani et al., 2017). As complexity interferes with the relationship between inputs and outputs, project managers are called to adapt

holistically, moving beyond traditional best competencies. This tension between traditional competencies and the need for adaptation is referred to as the "temporal paradox" (Trueba et al., 2022).

The PM expanded standard model addresses this tension by integrating both linear and adaptive processes to manage complexity effectively (Zhao et al., 2019). As project complexity increases, success rates tend to decline, largely because project teams may lack the skills to cope with ambiguity. To overcome this, project managers must involve stakeholders' capabilities and experiences to lessen the negative effects of complexity on project outcomes (Koolwijk et al., 2018).

Finally, complexity theory suggests that the interconnectedness of project agents fosters creativity and innovation, allowing projects to self-organize and adapt to new, stable patterns. Unlike chaotic systems that remain in infinite cycles of cause and effect, complex projects tend to achieve a balance between order and unpredictability, leading to efficient and adaptive behavior. By fostering commitment and collaboration among team members, project managers can utilize both tools and processes to manage complexity effectively and achieve success (Cleden, 2017).

Between 2015 and 2018, more than 10 articles specifically focused on the challenges related to theory development and its application within project management. These studies consistently pointed out the absence of strong theoretical foundations in project management research (Walker, 2015). Table 1 shows the most related literature used to set the basis of the research framework of this study. Walker (2015) noted that 97% of project management research during this period lacked any theoretical grounding. Similarly, an analysis of 190 articles relevant to this study found that only 37 explicitly referenced a theoretical framework.

Takey and de Carvalho (2015) attributed this gap to the relatively young status of the project management discipline, suggesting that researchers often rely on adjacent theories to compensate for the lack of a unified theoretical model. This issue has also been emphasized by Radujković and Sjekavica (2017) and Kivunja (2018) and underscores the critical need for more robust theoretical integration in project management research. It builds on Baccarini's (1996) foundational work, which utilized systems theory to explore project complexity. Over time, this line of research has evolved to incorporate other theories, including contingency theory, control theory, and project complexity theory (Svejvig & Andersen, 2015). In this study complexity theory serves as the primary theoretical foundation, providing a comprehensive lens through which to analyze project management competencies and outcomes.

Table 1: Literature included in the review

Year	***Author(s)***	***Journal/Publisher***	***Related literature***
2010	Ahuja, V., Yang, J., & Shankar, R.	International Journal of Construction Management	Building project management, Indian construction, complexity theory
2011	Castejon-Limas, M. et al.	Annals of Operations Research	Project complexity, effort estimates, project management competencies
2014	Faber, J., & Fonseca, L. M.	Dental Press Journal of Orthodontics	Sample size, research outcomes, methodology, PLS, complexity theory
2015	Berssaneti, F. T., & Carvalho, M. M.	International Journal of Project Management	Identification, variables, project success, Brazilian companies
2015	Brière, S., Proulx, D., Flores, O. N., & Laporte, M.	International Journal of Project Management	Project management competencies, project managers, international NGOs, project practitioners

Year	*Author(s)*	*Journal/Publisher*	*Related literature*
2015	Chang, L. C.	International Journal of Information Technology Project Management	Project management process, modeling
2015	de Carvalho, M. M., Patah, L. A., & de Souza Bido, D.	International Journal of Project Management	Project success, cross-industry, cross-country, project management competencies
2015	Liikamaa, K.	Elsevier Science BV	Sustainability, project framework, project development
2015	Lloyd-Walker, B. M., & Walker, D. H.	-	Procurement, complexity theory, projects
2015	Loufrani-Fedida, S., & Missonier, S.	International Journal of Project Management	Project management, critical competencies
2015	Marcelino-Sádaba, S., González-Jaen, L. F., et al.	Journal of Cleaner Production	Sustainability, project framework, project management
2016	Badewi, A.	International Journal of Project Management	Project management, benefits, project management success, governance, framework
2016	Davis, K.	International Journal of Project Management	Stakeholder success, success dimensions, project management, and complexity theory
2017	Aarseth, W., Ahola, T., Aaltonen, K., Økland, A., & Andersen, B.	International Journal of Project Management	Project complexity theory, project sustainability, strategies, systematic literature review
2017	Afroze, G., Khan, R. A., & Iee.	IEEE	Investigating impact, effective communication, practices, project complexity, project performance,
2017	Ahn, S., Shokri, S., Lee, S., Haas, C. T., & Haas, R. C. G.	Journal of Management in Engineering	Exploratory study and effectiveness, interface management, practices, large-scale, projects
2017	Algeo, C., & Connell, J.	Cambridge University Press	Developing organizational project management, competencies, industry, clusters
2017	Calderon, A., Ruiz, M., & O'Connor, R. V.	Systems, Software and Services Process Improvement (Springer)	ISO/IEC, project management, serious game
2017	Cleden, D.	Routledge	Project uncertainty, risk management, complexity theory
2017	Cleveland, S., & Assoc Informat, S.	Assoc Information Systems	Project complexity, framework development
2017	Currier, B. D. et al.	College & Undergraduate Libraries	Librarians, digital humanities, project skills

Year	*Author(s)*	*Journal/Publisher*	*Related literature*
2017	Dao, B. et al.	Amer Soc Civil Engineers	Project complexity, PCA, complexity theory
2017	Dao, B., Anderson, S., & Esmaeili, B.	American Society of Civil Engineers	Project complexity, principal component analysis, civil engineering
2017	Demirkesen, S., & Ozorhon, B.	International Journal of Project Management	Integration management, construction projects, performance analysis
2017	Dias, D. S., Perciuncula, G., Maffia, J., & Antoniolli, P. D.	Revista De Gestao E Projetos	Leadership, project management, professional profiles
2017	Ehsani, E., Kazemi, N., Olugu, E. U., Grosse, E. H., & Schwindl, K.	Neural Computing and Applications	Fuzzy logic, multi-objective programming, project management
2017	Fonseca, F., Letouze, P., Pompeu, R., Garcia, L., Regina, S., Franca, G., & IEEE	IEEE	IT management, barriers, project challenges, project management skills
2018	Aria, M., Capaldo, G., Iorio, C., Orefice, C. I., Riccardi, M., Fusco, S., & Siciliano, R.	Electronic Journal of Applied Statistical Analysis	Path, modeling, causal, detection, project, management, skills, research, Italy
2018	Estevez, J., Garcia-Marin, A. P., & Ayuso-Munoz, J. L.	International Journal of Engineering Education	Project-based learning, cooperative learning, project management complexity
2018	Gido, J., Clements, J., & Baker, R.	Cengage Learning	Project success, best practices, methodology, complexity theory
2018	Gonzalez Correa, J. A., Sanchez Castaneda, S. L., Velandia Quintero, D. A., & Eduardo Giraldo, G.	International Journal of Information Technology Project Management	IT PM management, success factors, SMEs
2018	Montequin, V. R., Balsera, J. V., Fernandez, S. M. C., Fernandez, F. O.	Complexity	Project complexity, failure factors, cluster patterns
2019	Alves, P. R., Tereso, A., & Fernandes, G.	Not Specified	Project, management, system, implementation, SMEs, project case study
2019	Armenia, S., Dangelico, R. M., Nonino, F., & Pompei, A.	Sustainability	Sustainable project management, conceptualization-oriented, literature review, research framework, future, studies

Year	*Author(s)*	*Journal/Publisher*	*Related literature*
2019	Bibeau, J., Berteletti, J., Goetz, J. M., & Massie, K.	Annals of Behavioral Medicine	Project, management, skills, behavioral, research
2019	Derakhshan, R., Turner, R., & Mancini, M.	International Journal of Project Management	Project governance, stakeholders, literature review
2019	Fewings, P., & Henjewele, C.	Routledge	Construction management, integrated approach, project execution
2019	Fewings, P., & Henjewele, C.	Routledge	Construction management, integrated approach, project execution
2020	Akanle, O., Ademuson, A. O., & Shittu, O. S.	Contemporary Issues in Social Research	Scope, limitation, social research, project management complexity
2020	Denicol, J., Davies, A., & Krystallis, I.	Project Management Journal	Megaprojects, performance, systematic literature review
2020	Durmaz, A., Dursun, İ., & Kabadayi, E. T.	IGI Global	Social desirability bias, self-report surveys, mitigation techniques
2020	Mamedio, D. F., & Meyer, V.	International Journal of Managing Projects in Business	Project complexity, complex systems
2020	Nicholas, J. M., & Steyn, H.	Routledge	Project management, engineering, business, and technology management
2021	Bhatti, S. H., Kiyani, S. K., Dust, S. B., & Zakariya, R.	International Journal of Managing Projects in Business	Ethical, leadership, project, success, mediating, trust, knowledge management
2021	Martinez Avila, M., Garcia-Machado, J. J., Fierro Moreno, E.	Mathematics	Collaborative public management, PLS model, mediation effect
2021	Montgomery, D. C., Peck, E. A., Vining, G. G.	John Wiley & Sons	Linear regression, analysis
2022	Andreev, A. I., Zinkina, J. V., & Petrovskaya, I. G.	Journal of Globalization Studies	Globalization impact, project management
2023	Locatelli, G., Ika, L., Drouin, N., et al.	European Management Review	Project management, research manifesto

Source: own research

Complexity theory originates from Van Assche's (2019) general systems theory, Boulding's (1956) work on system dynamics, and Ashby's (1956) concepts of cybernetics. It offers a framework for understanding how order and structure emerge from seemingly chaotic systems. This perspective moves beyond the traditional reductionist approach that has historically dominated project management research (Turner, 2016). According to Silvius and Schipper (2014), complexity theory examines how patterns and behaviors emerge in dynamic systems, demonstrating that even chaotic behavior can exhibit underlying order. This

framework expands project management research by emphasizing the importance of complex system interactions rather than simplistic, linear relationships.

Three key principles underpin complexity theory: non-linearity, emergence, and stability states. Non-linearity describes the sensitivity of complex systems to initial conditions, where minor changes can lead to disproportionate outcomes. These dynamics are influenced by factors such as actor behavior, self-organization, and system adaptation (Moradi et al., 2020).

Emergence involves the evolution and transformation of systems over time, while stability states refer to periods of predictability or instability within systems. Together, these principles provide a valuable framework for understanding and modeling complex project behaviors, making complexity theory particularly relevant to project management (Kivunja, 2018).

Two pivotal studies furthered the integration of complexity theory into project management research. Chang (2015) explored the concept of project complexity, while Takey and de Carvalho (2015) expanded on this framework to incorporate additional sub-dimensions, laying the groundwork for a broader theory of project management. Both studies highlight the mediating role of project management competencies in the relationship between project complexity and outcomes, emphasizing the importance of addressing complexity to achieve project success.

By applying complexity theory, this study contributes to the growing body of literature aimed at addressing the challenges posed by complex project environments. The findings offer a theoretical foundation for understanding project complexity and practical insights into the role of PM competencies in navigating complex systems to achieve positive outcomes. This approach not only fills a gap in theoretical understanding but also equips practitioners with tools to better manage the complexity of their projects (Van Assche et al., 2019).

2.3 Foundational Study Models

As projects exhibit random and nonlinear behavior, (Castejon-Limas et al., 2011) argued that complexity theory offers a suitable framework for studying these dynamics. The study uses both the standard project management model, which emphasizes the accumulation and standardization of competencies to increase project outcomes, and the extended model, which addresses how complexity disrupts the relationship between competencies and project success Geraldi, J. (2021).

While project management literature acknowledges the importance of competencies, it lacks a unified theory to guide practitioners (Brière et al., 2015). Of the numerous studies reviewed, only a small number references a project management theory directly. Niknazar & Bourgault (2017) pointed out that this gap is problematic, and recommended integrating perspectives from leadership and management theories to fill the Müller & Turner (2010) also noted the increasing unpredictability of projects, reinforcing the need for complexity theory to guide project management in these settings (Bush, 2020).

This study begins by drawing from general systems theory, where projects are viewed as open systems interacting with various internal and external factors. This theory, introduced by von Bertalanffy suggests that systems, including projects, are interconnected and evolve holistically (Van Assche et al., 2019). Through this lens, Liikamaa (2015) emphasized that projects operate as adaptive entities, adjusting to influences from neighboring systems (Dugan, 2024).

Radujković and Sjekavica (2017) applied general systems theory to describe how interdependencies in complex projects contribute to uncertainty and ambiguity. Complexity theory explains that while these tensions create instability, they eventually reorganize into stable and new patterns (Maqbool et al., 2017).

The unpredictability seen in project systems, involving various stakeholders and team members, requires adaptive management approaches (Liikamaa, 2015). Complexity theory offers insights into how projects evolve chaotically before settling into new stable patterns (Ehsani et al., 2017).

The dimensions of complexity in projects, emergent, sociopolitical, and structural, and affect the way project managers approach challenges. Structural complexity refers to measurable aspects like project size and team composition, while sociopolitical complexity relates to relationships and motives, which can create tension among project stakeholders (Niknazar & Bourgault, 2017). Emergent complexity arises dynamically throughout the project lifecycle, driven by factors that cannot be anticipated. These dynamics call for flexibility and adaptive management to navigate the "edge of chaos," a term used to describe the tipping point before stability re-emerges (Geraldi, 2021).

The standard project management model builds upon traditional methodologies and the accumulation of competencies through experience and education (Ahmad et al., 2018). These competencies, often codified in bodies of knowledge, guide the use of techniques and tools to execute projects. However, as complexity disrupts deterministic approaches, traditional methods may not always suffice in complex environments (Maqbool et al., 2017). Complexity challenges the linear relationships between inputs and outputs, introducing unpredictability that project managers must address (Cleden, 2017).

As complexity intensifies, the extended standard model of project management advocates for integrating both linear and adaptive approaches to cope with the unpredictability inherent in projects (Stevenson & Starkweather, 2010).

When complexity exceeds the project team's capacity to manage ambiguity, project success declines (Svejvig & Andersen, 2015). To mitigate this, project managers must leverage the collective knowledge and experiences of stakeholders (Maqbool et al., 2017).

Flexibility and innovation are critical in managing complex projects. Zuo et al. (2018) characterized the complexity of a project as the absence of predefined solutions, requiring both structured and adaptive approaches. In this context, projects are dynamic systems where self-organization emerges, blending deterministic order with nonlinear randomness (Mai et al., 2018). The expanded model suggests that commitment and collaboration among team members enable PM tools to handle and cope with complexity effectively (Dugan, 2024).

In summary, the foundational study model integrates both standard and expanded models of project management, rooted in complexity theory. It highlights the importance of competencies, collaboration, and adaptive strategies to manage the unpredictability that arises in complex projects. This holistic approach, supported by systems thinking, equips project managers with the flexibility to navigate uncertainty and ultimately achieve project success.

The interdisciplinary scope of project management and its diverse applications present difficulties in applying traditional reductionist methods to theoretical development. The field of project management evolved through the integration of professional expertise focused on achieving organizational goals, systems engineering, and systems analysis, making it more suitable to be examined through a systems perspective rather than a reductionist lens. This perspective allows for a more comprehensive understanding of its complex and interconnected nature (Silvius & Schipper, 2014). Although no single, universally accepted theory exists in project management, complexity theory aligns effectively with project management models and provides a robust adjacent theoretical framework for understanding its dynamics. This alignment has been emphasized in prior research (Walker, 2015).

Research in project management often starts with the standard model, which serves as the foundational framework for the field. The standard model focuses on two key constructs: PM

competencies and project performance. The standard model, rooted in the early stages of project management research, has demonstrated validity and utility through empirical support (De Rezende & Blackwell, 2019). However, it is not without its limitations, particularly regarding its generality and scope.

One notable limitation of the standard model is the broad and general nature of its definitions for project management competencies and project outcomes, which makes empirical validation challenging. This lack of specificity creates difficulty in applying the model to varied project settings and limits its ability to account for the nuanced variability in project outcomes (Moradi et al., 2020). Furthermore, the wide range of tools, techniques, and competencies in project management further complicates the model's explanatory power, as it cannot sufficiently address the variability or complexity of project outcomes (Tabassi et al., 2016).

To address these challenges, research drawing on complexity theory and Baccarini's framework has resulted in the development of the expanded standard model of project management that seeks to address the shortcomings of the original framework by incorporating new elements that account for the complexity of real-world project environments (Tabassi et al., 2016). The expanded model specifically incorporates three key components: initial conditions, context, and adaptive systems, which are vital for effectively applying project management skills in dynamic and ever-changing project environments. These elements recognize the need for project management practices to remain adaptable and responsive to the distinct requirements of each project (Takey & de Carvalho, 2015).

It proposes that project management skills serve as mediators in the relationship between project complexity and performance, underscoring the importance of adaptability and an awareness of context in ensuring project success (Radujković & Sjekavica, 2017). By addressing the complexities of project environments, this model provides a more comprehensive and realistic framework for understanding project management dynamics.

While the expanded standard model represents a substantial improvement over the original framework, it remains a generalized model that continues to face challenges in fully addressing the unique characteristics of diverse projects. Its development aligns with findings from case studies and empirical research, which underscore the importance of contextual factors in explaining project outcomes (Radujković & Sjekavica, 2017). Nonetheless, issues related to its generality persist, reflecting the ongoing maturation and evolution of the project management field. As the discipline goes on to develop, further refinement of the model will be necessary to achieve greater specificity and practical applicability.

2.4 Analysis of Existing Literature

This study is rooted in the core concepts of PM competencies, project performance, and project complexity. A thorough examination of the literature reveals that technological progress and globalization have significantly influenced how these areas are understood and applied in contemporary research. Previous approaches to project management competencies (Alvarenga et al., 2019), project complexity (Zuo et al., 2018), and project success (Alvarenga et al., 2019) are now being redefined to accommodate the evolving nature of modern projects. The following review outlines these developments in greater detail. Table 2 shows the most related literature which used quantitative studies that examined PM competencies and project complexity.

Table 2: Quantitative Studies That Examined PM Competencies and Project Complexity

Year	*Author(s)*	*Journal/Publisher*	*Related Keywords*
2010	Stevenson, D. H., & Starkweather, J. A.	International Journal of Project Management	IT project management competencies, soft skills
2014	Silvius, A. G., & Schipper, R. P.	Journal of Human Resource and Sustainability Studies	Sustainability, project management, competence gap, project management competencies
2015	Takey, S. M., & de Carvalho, M. M.	International Journal of Project Management	Competency mapping, engineering, project management
2016	Padalkar, M., & Gopinath, S.	International Journal of Project Management	Project management, research trends, thematic trends
2016	Samset, K., & Volden, G. H.	International Journal of Project Management	Project governance, front-end planning, paradoxes
2016	Silva, G., Warnakulasooriya, B., & Arachchige, B.	13th International Conference on Business Management (ICBM)	Construction project, success criteria, literature review
2017	Radujković, M., & Sjekavica, M.	Procedia Engineering	Project management, success factors, project management competencies
2017	Sanchez, O. P., & Terlizzi, M. A.	International Journal of Project Management	Cost management, time management, IS development
2017	Silvius, G.	Journal of Cleaner Production	Sustainability, project innovation
2017	Tehseen, S., Ramayah, T., & Sajilan, S.	Journal of Management Sciences	Common method variance, testing, control, and project management competencies
2018	Nijhuis, S., Vrijhoef, R., & Kessels, J.	Project Management Journal	Project management, competence, research
2018	Plumanns, L., Bitter, J., Janssen, D., Vossen, R., & Hees, F.	4th International Conference on Production Economics and Project Evaluation	Project risks, SMEs, risk management, project management competencies
2018	Poveda-Bautista, R., Diego-Mas, J. A., & Leon-Medina, D.	Complexity	Project management, complexity, IT projects
2018	Safapour, E., et al.	American Society of Civil Engineers	Project complexity, cost performance, construction
2018	Safapour, E., et al.	American Society of Civil Engineers	Project complexity, change orders, construction
2018	Souid, L., & Koszalka, T. A.	EDULEARN18: 10th International Conference on Education and New Learning Technologies	Cognitive flexibility, project management, skills development
2018	Zuo, J., Zhao, X. B., Nguyen, Q. B.	Engineering Construction and Architectural Management	Soft skills, construction management, project success

Year	*Author(s)*	*Journal/Publisher*	*Related Keywords*
	M., Ma, T., & Gao, S.		
2018	Zwikael, O., Chih, Y.-Y., & Meredith, J. R.	International Journal of Project Management	Benefit management, project targets
2019	Pereira, S. D., & de Freitas, H. M. R.	Revista De Gestao E Projetos	Project management, competencies, mobile context
2019	Saisa, M. E. K., et al.	International Journal of Information Technology Project Management	Agile project management, university-industry collaboration
2019	Sarmad, T., & Choudhary, M. A.	IEEE	Project management, complexity, challenges, China-Pakistan Economic Corridor
2019	Sataic, I., Popovic, T., & Ulicni Niksic, O.	Josip Juraj Strossmayer Univ Osijek	Project management, challenges, education, case study
2019	Song, Y., Jun, P. B., & 정종필	KIPS Transactions on Software and Data Engineering	SMEs, productivity improvement, project management
2019	Sonta-Draczkowska, E., & Mrozewski, M.	Project Management Journal	Project management, product development, technology-based firms
2019	Tereso, A., et al.	Project Management Journal	Project management, private organizations, practices
2020	Saharan, V. A., et al.	CRC Press	Research methodology, ethics, pharmaceutical sciences
2020	Trinh, M. T., & Feng, Y. B.	Journal of Construction Engineering and Management	Project complexity, construction safety, resilient safety culture, project management competencies
2021	Silvius, G.	Procedia Computer Science	Project management office, sustainability, sustainable practices
2022	Samara, A., et al.	International Journal of Construction Management	Project Sustainability, international development, INGOs, refugee projects, project management competencies

Source: own research

The intersection of project management and crisis-driven humanitarian initiatives has garnered substantial scholarly attention, particularly in response to the rising complexity of refugee integration and aid projects. The Figure 1 shows that this trend is particularly relevant to emerging economies, where project complexity poses unique challenges that demand nuanced approaches to management (Saadi et al., 2023).

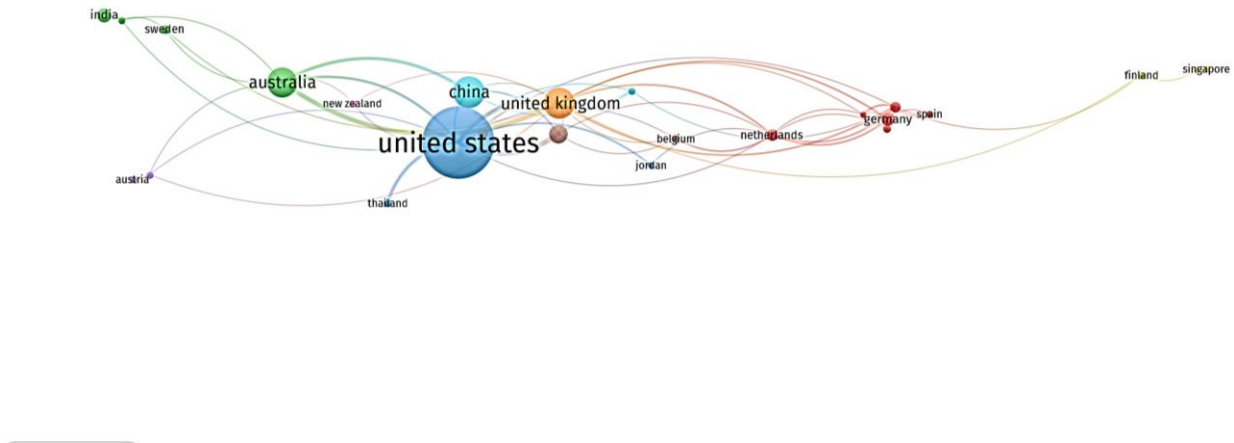

Figure 1: Co-authorship by country

Source: own research results

Within this context, project management competencies including interpersonal, technical, and adaptive skills are seen as critical drivers of project performance. However, existing literature suggests that the efficacy of these competencies is often moderated by the dynamic nature of project complexity, which is shaped by structural, sociopolitical, and emergent factors. Complexity in refugee integration projects is further exacerbated by unpredictable stakeholder needs and shifting policy landscapes, necessitating managers who can blend technical proficiency with emotional intelligence and cultural sensitivity. The bibliometric analysis underscores the global interest in sustainable project management shown in Figure 2, with frequent mentions of "refugees" and "humanitarian aid," signifying a shift in research priorities toward social and environmental sustainability in complex project environments.

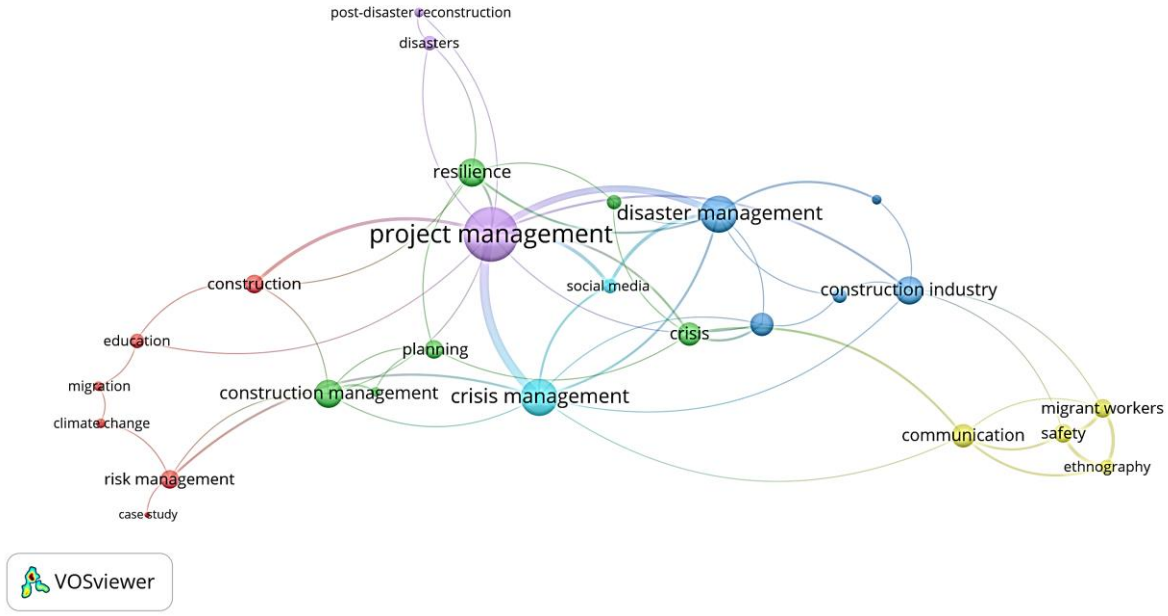

Figure 2: Map of co-occurrence of author's keywords

Source: own research results

Addressing these gaps requires further empirical studies that link project management competencies with performance outcomes in complex humanitarian environments. Such research would contribute to the refinement of project management frameworks, ensuring that integration projects not only meet immediate needs but also promote long-term resilience and sustainability.

The competencies of project management in Hungary have their roots in historical and economic transitions, including significant influences from the post-World War II era and the country's transition to a market economy after the 1956 Hungarian Revolution. During the socialist period, large-scale government-driven initiatives, such as the development of infrastructure, industrial projects, and centralized urban planning, shaped Hungary's approach to managing complex projects. However, the shift to a market economy in the 1990s created an environment where modern project management competencies became essential for navigating economic liberalization, privatization, and globalization (Nagy et al., 2018).

Hungary's post-revolution economic restructuring, alongside its eventual integration into the European Union, necessitated the adoption of internationally recognized project management practices. The introduction of systems engineering, as well as large-scale technological development initiatives, highlighted the need for structured methodologies and robust frameworks to manage uncertainty and coordinate diverse stakeholders. Programs such as Budapest's urban redevelopment, large-scale transportation infrastructure, and industrial modernization projects required innovative approaches, tools, and techniques for successful delivery. These projects provided the foundation for modern Hungarian project management, which was influenced by global methodologies such as those outlined in the Project Management Body of Knowledge (PMBoK) and PRINCE2 (Institute, 2021).

Early project management practices in Hungary focused on two primary streams: the technical and operational aspects of projects and the organizational strategies required to ensure successful execution. Tools such as Work Breakdown Structures (WBS), Gantt Charts, Critical Path Methodology, and Program Evaluation and Review Technique (PERT) became widely adopted for planning and tracking project progress (Chang, 2015). At the same time, organizational strategies, such as matrix management structures, emphasized coordination and communication across project teams. Together, these tools and strategies laid the groundwork for the multidisciplinary approach to project management that is now prevalent in Hungary (EMIS, 2017).

As Hungary modernized, project management became integral to achieving economic and developmental objectives. Modern project management, with its focus on mobilizing resources and achieving time-bound goals, integrates competencies from diverse fields, including finance, supply chain management, operations, and human resource management. This interdisciplinary perspective has enabled Hungarian organizations to address complex challenges and improve project outcomes across sectors such as IT, infrastructure, energy, and education (Aranyossy et al., 2018).

2.4.1 Project Management Competencies

Project management competencies are generally recognized as a combination of behaviors, skills, and knowledge essential for the successful execution of projects. Traditional views focused on technical knowledge and the effective use of project management tools (Turner, 2016). However, with the advancement of technology, the role of interpersonal skills such as leadership, communication, and emotional intelligence has gained prominence (Banihashemi et al., 2017). The Project Management Institute (PMI) divides project management competencies into distinct categories: technical, personal, and contextual (Brière et al., 2015).

Personal competencies, which pertain to emotional intelligence and interpersonal relationships, have been identified as crucial yet under-researched areas in project management (Cicmil et al., 2017). Research suggests that human-centered competencies, such as empathy and emotional awareness, directly contribute to project success (Mai et al., 2018). Furthermore, effective project managers not only understand their emotional states but also can gauge the attitudes and motivations of their team members, fostering a more collaborative and high-performing work environment.

Various studies have emphasized that successful project management depends on competencies like communication, leadership, team building, problem-solving, and stakeholder management. For instance, Bush (2020) asserts that adapting competencies based on the unique requirements of each project type and context is essential. Mai et al. (2018) highlight that merely possessing knowledge of these competencies is insufficient; successful project managers must also demonstrate the ability to apply these skills effectively in dynamic project environments.

As projects evolve throughout their life cycles, different competencies take on varying levels of importance. Early-stage project management focuses on interpersonal competencies, such as communication and stakeholder engagement, while technical decision-making becomes more critical in later stages (Ehsani et al., 2017). Additionally, in response to the growing trend of remote and mobile work, social competencies such as flexibility, leadership, and knowledge-sharing are becoming increasingly important.

The literature suggests that technical project management competencies alone are insufficient for managing complex, uncertain, and ambiguous projects. Human-centered competencies, including strategic planning, leadership, and communication, are increasingly critical. Particularly, Generation Z project managers, although creative and innovative, tend to lack these human-centered competencies, which are vital for navigating today's complex project environments (Cardona-Meza & Olivar-Tost, 2017).

Project management competency (PMC) is a critical element in the success of projects, encompassing a range of skills and knowledge areas that enable project managers to effectively plan, execute, and deliver projects. According to the Project Management Institute (2021), project management competencies are classified into two main categories: technical and professional competencies, and soft skills and personal competencies. These competencies not only ensure that project managers can address the complexities of their projects but also foster collaboration and leadership, which are essential for project success (Dugan, 2024). The ability of project managers to balance these competencies is integral to navigating the challenges of project management in modern, dynamic environments.

The field of project management competencies is characterized by its diversity and lack of a standardized framework, making it challenging to comprehensively analyze. To overcome this challenge, a meta-analytic approach was employed in line with methodologies proposed by researchers such as Moradi (2020). This approach aimed to identify tools, techniques, and competencies within project management by systematically examining how researchers define and investigate these competencies (Radujković & Sjekavica, 2017). Variables and indicators from both qualitative and quantitative studies were indexed to create a detailed and comprehensive definition of project management competencies. The review began with an overview of the field and was followed by an examination of project management competencies, qualitative and quantitative research findings, and definitions adopted in this study.

Qualitative Case Study Research on Project Management Competencies

A total of 21 articles employed qualitative case study methodologies to study PM competencies. These publications were categorized into four thematic subgroups:

1. Contextual Adaptation in Project Planning and Risk Management

Case studies by De Rezende and Blackwell (2019) emphasized the importance of contextually adaptive and closed-loop planning throughout the project lifecycle. Similarly, Turner (2016) explored these management techniques in achieving project performance. These studies collectively concluded that rigid, linear approaches to risk management and project planning, which exclude adaptive mechanisms and feedback loops, often lead to poor project results. This subgroup highlights that project management is a complex, iterative process requiring continuous adaptability and integration of feedback.

2. Application and Contextual Variability of Project Management Competencies

Several case studies focused on the application of project management competencies in diverse contexts. Studies by Takey and de Carvalho (2015) and Maqbool (2017) explored the effectiveness of project management competencies across various settings. Additional research by Radujković and Sjekavica (2017), Cicmil et al. (2017), Alvarenga (2019), and Nicholas and Steyn (2020) assessed competencies in different environments.

3. Managing Uncertainty and Complexity in Project Management Competencies

This subgroup examined how uncertainty and complexity affect the selection and implementation of project management competencies. Case studies by Silva et al. (2016), Zuo et al. (2018), Loufrani-Fedida and Missonier (2015), and Silvius and Schipper (2014) integrated dimensions of complexity and uncertainty into their analyses. Findings suggested that carefully selected competencies could mitigate complexity and streamline project execution, underscoring the importance of understanding project-specific attributes when deploying management competencies.

4. Flexibility and Systems Thinking in Dynamic Environments

Research in this subgroup emphasized flexibility and systems thinking in managing projects within dynamic environments. Studies by Moradi (2020) demonstrated the necessity of holistic systems approaches to achieve positive project outcomes. These studies integrated tools and techniques into cohesive frameworks rather than applying them in isolation. This perspective builds upon earlier findings on managing complexity and uncertainty, advocating for a broader view that combines adaptability, context, and systemic approaches (Silvius & Schipper, 2014).

Quantitative Research on Project Management Competencies

To complement qualitative insights, 53 studies employed quantitative methodologies, primarily using survey and correlational research designs.

1. Survey-Based Research

Thirteen studies used survey methods to explore project management competencies, divided into 2 collections:

- The first grouping, including Banihashemi (2017), Takey (2015), provided broad insights into PM competencies, techniques, and tools. However, these studies lacked specificity and depth.
- The second group, comprising longitudinal studies by Bockova et al. (2019) and Rahmana et al. (2014), provided a wide-ranging analysis of 108 project management competencies, techniques, and tools. These studies offered insights into the evolution and application of competencies over time, distinguishing between competencies and implementation frameworks like PRINCE2 and PMBoK.

2. Correlational Research

Correlational studies accounted for 40 of the 53 quantitative studies reviewed, reflecting the field's preference for positivist approaches and mathematical methods (Chang, 2015). These studies aimed to empirically test the relationship between project management competencies and project outcomes. However, inconsistencies in defining competencies and the weak theoretical underpinnings of many studies posed challenges. Despite these limitations, correlational research has been critical in establishing empirical links between project management competencies and outcomes.

Longitudinal Insights and Emerging Trends

Longitudinal research by Geraldi and Söderlund revealed notable trends in the usage of project management competencies. For instance, certain competencies, such as contractual commitment databases and simulations, were phased out due to decreased relevance (Geraldi & Söderlund, 2018). Additionally, a shift away from extensive tool usage was observed, raising questions about whether this trend indicates a refinement in competency application or a move missing from project management as a primary management methodology. These findings highlight the importance of consistently defining and monitoring competencies to evaluate their effectiveness accurately.

Research on project management competencies, both qualitative and quantitative, underscores the evolving nature of the field. Qualitative studies emphasize the need for adaptability, contextual sensitivity, and systems thinking in managing complexity and uncertainty. Quantitative research provides empirical evidence supporting the effectiveness of specific competencies but highlights challenges such as inconsistent definitions and evolving tool usage trends. By synthesizing insights from both qualitative and quantitative research, this study aims to enhance understanding of project management competencies and their impact on project outcomes. Continued research in this area is essential to address gaps and ensure the effective application of project management competencies across diverse contexts.

2.4.2 Soft Skills and Personal Competencies

Soft skills and personal competencies, which focus on interpersonal and emotional capabilities, are vital to the overall effectiveness of a project manager. These skills include leadership, communication, emotional intelligence, conflict resolution, and adaptability. Emotional intelligence, in particular, has gained attention for its role in enhancing the ability of project managers to understand their teams' emotions and to foster positive relationships, leading to improved team performance and collaboration (Müller & Turner, 2010). Communication is another critical soft skill, as it helps in effectively conveying project goals, progress, and expectations to various stakeholders, ensuring alignment and mitigating misunderstandings (Kroh & Schultz, 2023). Additionally, personal competencies such as decision-making, problem-solving, and time management allow project managers to handle uncertainties and challenges in complex project environments (Cleden, 2017).

Studies emphasize that the presence of strong soft skills often differentiates successful project managers from their less effective counterparts. Monk & Ogolsky (2019) found that project managers with high emotional intelligence and adaptability tend to navigate complex environments better, fostering team cohesion and project success. Furthermore, Müller & Turner (2010) highlight the importance of leadership, noting that project managers who can lead and motivate teams are more likely to deliver projects successfully, particularly in high-stakes scenarios where collaboration and trust are essential. Therefore, soft skills and personal competencies are crucial not only for day-to-day project management but also for long-term project success.

Competency is a multidimensional construct with varying definitions depending on the context. Magano et al. (2020) categorized competencies into several dimensions, including performance abilities, domain-specific prerequisites, learned knowledge and skills, motivational and social factors, and subjective self-evaluations. In project management, the concept of competency often relates to personal skills, influencing abilities, emotional intelligence, professionalism, and cognitive capabilities, all of which are critical for successful project execution. Competency assessments measure an individual's performance in specific tasks and domains, yet their effectiveness depends on how these assessments capture real-world scenarios (Pereira & de Freitas, 2019).

Personal Skills and Attributes

Personal skills like orientation, commitment, and confidence are essential in ensuring a project manager aligns with project goals and objectives. Orientation towards goals involves demonstrating a clear focus on project outcomes (Ribeiro Serra et al., 2021). Commitment and confidence, highlighted in research by Kunrath (2020), enable project managers to navigate complex scenarios and maintain focus on achieving success. The initiative, a vital personal attribute, allows project managers to proactively address challenges, as Uzoka (2018) explained, particularly when external events or domain uncertainties emerge. Open-mindedness and attention to detail further enable managers to improve project outcomes, as these skills foster adaptability and precision in planning and execution (Kunrath et al., 2020).

Courage in tackling difficult project situations and maintaining morale within teams, often supported by a sense of humor, can significantly impact team cohesion and success. According to Uzoka (2018), project managers with strong interpersonal skills and courage are better equipped to handle conflicts, thus improving stakeholder satisfaction. Multi-tasking abilities and discipline, essential for managing complex projects, are supported by a structured competency framework like PMI's PMBOK (Institute, 2021; Pereira & de Freitas, 2019).

Influencing Skills

The ability to influence and persuade stakeholders is a critical competency for project managers. Leadership skills inspire and guide project teams, fostering a collaborative environment (Turner & Baker, 2019). Conflict management, as noted by Algeo & Connell (2017), enables managers to resolve disagreements effectively, ensuring that project goals remain on track. Negotiation skills, paired with charisma, allow project managers to engage with stakeholders positively, facilitating alignment with project objectives (Zuo et al., 2018).

Motivating team members to perform at their best is a hallmark of transformational leadership, as demonstrated by Maqbool (2017). This requires influencing skills that extend beyond technical expertise to foster engagement and build trust among team members and stakeholders.

Emotional Skills

Emotional intelligence (EI) encompasses stress management, empathy, and interpersonal sensitivity skills that are vital for managing complex project environments. Stress management allows project managers to maintain clarity and focus under pressure, while self-awareness aids in recognizing one's strengths and areas for improvement (Khosravi et al., 2020). Empathy, as suggested by Cleden (2017), helps project managers address the concerns of team members, creating a supportive and collaborative work environment.

Interpersonal sensitivity and the ability to build and maintain relationships are essential for fostering teamwork. These skills align with the concept of self-motivation, as discussed by

Cicmil (2017), where managers actively seek to achieve project objectives while inspiring their teams to do the same.

Professionalism

Professional ethics and accountability are foundational to project management competencies. Adhering to ethical principles, as outlined by PMI (2021), ensures that project managers act with integrity and transparency throughout the project lifecycle. Accountability involves taking responsibility for decisions and actions and reinforcing trust among stakeholders (Radujković & Sjekavica, 2017). This is particularly important in high-stakes projects, where ethical lapses can have significant consequences for project outcomes.

Cognitive Skills

Cognitive skills, including problem-solving, decision-making, and critical analysis, are central to effective project management. According to Geraldi (2021), problem-solving involves addressing project challenges using innovative and strategic approaches. Creativity and critical thinking enable project managers to devise novel solutions and evaluate the implications of their decisions (Shekh-Abed, 2025).

Strategic perspective and systems thinking, as noted by Geraldi (2021), provide project managers with a holistic understanding of project dynamics, allowing them to anticipate trends and address emerging challenges. Vision and imagination are essential for articulating the strategic direction of projects, while continuous learning ensures that project managers stay updated with evolving methodologies and technologies (Keane, 2022).

Integrating Competency Frameworks in Project Management

Competency frameworks like PMI's PMBOK and IPMA's ICB provide structured approaches to developing and assessing project management competencies. These frameworks emphasize integrating technical knowledge, personal attributes, and interpersonal skills to achieve project success (Algeo & Connell, 2017). The PMCD framework, for example, categorizes competencies into three dimensions: knowledge, performance, and personal traits, ensuring a comprehensive evaluation of project management capabilities (Cardona-Meza & Olivar-Tost, 2017; Institute, 2021).

Competency in project management is not static but evolves through experience, learning, and adaptation. As Alvarenga (2019) noted, project managers must continuously refine their skills to meet the demands of increasingly complex projects. This involves balancing technical expertise with soft skills like leadership, empathy, and communication.

Competencies in project management extend beyond technical knowledge to encompass personal, emotional, and cognitive skills, as well as professionalism and influencing abilities. These competencies collectively determine a project manager's ability to navigate complex environments and achieve success. By leveraging structured frameworks and fostering continuous learning, project managers can enhance their effectiveness and contribute to achieving organizational objectives. Future research should focus on exploring how these competencies interact in diverse project contexts, providing insights into their role in improving project outcomes.

2.4.3 Technical and Professional Competencies

In addition to soft skills, technical and professional competencies are fundamental for project managers, as they provide the necessary expertise to manage the technical aspects of projects. These competencies include proficiency in project management methodologies, risk

management, budgeting, scheduling, and quality control (PMI, 2017). Technical skills, such as knowledge of project management tools (e.g., Gantt charts, work breakdown structures) and methodologies (e.g., Agile, PRINCE2), are essential for ensuring that the project is planned and executed according to established best competencies (Turner, 2016). Moreover, project managers must possess a deep understanding of the industry-specific technicalities of their projects, as this knowledge allows them to make informed decisions and effectively communicate with technical teams (Brière et al., 2015).

Research shows that technical competencies are indispensable for managing project scope, time, and cost, key factors in determining project success. For example, studies by Rezvani et al. (2016) found that project managers with high technical competence were better equipped to deal with the intricacies of project management processes and mitigate risks effectively. Additionally, technical competencies help project managers adopt appropriate project management methodologies that fit the project's complexity and environment. Despite the increasing focus on soft skills, technical competencies remain critical, especially for managing complex projects with demanding technical requirements (Koolwijk et al., 2018). However, the integration of both technical and soft skills is necessary, as projects require not only structured management but also the ability to navigate interpersonal dynamics.

The success of projects in complex organizational environments significantly depends on the competencies of project managers, encompassing technical, professional, contextual, and communication skills, as well as team collaboration and adaptability to evolving challenges. These competencies enable project managers to meet stakeholder expectations, optimize resources, and ensure project alignment with organizational objectives (Müller et al., 2019; Wang et al., 2019).

Technical and professional competencies are foundational to effective project management, with a focus on mastering domains such as time, cost, risk, and quality management. Time management ensures project timelines are adhered to without compromising quality, while cost management requires project expenditures to remain within budgetary constraints (Turner, 2016). Risk management, on the other hand, involves identifying, assessing, and mitigating potential risks that could hinder project progress (Khan et al., 2020). Maintaining quality is critical for meeting or exceeding stakeholder expectations, emphasizing the need for a well-defined quality assurance strategy (Locatelli et al., 2023).

Procurement and resource management are equally important. Procurement skills ensure the acquisition of necessary resources, while human resource management facilitates effective task allocation and team support (Butler et al., 2020). Additionally, scope management plays a pivotal role in preventing scope creep and ensuring deliverables align with project objectives.

Knowledge and Experience

In-depth technical expertise and relevant experience are essential for project managers to provide technical guidance and solve complex challenges. Experienced managers are better equipped to anticipate project issues and implement proactive solutions, ensuring seamless project execution (Turner, 2016). Furthermore, business expertise allows project managers to align project goals with broader organizational strategies, delivering measurable value and strengthening the project's strategic impact (de Araujo et al., 2018).

Administrative expertise supports the efficient coordination of project activities, facilitating teamwork and resource optimization. These competencies help ensure project plans are implemented effectively and that teams remain aligned with organizational goals (Geraldi & Söderlund, 2018).

Contextual Skills

Contextual skills such as adaptability and contextual awareness enable project managers to navigate dynamic environments. Adaptability ensures managers can respond to evolving requirements and unexpected challenges, while contextual awareness allows them to understand organizational environments, constraints, and stakeholder expectations. Strategic alignment is critical to ensure that project goals contribute to overarching organizational objectives, maximizing their impact (Alvarenga et al., 2019).

Political awareness further empowers managers to navigate organizational dynamics effectively, facilitating conflict resolution and decision-making (Turner, 2016). Networking is another vital contextual skill, helping managers build relationships that support resource sharing and collaboration across teams and organizations (Barlow et al., 2016).

Management Skills

Management skills such as planning, monitoring, and directive leadership are central to effective project delivery. Planning involves developing comprehensive project plans that outline objectives, timelines, and metrics for success, while monitoring and control ensure alignment with these plans throughout the project lifecycle (Kerzner, 2022). Directive leadership provides clear guidance to team members, ensuring they understand their roles and responsibilities.

Coordination and prioritization also enhance project management. Coordination ensures activities across stakeholders and teams are synchronized, while prioritization enables managers to focus on tasks that have the greatest impact on project outcomes (Sipes, 2016).

Communication Skills

Communication skills are critical for fostering collaboration and ensuring smooth project execution. Verbal and written communication allows managers to convey information clearly and concisely, while active listening facilitates meaningful engagement with stakeholders and team members. Open communication channels build trust and encourage constructive feedback, promoting a positive project culture (Silvius & Schipper, 2014).

Effective presentation skills allow managers to deliver engaging updates and findings, particularly in multicultural environments where communication strategies must adapt to diverse team dynamics (Barlow et al., 2016). Multi-level communication ensures consistent information flow across all levels of the organizational hierarchy.

Team Working Skills

Teamwork is a critical component of project success. Collaboration fosters synergy among team members, enabling them to achieve shared goals. Providing support and assistance helps build trust and enhances team performance, while developing the skills and capabilities of team members contributes to overall productivity (Vogler et al., 2018). Delegation ensures tasks and responsibilities are distributed effectively, allowing team members to take ownership of their roles and enabling managers to focus on strategic priorities (Sipes, 2016).

Trustworthiness is essential for creating an environment where team members feel confident in their contributions and leadership. Effective escalation processes also play a crucial role in addressing conflicts and project issues promptly, minimizing disruptions (Zuo et al., 2018).

By combining technical, contextual, managerial, communication, and teamwork skills, project managers are better equipped to navigate the complexities of modern projects and ensure successful outcomes. The integration of these competencies enables organizations to

achieve project goals while meeting stakeholder expectations and aligning with broader strategic objectives.

2.4.4 Project Complexity

Project complexity is another key factor affecting project success. Over the years, the understanding of project complexity has expanded from simple definitions to a more intricate exploration of its causes and impacts on project management. Factors contributing to complexity include technological, organizational, and environmental interdependencies (Kroh & Schultz, 2023). The interconnectedness of these elements often leads to ambiguity and uncertainty, making project management more challenging (Zhao et al., 2019).

Recent literature has moved beyond defining and categorizing complexity to exploring how project managers can manage it. For example, He et al., (2015) emphasize that hidden interdependencies within complex projects significantly affect decision-making, particularly in areas with varying social, financial, and technical interests. In their study of Hong Kong-based projects, the authors found that technical and organizational complexities could have both positive and negative impacts on project outcomes, depending on how well they were managed (Cardona-Meza & Olivar-Tost, 2017).

The role of stakeholders in contributing to project complexity is another area of focus. Disagreements among stakeholders, conflicting interests, and inadequate information sharing can escalate complexity and hinder project performance (Zhao et al., 2019). Interestingly, while technological and managerial complexities were found to positively influence project performance in some cases, environmental and informational complexities were negatively correlated with performance.

Complexity science views complexity as a prospect if appropriate instruments exist to direct pressures. A project is often understood as a system, yet Haynes (2015) proposed that complexity results from the lack of adequate resolutions. Their research focused on collaborative behavior, showing that project managers can manage complexity by facilitating information flow. The study also highlighted that corporate culture and organizational values moderate project complexity, suggesting that these factors can help mitigate the challenges posed by complexity (Mai et al., 2018).

Project complexity is frequently cited as a major cause of project failure. Aarseth et al. (2017) described projects as "organic" entities, characterized by complex and adaptive behaviors. They emphasized that projects are constantly changing, requiring project managers to foster flexibility and adaptability within teams. Although no universally accepted definition of project complexity exists, Radujković & Sjekavica (2017) argued that sociopolitical factors significantly contribute to the complexity of projects, aligning with Kerzner's (2022) three-dimensional definition. This perspective underscores the importance of trust and communication, as these factors help both project managers and teams navigate complex project environments.

The literature also highlights collaboration and trust as key mechanisms for managing project complexity. The rise of collaborative contracts, where parties agree to share risks and benefits, has been noted to increase contracting can heighten project complexity (He et al., 2015). Their study found that in low-complexity conditions, rules and procedures were emphasized, whereas in high-complexity conditions, trust and collaboration were prioritized over formal regulations. This shift suggests that in complex environments, rigid adherence to contractual terms may be less effective than fostering mutual trust and open communication.

Rezvani (2016) linked supply and financial risks to project complexity, suggesting that risk management processes such as identification, analysis, and control can also be applied to manage complexity. He et al. (2015) further emphasized that many project managers struggle to grasp the essence of complexity, which contributes to project failure. They argued that

project complexity stems not just from tangible factors like size but also from sociopolitical dynamics. The interplay of these factors demands a more nuanced understanding of complexity.

Structural factors also play a role in project complexity, as highlighted by Badewi (2016). As project size increases, effective communication and knowledge sharing can break down, leading to confusion and misinterpretation. Personal agendas and power dynamics further contribute to complexity, particularly in large-scale projects like metro rail megaprojects in India (Ahuja et al., 2010).

The growing body of work also highlights the mediating role of project complexity in shaping project outcomes. Studies have consistently shown that while competencies are foundational, they must be complemented by adaptive strategies that acknowledge the intricate, evolving conditions of refugee integration projects. This aligns with complexity theory, which frames projects as adaptive systems influenced by both internal processes and external uncertainties (Saadi et al., 2023).

The sustained interest in these themes, reflected in high-citation authors and prolific institutions, points to a vibrant research community dedicated to refining project management practices for crisis response. Yet, significant gaps remain, especially in examining how project management competencies can be effectively harnessed to navigate complexity and achieve durable outcomes in refugee integration initiatives.

Construction projects are inherently complex, and poor management of this complexity can lead to adverse outcomes, such as delays and cost overruns. Improper handling of complexity is consistently linked to unsatisfactory project results (Moradi et al., 2020). Numerous studies agree that project complexity negatively impacts project performance and success (Nicholas & Steyn, 2020). The significance of project complexity has drawn substantial scholarly attention, especially due to its role in contributing to budget and time overruns in large-scale projects (Cicmil et al., 2017). As a primary driver of uncertainty, complexity introduces additional costs and diminishes performance when it is not addressed early in the project lifecycle (Silva et al., 2016). Radujković and Sjekavica (2017) emphasized that project complexity significantly affects cost and schedule performance during the project delivery selection process. Additionally, Tabassi et al. (2016) identified complexity as a key factor behind project failures. Despite this recognition, Cicmil (2017) argued that the interplay between project complexity, uncertainty, risk, and project performance remains an area requiring further exploration.

Managing complexity is essential for achieving positive outcomes for all project stakeholders. A comprehensive understanding of project complexity is crucial in mitigating risks and ensuring project success. The construction industry is characterized as dynamic, risky, and challenging, noting its frequent struggles in managing inherent risks and achieving desired outcomes. This section explores various definitions and dimensions of project complexity to provide deeper insights into this multifaceted concept (Tabassi et al., 2016).

Project complexity is widely recognized as a central yet elusive concept in project management research. Despite extensive scholarly efforts, no single, universally accepted definition of project complexity exists (Silvius & Schipper, 2014). Loufrani-Fedida and Missonier (2015) observed that "the term is broadly and intuitively applied, without a standard definition, explanation or conceptualization," complicating its practical application. Some scholars have described complexity as a "know it when you see it" phenomenon, relying heavily on subjective interpretations and individual perceptions (Takey & de Carvalho, 2015).

Different researchers have proposed various definitions of project complexity, focusing on diverse attributes such as interdependencies, unpredictability, uncertainty, and difficulty. For instance, Nicholas and Steyn (2020) emphasized interdependencies and differentiation, while Conforto and Amaral (2016) highlighted the challenges associated with understanding, predicting, and controlling complex project behavior. Many of these definitions align with the

broader dimensions of structural and technical complexity outlined by Conforto and Amaral (2016).

The diversity of conceptualizations surrounding project complexity highlights its multifaceted nature. Among the available frameworks, Takey and de Carvalho (2015) classification of complexity into faith, fact, and interaction offers a comprehensive perspective. This framework addresses both tangible attributes, such as task interdependencies and project scope (complexity by fact), and intangible dimensions, such as stakeholder dynamics and behavioral uncertainty (complexity by interaction). Additionally, it recognizes the challenges posed by unforeseen events and innovation (complexity by faith), making it particularly well-suited for examining diverse project scenarios.

For this study, Turner (2016) classification is adopted to define project complexity. This approach provides a holistic understanding of complexity, encompassing its structural, behavioral, and environmental dimensions. Subsequent discussions will explore each of these dimensions in greater detail, aligning them with related concepts from other researchers and demonstrating their practical relevance to managing project complexity.

Some researchers, including Zuo et al. (2018) and Cicmil et al. (2017), argued that project complexity is inherently subjective, depending on individual perceptions and experiences. This perspective suggests that complexity is influenced by how individuals interact with and interpret the project system. Binder (2016) took this view further, proposing a dynamic conceptualization of complexity that focuses on evolving patterns rather than static characteristics.

Conceptualizing Complexity Using the TOE Framework

The Technology-Organization-Environment (TOE) framework introduced by Silvius and Schipper (2014) offers a comprehensive classification of project complexity by dividing it into three dimensions: technical, organizational, and environmental complexity.

1. Technical Complexity: This dimension focuses on structural attributes such as project scope, task interdependencies, and technological uncertainties. It examines how multiple interconnected elements, such as tasks and deliverables, contribute to the overall complexity of a project.

2. Organizational Complexity: This dimension considers softer aspects, such as stakeholder dynamics, resource availability, and trust among team members. It reflects the complexity arising from managing human resources, team interactions, and organizational hierarchies.

3. Environmental Complexity: This dimension addresses external factors, such as political influences, market competition, and site-specific conditions, which often complicate project execution.

The TOE framework aligns closely with Takey and de Carvalho (2015) classification, which categorizes project complexity into three patterns: complexity by fact, complexity by faith, and complexity by interaction.

- Complexity by Fact: Refers to managing extensive volumes of interconnected information, such as project constraints, dependencies, and large-scale data sets. Managing complexity by fact requires maintaining a holistic perspective without becoming overwhelmed by granular details.

- Complexity by Faith: Involves handling unknown and unforeseen project elements that introduce uncertainty and require adaptive strategies rather than pre-planned approaches. This type of complexity often arises in innovative or first-of-its-kind projects.

- Complexity by Interaction: Relates to social and behavioral dynamics, including managing diverse stakeholders, fostering collaboration, and addressing conflicting interests within the project team. It emphasizes the role of effective communication and engagement in reducing complexities.

Radujković and Sjekavica (2017) conceptualization integrates both hard, quantifiable elements and soft, behavioral aspects, making it highly relevant for addressing real-world project scenarios. Their approach also accounts for environmental factors, providing a robust framework for analyzing project complexity across diverse contexts.

Managing project complexity is essential for ensuring successful project outcomes, particularly in the construction sector, where the stakes are high and challenges are numerous. While project complexity negatively affects performance, cost, and schedule adherence, frameworks such as the TOE model and Cicmil (2017) classification offer valuable insights into its management. By understanding the interplay between complexity by fact, faith, and interaction, project managers can develop more effective strategies to address complexity, mitigate risks, and enhance project success.

This study adopts Maqbool's (2017) comprehensive framework as the foundation for analyzing project complexity. By incorporating both measurable and perceived dimensions, this approach provides a robust lens through which project managers can navigate the complexities of their work, ensuring more reliable and successful outcomes.

Selecting a Definition for This Study

Considering the varying perspectives on project complexity, this study adopts De Rezende and Blackwell's (2019) framework, which categorizes complexity into three dimensions: complexity by fact, complexity by faith, and complexity by interaction. This approach provides a comprehensive lens to understand complexity by addressing challenges associated with managing known processes (complexity by fact), dealing with unexpected and unforeseeable issues (complexity by faith), and navigating the social and organizational dynamics of projects (complexity by interaction).

By integrating these dimensions, this study recognizes both measurable attributes and softer, perception-driven factors contributing to project complexity. The subsequent sections expand on these dimensions and explore their implications for effectively managing complex projects.

Complexity by Fact

Complexity, by fact, pertains to structural complexity and involves handling large volumes of interconnected data, including project constraints, activities, interdependencies, and information about project participants. It emphasizes the challenges associated with analyzing and synthesizing detailed information under tight time constraints for decision-making (Zuo et al., 2018). The key difficulty lies in maintaining an overarching, integrated view of the project while managing intricate factual details. Factors like project size and the degree of interdependencies among project elements play a significant role in determining complexity by fact (Chang, 2015).

Project Size

Project size has long been regarded as a critical factor contributing to complexity. It can be quantified by the number of project components, tasks, interrelated activities, or stakeholders (Banihashemi et al., 2017). Other indicators include the monetary value of the project, the team size, and the number of deliverables or structural components involved. Larger projects inherently demand greater coordination, which increases the number of interfaces between work elements. These additional interfaces create challenges for team members as they attempt to integrate and manage vast amounts of interdependent information without being overwhelmed by the details (Alvarenga et al., 2019).

Interdependence

Interdependencies refer to the connections and relationships between various project components, tasks, or external entities. They may arise within the project or from interactions with external organizations, shared resources, and overlapping technologies (Nicholas & Steyn, 2020). High levels of interdependency exacerbate complexity by increasing constraints and limiting the timely collection and analysis of information. This, in turn, creates further challenges in addressing project requirements and achieving successful outcomes (Cicmil et al., 2017).

Complexity by Faith

Complexity by faith occurs when projects are characterized by novelty, unforeseen issues, or objectives that cannot be fully anticipated. This dimension emphasizes the need for adaptability, as project teams must navigate ambiguous requirements and uncertain conditions. Novelty often introduces uncertainty because project teams may lack prior experience or knowledge about the requirements of the task at hand (Silvius & Schipper, 2014).

Uncertainty

Uncertainty is a defining aspect of complexity by faith. It refers to the potential for unforeseen events or conditions to arise at any stage of the project lifecycle (Silva et al., 2016). This includes the unpredictability of future states of project elements, their interactions, and the consequences of these interactions. Ambiguity may stem from unclear goals, evolving stakeholder expectations, or insufficient resources (Silvius, 2021). Additionally, project dynamism such as changes in technology, project scope, or stakeholder relationships further amplifies uncertainty, requiring ongoing adjustments to plans and resources (Radujković & Sjekavica, 2017).

In managing complexity by faith, project teams often rely on trial-and-error approaches, experimentation, and iterative planning to adapt to evolving circumstances (Bredillet et al., 2015). This highlights the importance of flexibility and decision-making strategies tailored to uncertain and ambiguous conditions.

Complexity by Interaction

Complexity by interaction arises from the relationships and interfaces between project stakeholders, organizational structures, and activities. This dimension focuses on the social and behavioral challenges associated with managing diverse stakeholder groups and their varying expectations and motivations. Stakeholders, including project sponsors, customers, end users, and affected communities, exert influence over the project's direction and outcomes (Zuo et al., 2018).

Stakeholder Conflicts:

A significant source of complexity in interaction is the conflict of interests among stakeholders. Each stakeholder group brings unique perspectives, definitions of success, and desired outcomes, which often lead to disagreements and complicate decision-making (Takey & de Carvalho, 2015). For instance, some stakeholders may prioritize cost efficiency, while others emphasize quality or environmental sustainability. This lack of consensus can hinder project progress and create inefficiencies in communication and coordination (Banihashemi et al., 2017).

Communication and Transparency:

Effective communication and transparency are crucial for addressing complexity through interaction. Miscommunication, insufficient information sharing, or unclear expectations often exacerbate stakeholder conflicts and make collaboration more challenging. High volumes of communication, such as emails, meetings, and reports, may lead to information overload and misunderstandings (Nicholas & Steyn, 2020). Project managers must foster clear communication, build trust, and align stakeholder interests with project objectives to mitigate these challenges (Aarseth et al., 2017).

Complexity theory explores the emergence of patterns, order, and structure within seemingly chaotic systems. It is particularly relevant to project management because it highlights the dynamic, non-linear nature of project environments. Complexity theorists argue that projects cannot be fully understood by analyzing their individual components in isolation. Instead, outcomes are shaped by the interactions and relationships among various elements of the system (Takey & de Carvalho, 2015).

Projects and organizations are often viewed as open systems, continuously interacting with their external environments. This interaction introduces dynamic conditions, making stability unattainable and undesirable (Conforto & Amaral, 2016). Non-linear interactions mean that small changes in project elements can lead to significant and often unpredictable outcomes, while major changes might have minimal impact. These dynamics emphasize the importance of context and history in shaping project results (Banihashemi et al., 2017).

Distinction Between "Complicated" and "Complex" Projects:

Complicated projects are generally predictable, with well-defined relationships among project elements that can be managed using traditional planning and organizational structures. In contrast, complex projects are characterized by interdependencies, emergent behaviors, and unpredictable outcomes (De Rezende & Blackwell, 2019). Complex projects often require innovative solutions, adaptability, and collaborative stakeholder engagement to navigate tensions and achieve objectives (Takey & de Carvalho, 2015).

Sense-Making Theory

The Sense-making theory provides a framework for understanding how individuals and organizations interpret their environments to develop actionable insights. It emphasizes social interactions and ongoing adaptation to evolving circumstances, making it particularly relevant for managing project complexity (Tabassi et al., 2016).

Key principles of sense-making theory include retrospective learning, identity construction, and social interaction. These principles highlight the importance of past experiences, stakeholder collaboration, and contextual understanding in navigating uncertainty and ambiguity (Silva et al., 2016).

In projects marked by complexity and uncertainty, sense-making fosters coherence and enables effective decision-making. By creating plausible interpretations and aligning stakeholder perspectives, project leaders can address emerging challenges and ensure progress toward project objectives (Cicmil et al., 2017).

In conclusion, the dimensions of complexity by fact, faith, and interaction provide a comprehensive framework for understanding project complexity. These perspectives, combined with insights from complexity theory, chaos theory, and sense-making theory, offer valuable strategies for managing the challenges of complex projects. By embracing flexibility, fostering collaboration, and building adaptive systems, project teams can navigate complexity and achieve successful outcomes.

Complexity and Chaos Theory

The Chaos theory examines how dynamic systems evolve in unpredictable ways over time. It is particularly useful for understanding projects with rapidly changing conditions and unforeseen disruptions (Alvarenga et al., 2019). Traditional project management approaches are often inadequate for such environments, as they rely on linear and static planning. Instead, chaos theory emphasizes the need to recognize emerging patterns and respond dynamically to evolving challenges (Maqbool et al., 2017).

Project teams operating in chaotic environments must focus on building resilient systems, fostering collaboration, and embracing adaptability. This allows them to effectively manage unforeseen challenges and align project goals with emergent conditions (Radujković & Sjekavica, 2017).

Structuration Theory

The Structuration theory frames structure as a set of normative and symbolic rules that simultaneously enable and constrain actions. These structures are shaped, maintained, and redefined through the actions of individuals within social systems, emphasizing a dynamic relationship between structure and agency (Banihashemi et al., 2017). Norms, symbols, and tangible artifacts serve as structures that both facilitate and guide social behavior while being continuously reproduced through individual and organizational actions (Conforto & Amaral, 2016).

In this context, actors within a system are regarded as knowledgeable agents who utilize rules and resources to shape processes and events. However, while these structures provide a framework for action, they can also impose constraints. For instance, in decision-making meetings, a common structural mechanism may be restricted by time limitations or unequal participation among stakeholders (Maqbool et al., 2017).

In project management, structuration theory conceptualizes organizations as networks of social interactions shaped by ongoing negotiations of roles, norms, and meanings (Bredillet et al., 2015). Project environments are seen as dynamic social systems, where complexity arises from two primary components:

1. Individual Actors: The decisions, behaviors, and interactions of project team members and stakeholders.

2. Social Systems: Organizational structures, including communication channels and decision-making frameworks that guide collective actions (Gido et al., 2018).

Structuration theory explains how these components interact in complex projects. Team members operate within established rules but also possess the agency to adapt and reshape these structures, creating a recursive relationship between action and structure (Aarseth et al., 2017).

Effective communication systems play a critical role in managing complexity by facilitating the dissemination of information and enabling collaborative decision-making (Zuo et al., 2018). However, structural constraints such as limited stakeholder participation and time pressures can hinder these processes. Structuration theory offers insights into overcoming such challenges by focusing on the interplay between actors and structures, emphasizing the need for adaptive and negotiated approaches to complexity management.

Ultimately, structuration theory highlights the importance of stakeholder interaction and negotiation in addressing project complexity. By viewing projects as dynamic social systems, this theory provides a useful framework for understanding the intricate relationships and structures that influence project outcomes.

Social Identity Theory and Project Complexity

Social identity theory focuses on how individuals derive their sense of self and behavior based on their membership in social groups. These groups, defined by shared identities and perceptions, significantly influence individual actions and self-concepts (Fewings & Henjewele, 2019). Social identity refers to an individual's awareness of belonging to a specific social group, such as a profession or organization, which in turn shapes their actions and interactions (Silvius, 2021).

Social identity theory comprises three core processes:

1. Social Categorization: Grouping individuals into social categories or classes.
2. Social Comparison: Evaluating one's group relative to others.
3. Positive Distinctiveness: Favoring one's group over others to maintain a positive sense of identity (Nicholas & Steyn, 2020).

Within project environments, social identity theory provides valuable insights into the emotions, behaviors, and interactions of stakeholders operating within teams or organizations. For example, organizational identity is shaped by the collective understanding of what distinguishes a team or organization from others (Gido et al., 2018). External factors such as structural changes or policy reforms further influence identity construction and stakeholder behavior (Silva et al., 2016).

Social categorization and comparison within project teams promote conformity and alignment, fostering collaboration and minimizing complexity in stakeholder interactions (Cicmil et al., 2017). By addressing the diverse identities and expectations of stakeholders, project managers can better navigate and mitigate the complexities arising from social interactions.

Social Capital Theory and Project Complexity

Social capital theory examines the value embedded in social networks, relationships, and interactions, which individuals and groups leverage to achieve objectives (Silvius, 2021). Social capital, as a resource, facilitates knowledge sharing, collaboration, and innovation by fostering trust, shared norms, and mutual understanding (De Rezende & Blackwell, 2019).

Social capital is typically categorized into three dimensions:

1. Cognitive Dimension: Shared values, norms, and codes that enhance collaboration and understanding.
2. Relational Dimension: The trust and interpersonal relationships developed over time among network members.
3. Structural Dimension: The network of connections and interactions within a system, emphasizing social interactions and organizational centrality (Tabassi et al., 2016).

In project contexts, social capital is essential for managing complexity. For instance, collaborative stakeholder relationships and shared experiences enable effective knowledge exchange and problem-solving in complex projects, particularly in engineering and construction domains (Banihashemi et al., 2017). Additionally, social capital supports organizational learning by transferring knowledge across boundaries and improving project performance (Takey & de Carvalho, 2015).

Complex projects often involve diverse teams, requiring high levels of social capital to overcome communication barriers and promote collaboration. Shared experiences and strong interpersonal connections help project teams navigate challenges, adopt innovative practices, and achieve project objectives (Alvarenga et al., 2019).

Baccarini's Research Stream on Project Complexity

Baccarini's (1996) seminal work on project complexity serves as a foundation for much of the research in this field. He identified two primary dimensions of project complexity: organizational complexity and technical complexity. These dimensions encompass factors such as structural interdependencies, task coordination, and technical uncertainty.

Subsequent research expanded on Baccarini's framework, focusing on two main areas:

1. Management in Complexity: Addressing project complexity as an inherent characteristic that requires strategic management approaches, such as risk and uncertainty management (Alvarenga et al., 2019).
2. Management of Complexity: Focusing on contingency theories that highlight the role of project management competencies in mitigating complexity (Silvius & Schipper, 2014).

Zuo et al. (2018) proposed a five-factor framework for understanding project complexity, encompassing structural complexity, uncertainty, dynamic complexity, pace, and socio-political complexity.

Project Complexity in IT and Software Projects

The software and IT industry, particularly in emerging economies, is characterized by high levels of complexity, which pose significant challenges for achieving project success (Silva et al., 2016). Complexities in IT projects often stem from rapid technological advancements, regulatory requirements, and the need for innovation (Silvius, 2021). Additionally, IT projects involve diverse stakeholders, intricate systems, and dynamic conditions, all of which amplify complexity (Conforto & Amaral, 2016).

In emerging economies, resource limitations, political instability, and skill shortages exacerbate these challenges (Fewings & Henjewele, 2019). For instance, inadequate project governance and funding delays are prevalent issues in regions like South Asia (Cicmil et al., 2017).

Structuration, social identity, and social capital theories, along with frameworks like Baccarini's and Geraldi's, provide a comprehensive foundation for understanding and addressing project complexity. Whether in construction or IT projects, these theories highlight the importance of stakeholder interactions, organizational learning, and adaptive strategies in navigating complex project environments. Effective communication, leadership, and collaboration are critical for managing complexity and improving project outcomes. By applying these theoretical frameworks, project managers can develop tailored strategies to mitigate the challenges posed by complex systems, ultimately enhancing project success.

2.4.5 Project Performance

Traditionally, project success has been measured by the "triple constraints" of time, cost, and scope (Meredith et al., 2017). However, there is a growing consensus that these metrics alone are insufficient for evaluating success. For instance, Haynes (2015) argued that project success extends beyond the triple constraints to include factors such as stakeholder engagement, team dynamics, and customer satisfaction. Social and psychological factors significantly impact task accomplishment and, by extension, project success.

Stakeholder impressions have become increasingly important in evaluating project success. The project's success is now defined by stakeholders, who consider not only the achievement of technical objectives but also customer service and ongoing engagement. This shift toward a more holistic view of success reflects broader changes in the project management field, where the human element is now recognized as critical. Advances in neuroscience have also provided insights into how individuals perceive success. The human brain forms mental models of ideal performance based on experience, suggesting that perceptions of success are highly

individualized. These perceptions are flexible and shaped by psychological factors, highlighting the subjective nature of project success (Alzahrani, 2020).

Project managers are still tasked with delivering objectives efficiently, but there is increasing recognition that the traditional focus on the triple constraints is inadequate. Rezvani et al. (2016) found that project managers often imitate competencies from other projects to gain legitimacy and noted that the growing consensus in the field is that success is multifaceted and depends on more than just meeting time, cost, and scope requirements. This broader perspective includes factors such as team dynamics and stakeholder relationships, which can be just as important in determining project outcomes.

Recent studies have expanded the definition of project success to include strategic alignment and long-term sustainability. Haynes (2015) found that while efficiency remains relevant, other factors such as customer engagement and organizational impact are increasingly important. Stakeholder involvement throughout the project life cycle is essential for success, especially in complex projects.

Project governance is another critical factor in determining project success. Young et al. (2020) found that trust-based governance structures, which emphasize alignment with stakeholder needs and feedback, are more effective in navigating complex projects. This finding suggests that governance models that foster collaboration and adaptability are better suited to managing the challenges posed by complexity.

Finally, the literature underscores the importance of knowledge sharing and creativity in achieving project success. Ehsani et al. (2017) found that project managers who effectively facilitate communication and conflict resolution are more likely to meet cost, schedule, and quality criteria. Fostering an innovative organizational climate predicts project success, particularly in environments that encourage risk-taking and creativity. These findings suggest that a more flexible and collaborative approach to project management is essential for navigating the complexities of modern projects (Badewi, 2016).

The first construct examined in this study is project outcomes, which represents a fundamental focus in project management, addressing how to evaluate and shape the results of a project. Traditionally, project management has concentrated on identifying the key factors that contribute to the success or failure of projects. Within the existing literature, terms such as "project success," "project failure," and "project performance" are frequently used to describe project results. The research adopts the broader term "project outcomes," as defined by Tabassi et al. (2016), to encapsulate both positive and negative results, addressing the broad scope of possible project consequences. The term "project success" is often perceived as overly optimistic, implying exclusively positive results, and therefore does not adequately reflect the spectrum of outcomes that include challenges and failures (De Rezende & Blackwell, 2019).

The understanding and definitions of project success and failure have evolved. Nicholas and Steyn (2020) identified three distinct periods in the evolution of these definitions. The first period, spanning 1960–1980, focused on the "triple constraints," also known as the "Iron Triangle," which assessed project outcomes based on adherence to time, cost, and quality requirements. The second period, between 1980 and 2000, introduced the concept of critical success factors, adding customer satisfaction as a crucial metric in determining project outcomes. The third period, beginning in 2000, expanded the scope to incorporate strategic success metrics, addressing program, portfolio, and organizational performance. However, while these strategic metrics represent a valuable advancement in evaluating project success, they are beyond the scope of this study, as this research is limited to assessing outcomes at the individual project level.

The Triple Constraints

A widely recognized and applied framework for evaluating project outcomes is the "triple constraints," also referred to as the "Iron Triangle." This model assesses project outcomes through three dimensions: time, cost, and quality. While specific interpretations of these dimensions may vary, there is broad agreement in the literature that these three collectively measure a project's performance in terms of adhering to planned schedules, budgetary constraints, and defined quality standards (Radujković & Sjekavica, 2017).

A review of 49 studies published between 2018 and 2024 (summarized in Table 1) highlights the consistent inclusion of time and cost as typical indicators of project performance. However, variations were observed in how quality was defined and measured. For instance, Loufrani-Fedida and Missonier (2015) proposed an additional metric for cost performance, differentiating between on-budget delivery and cost savings as separate dimensions. While the inclusion of time and cost in project outcome assessments is consistent across studies, the quality dimension often exhibits variability, reflecting differing interpretations and operationalizations in the literature.

By employing the triple constraints as the foundation for project outcome evaluation, this study maintains consistency with prior research while ensuring relevance within the broader field of PM.

Triple Constraints and its Quality Dimension

The quality dimension has frequently been a subject of debate due to its subjective nature and context-specific interpretations. Silva et al. (2016) defined quality as the degree to which the product, service, or deliverable of the project meets its intended purpose. However, evaluating quality is often highly dependent on context, leading to inconsistencies in its definition and measurement.

Three primary sub-categories have emerged in the literature to evaluate quality within projects:

1. Meeting Predetermined Quality Standards: This sub-category assesses whether the project adheres to predefined quality requirements, often used in projects delivering goods or services to clients (Tabassi et al., 2016).

2. Technical Specifications: This dimension examines whether the project meets technical requirements, commonly applied in technical development and engineering projects (Cicmil et al., 2017).

3. Planned Objectives: This sub-category evaluates whether the project achieves its planned objectives, a common measure in information technology, software, and service industries (Silva et al., 2016).

While these sub-categories provide distinct perspectives on quality, their application often varies depending on the project type and context, reflecting the diversity of projects and their associated outcomes.

Criticisms of the Triple Constraints

The triple constraints framework has faced criticism on two key fronts. First, Cicmil et al. (2017) argued that quality is inherently subjective and context-dependent, making it difficult to establish as a universal measure of project outcomes. This critique is particularly relevant in service-oriented projects, where defining and quantifying quality can be complex. Given the diverse nature of industries and deliverables in project management, creating a universal definition of quality remains challenging. Among 12 articles published in leading project management journals since 2010, only two explicitly considered quality as a metric for evaluating project outcomes (Alvarenga et al., 2019).

The second critique is that the triple constraints fail to comprehensively capture the full range of project outcomes. This limitation has prompted scholars to explore additional dimensions, such as client satisfaction and strategic alignment, as supplementary indicators of project outcomes (Zuo et al., 2018).

Client Satisfaction

The inclusion of client-centric dimensions has marked a significant evolution in defining project outcomes. Building on their earlier work on critical success factors, Silva et al. (2016) introduced three client-centric dimensions for assessing project outcomes: client use, client satisfaction, and effectiveness.

1. Client Use: This refers to the extent to which the deliverables of the project are utilized by the client as intended. However, this metric has been inconsistently applied, with only nine out of 62 reviewed studies including client use as a measurable component of project outcomes (Alvarenga et al., 2019).

2. Client Satisfaction: This measure measures the client's level of satisfaction with the project and its outcomes. Twenty-eight studies included client satisfaction as a key indicator, making it the 4th most used measure after time, cost, and quality (Radujković & Sjekavica, 2017).

3. Effectiveness: Defined as the extent to which the project delivers benefits to its intended users, effectiveness has received limited attention. Only six studies since 1998 incorporated effectiveness into assessments of project outcomes (Nicholas & Steyn, 2020).

Strategic Elements

In recent years, research on project outcomes has expanded to include strategic dimensions, such as profitability, stakeholder satisfaction, and alignment with business objectives (Takey & de Carvalho, 2015). These metrics extend beyond the scope of individual projects, addressing outcomes at the program, portfolio, and organizational levels. While these developments reflect the evolving nature of project management, they were excluded from this study, which focuses on project-specific outcomes.

Measurement of Project Performance

The measurement tool developed by Nicholas and Steyn (2020) was selected to operationalize these dimensions, ensuring consistency with prior research. This framework evaluates project outcomes across multiple dimensions, including time, cost, quality, technical specifications, client satisfaction, and business objectives. This instrument also addresses concerns regarding the subjective nature of quality by incorporating distinct measures for context-specific quality and alignment with business goals (Kivunja, 2018). Although the business objectives dimension is less commonly used in other studies, it was retained to ensure consistency with the original framework, enhancing the reliability and comparability of this study's findings.

Following the evaluation of project outcomes, the next construct explored in this research is project management competencies.

2.4.6 Project Management in Hungary

The evolution of project management practices in Hungary has been driven by the need to improve project outcomes in various sectors. However, like other countries, Hungary faces challenges in consistently achieving desired results. Research from the Project Management Institute (PMI) highlights that globally, only nine percent of establishments consider them highly effective at achieving strategic goals, with just over half of projects meeting their intended outcomes (Kocsir & Varga, 2020). Hungary reflects similar trends, where challenges

in resource allocation, stakeholder management, and regulatory compliance continue to affect project success.

In Hungary, IT projects have gained significant momentum, particularly in the context of digital transformation and technological innovation. Projects such as the implementation of enterprise resource planning (ERP) systems, e-governance platforms, and software development for public services have demonstrated the importance of adopting modern project management methodologies. The Hungarian government's efforts to digitize public administration services, such as the development of the National Tax and Customs Administration's online platform, required robust project planning and risk management to ensure timely delivery and stakeholder satisfaction.

Private-sector IT projects in Hungary, such as cloud computing adoption, fintech innovations, and e-commerce platform development, often rely on agile methodologies to address the dynamic nature of technology projects (Nagy et al., 2018). For instance, Hungarian startups in Budapest's growing tech ecosystem have embraced agile frameworks to manage product development cycles and respond to changing market demands. However, challenges such as scope creep, budget constraints, and communication issues among stakeholders are common, highlighting the need for stronger project management competencies.

Hungary's non-IT projects, particularly in construction, infrastructure, and energy, have also benefited from advancements in project management. Large-scale transportation initiatives, such as the modernization of Budapest's metro system and the development of the M4 motorway, required meticulous planning and coordination. These projects, often co-funded by the European Union, adhered to strict project management standards to ensure compliance with funding requirements and international benchmarks (Oláh et al., 2019).

The renewable energy sector in Hungary has also seen the application of the PM model, with projects such as wind farms and solar energy installations requiring effective stakeholder management and resource allocation. Additionally, urban redevelopment projects, such as the restoration of Budapest's historic districts, involved multiple stakeholders, including government agencies, private developers, and local communities. These projects highlight the importance of balancing technical competencies with social and environmental considerations (Sadkowska, 2018).

Public-sector projects in Hungary have faced similar challenges to those seen in private-sector initiatives. For instance, the modernization of Hungary's education system through the introduction of digital learning platforms and infrastructure upgrades for schools has encountered delays due to funding constraints and stakeholder disagreements. Similarly, healthcare infrastructure projects, such as the development of regional hospitals, have struggled with issues related to procurement, resource allocation, and regulatory compliance (Loufrani-Fedida & Missonier, 2015).

European Union funding has played a significant role in shaping public-sector projects in Hungary, particularly in the areas of transportation and environmental sustainability. However, these projects often face bureaucratic delays and complex reporting requirements, which can hinder their progress. The adoption of internationally recognized project management frameworks, such as PRINCE2 and PMBoK, has helped address some of these challenges by providing structured methodologies for planning, execution, and monitoring (Cardona-Meza & Olivar-Tost, 2017).

Academic research in Hungary has contributed significantly to the understanding and development of project management competencies. Hungarian universities and research institutions have conducted studies examining the relationship between project management practices and project outcomes across various industries. These studies highlight the importance of contextualizing project management methodologies to align with Hungary's unique economic, social, and regulatory environment.

For IT projects, academic research has focused on the adoption of agile methodologies and their impact on project success. Studies have examined factors such as stakeholder communication, risk management, and team dynamics, emphasizing the need for continuous improvement and adaptability (Chang, 2015). Non-IT projects, on the other hand, have been analyzed through the lens of resource allocation, environmental sustainability, and stakeholder engagement. Academic insights have informed the best practices for managing complex projects, particularly those involving public-private partnerships and EU-funded initiatives.

Project management in Hungary has evolved significantly, driven by the need to address complex challenges in both IT and non-IT sectors. While the adoption of modern methodologies has improved project outcomes, gaps in implementation and stakeholder coordination remain. Hungarian organizations must continue to invest in project management training and tools to address these challenges, particularly in the context of rapid technological advancements and increasing regulatory requirements (Hettich & Stufe, 2019). By leveraging international best practices and aligning them with Hungary's unique context, project management can play a critical role in driving economic development and improving the success rates of projects across all sectors.

2.5 Key Findings from the Literature Review

Research findings reveal a strong correlation between project management competencies and project performance, with complexity playing a dual role as both a challenge and an opportunity. While project management competencies tend to enhance project outcomes, increased complexity often hampers performance if not effectively managed. This synthesis evaluates the interplay of competencies, complexity, and project performance.

The literature review focused on research within the domain of project management, analyzing the three critical constructs of project performance, PM competencies, and project complexity. The primary objective of the literature review was to provide a holistic overview of existing studies, aiming to explore how these constructs interact with one another. Additionally, the review scrutinized the explanations and operationalizations of these constructs to assess their theoretical and empirical relationships comprehensively.

A total of 191 articles and reports investigating at least one of these three constructs were identified. Collectively, these studies provided support for the standard project management model, which posits that project management competencies positively influence project outcomes. Among the reviewed studies, 42 specifically focused on the relationship between project management competencies and project outcomes. The findings generally supported the validity of the standard model; however, notable inconsistencies emerged due to variations in the definitions, measurements, and operationalizations of the constructs across studies. Furthermore, only 6 reports were based on project complexity as a variable in their analysis (Aarseth et al., 2017). The lack of uniformity in defining and measuring project performance, PM competencies, and project complexity presented a significant challenge in synthesizing and comparing the findings across the body of literature.

To address these discrepancies, the constructs required precise definitions and operationalizations for this study. The literature review started with an examination of project outcomes. Researchers generally agreed that the triple constraints, scope, schedule, and cost are foundational measures of project performance (Nicholas & Steyn, 2020). Additionally, client satisfaction and alignment with business strategy emerged as significant dimensions. For this study, project outcomes were defined to include stakeholder satisfaction and triple constraints, as these are directly relevant to individual projects. The business strategy dimension was excluded, as it pertains more to the assessment of programs, portfolios, or

broader organizational performance rather than individual project outcomes (Banihashemi et al., 2017).

The second step involved analyzing the definitions and operationalizations of project management competencies. The longitudinal studies conducted by Silva et al. (2016) provided a comprehensive framework for defining project management competencies. Their research systematically identified 108 tools, techniques, and competencies relevant to project management. However, the analysis of the broader literature revealed three additional variables requirements definition, negotiation, and reward, mentioned in other studies but were not extensively covered in Besner and Hobbs' framework. These variables were excluded from the operational definition of PM competencies for this study due to their low frequency in the reviewed literature.

The literature review also focused on project complexity, adopting the definition and operationalization proposed by Alvarenga (2019). Their framework represents the culmination of nearly 20 years of research on project complexity and synthesizes prior work into a cohesive model. Loufrani-Fedida and Missonier (2015) conceptualized project complexity as a multidimensional construct encompassing structural, socio-political, and emergent complexities. This definition captures the dynamic and multifaceted nature of project complexity, making it particularly relevant to this study.

In addition to addressing the constructs' definitions and operationalizations, the review revealed two significant research gaps. The first gap concerned the inconsistencies in defining and operationalizing project outcomes, PM competencies, and project complexity. This study addressed this gap by adopting robust, well-established frameworks to clearly define and operationalize these constructs. By grounding the definitions in prominent works such as those of Cicmil et al. (2017) for complexity, Maqbool (2017) for competencies, and Silvius and Schipper (2014) for outcomes, this study ensured consistency and rigor.

The second gap identified was the lack of research examining the mediating role of PM competencies in the connection between project complexity and project performance. Despite substantial literature on the individual relationships between these constructs, few studies have explored the possibility that PM competencies mediate the impact of project complexity on project performance. The research sought to address this gap by testing the proposed mediation hypothesis. Specifically, it posited that project management competencies could act as a critical mechanism through which the challenges posed by project complexity are mitigated, leading to improved project outcomes. By doing so, the research aimed to provide new insights and expand the theoretical understanding of how these constructs interrelate.

Definitions and Operationalizations of Constructs

Project Outcomes

Project outcomes were defined based on the triple constraints of cost, schedule, and scope, with the addition of client satisfaction as an essential dimension. This definition aligns with previous research that views time, cost, and quality as the fundamental measures of project success (Banihashemi et al., 2017). The decision to include client satisfaction reflects the evolving perspective in project management, which increasingly recognizes the importance of stakeholder perceptions and experiences in determining project success (Banihashemi et al., 2017).

Project Management Competencies

The operationalization of project management competencies relied heavily on the comprehensive framework established by Nicholas and Steyn (2020). Their longitudinal research identified a diverse set of competencies, tools, and techniques integral to effective project management. These competencies include activities, from risk management and

communication planning to resource allocation and stakeholder engagement. Although additional variables such as negotiation, reward, and definition were identified in the broader literature, they were excluded from this study due to their relatively low prevalence (Alvarenga et al., 2019).

Project Complexity

Aarseth et al. (2017) framework was adopted to define and measure project complexity. This model categorizes complexity into three dimensions:

1. Structural Complexity: Includes elements such as project size, scope, and technical interdependencies.
2. Socio-Political Complexity: Encompasses stakeholder dynamics, organizational politics, and communication challenges.
3. Emergent Complexity: Captures uncertainty, ambiguity, and the dynamic nature of project environments.

This framework provides a holistic understanding of project complexity, emphasizing its multifaceted and evolving nature.

Gaps and Contributions

The literature review highlighted two critical gaps. First, inconsistencies in the definitions and operationalizations of the constructs limit the comparability of findings across studies. This study addressed this gap by adopting well-established frameworks to define and measure project outcomes, project management competencies, and project complexity. Second, the mediating role of project management competencies in the relationship between project complexity and project outcomes remained underexplored. By empirically testing this mediation hypothesis, the study aims to contribute to the field by offering a more nuanced understanding of how project management competencies influence the outcomes of complex projects.

By addressing these gaps, this research contributes to advancing the theoretical and practical understanding of project management. It integrates insights from prior studies while providing a clear and consistent framework for examining the interplay between project outcomes, competencies, and complexity.

2.5.1 PM Competencies and Project Performance

The PM competencies have been repeatedly shown to positively impact project performance. The ability to negotiate, facilitate, and adapt is essential in managing complexities that arise throughout the project lifecycle. The project managers who are skilled in facilitation while maintaining expectations can effectively mitigate project complexity. They concluded that competencies enable managers to handle structural aspects of complexity, such as stakeholder interactions and resource management, although the study's qualitative nature precluded establishing a direct causal relationship between competencies and project performance (Berssaneti & Carvalho, 2015).

Brière (2015) also reinforced the importance of project management competencies in improving project efficiency, particularly in the context of project-based firms in the United Arab Emirates. The study demonstrated that when project managers encourage creativity and continuous improvement, the team’s performance significantly improves. Project managers who are adept at fostering an environment of collaboration and innovation are more capable of handling complexity. These findings highlight those competencies, particularly leadership skills, that contribute to managing complexity and driving project success.

Additionally, the research of Niknazar and Bourgault (2017) highlighted the role of leadership styles, particularly transformational leadership, in motivating and inspiring project

teams in Pakistan. The ability to engage team members and utilize procedural tools like risk registers and role matrices positively influenced project outcomes. These procedural competencies, combined with human-centered leadership approaches, were instrumental in ensuring project success, underscoring the multidimensional nature of project management skills.

Bush (2020) took a similar perspective, focusing on the role of human-centered project management competencies in strengthening collaboration and knowledge sharing within teams. Their research found that while technical competencies related to project planning and monitoring are necessary, they are not sufficient to drive performance alone. Instead, it is the application of soft skills and team-oriented leadership that has a greater impact on project success, particularly in environments characterized by high levels of complexity.

Research in both public and private sectors, as well as in academic settings, has consistently demonstrated that project management competencies play a crucial role in achieving positive project outcomes. However, the absence of a universally accepted definition of project management competencies continues to present challenges for practitioners and researchers alike. Globally, various standardized frameworks have been developed to provide structure and clarity in defining these competencies. The three most prominent frameworks are the Project Management Body of Knowledge (PMBoK) from the Project Management Institute (PMI), the Competence Baseline, the International Project Management Association, and Projects in Controlled Environments (Alvarenga et al., 2019).

The PMBoK framework was utilized here due to its widespread global recognition, with over 792,586 individuals certified as Project Management Professionals (PMPs) worldwide (Institute, 2021). PMBoK describes project management as "the application of knowledge, skills, tools, and techniques". It identifies 47 project management processes, categorized into 5 process groups and 10 knowledge areas, which served as the foundation for analyzing project management competencies in the reviewed literature.

The literature review encompassed 114 studies that examined project management competencies. Each study was systematically analyzed and categorized by its strategies, approaches, research methods, constructs, variables, definitions, and indicators. Using the PMBoK framework, constructions were indexed into relevant knowledge areas (KAs) or process groups (PGs). Constructs that could not be directly aligned with PMBoK categories were grouped under newly created themes based on their general relevance. This categorization enabled a detailed and comprehensive analysis of the competencies, revealing that not all constructs could be fully captured within the PMBoK framework, which served as the basis for further exploration of project management competencies in qualitative and quantitative research.

Qualitative Research on Project Management Competencies

The qualitative analysis of 34 studies from the 114 identified research articles uncovered key themes, trends, techniques, and tools, within project management. Thirteen of these studies used historical research methods to explore the evolution of project management competencies and were further categorized into three thematic subgroups:

1. Development of Competencies:

Studies in this subgroup examined the evolution of project management competencies in response to emerging challenges, demonstrating their significant impact on project outcomes. The works of Alvarenga (2019), Banihashemi (2017), and Binder (2016) highlighted how competencies were refined over time to meet new demands in diverse contexts.

2. Challenges and Gaps:

Research by Nicholas and Steyn (2020) addressed the gaps in project management frameworks, particularly the overemphasis on compliance and rigid control at the expense of adaptability.

3. Adaptability and Uncertainty Management:

Studies such as those by Silva et al. (2016) explored the critical role of adaptability in addressing project uncertainty and complexity. Silva et al. (2016) proposed a paradigm shift toward more flexible and holistic approaches to project management.

Contributions to the Field

The historical and qualitative analyses demonstrated that project management competencies are continuously evolving to meet the demands of modern projects, particularly those characterized by complexity and uncertainty. The findings emphasize the need to shift from rigid frameworks to more dynamic, adaptive approaches that acknowledge the diverse and changing nature of project environments. This evolution forms the foundation for further exploration through quantitative research.

Findings from Research on PM Competencies and Project Performance

Studies on Specific Project Management Competencies

Ten quantitative studies focused on specific competencies, such as human resource management (Conforto & Amaral, 2016), stakeholder management (Aarseth et al., 2017), and risk management (Cicmil et al., 2017). All reported significant relationships between these competencies and project outcomes. However, inconsistencies arose in studies by Tabassi et al. (2016) and Nicholas and Steyn (2020), which highlighted challenges in defining competencies.

Studies on Project Management Competencies as a Whole

Thirty-two studies analyzed the broader relationship between project management competencies and performance. While positive correlations were consistently identified, mixed results underscored the complexity of these relationships. For instance, Fewings and Henjewele (2019) noted that adaptability to project characteristics influences outcomes, while Conforto and Amaral (2016) explored the role of technical uncertainty in shaping success.

Emerging Dimensions in Research

A subset of studies integrated project complexity as an additional dimension, emphasizing its influence on the competencies-outcomes relationship. These studies, including Zuo et al. (2018) and Binder (2016), highlighted the importance of incorporating complexity, adaptability, and uncertainty into project management models.

The review of the literature demonstrates the critical connection between PM competencies and performance while underscoring the limitations of current models. By introducing project complexity as a significant factor, this study advances the understanding of how competencies can mitigate challenges and improve outcomes in dynamic project environments. Future research should further explore the incorporation of complexity, compliance, and uncertainty into project management models to enhance their practical and theoretical contributions.

2.5.2 Relationship Between Competencies and Complexity

Managing complexity requires more than technical know-how; it also demands a high degree of emotional and interpersonal intelligence. Several studies highlight the importance of social and emotional competencies in navigating complex project environments. For instance,

Niknazar and Bourgault (2017) found that project managers who could adapt to their project environment and foster a culture of knowledge-sharing and collaboration were more likely to achieve successful outcomes. Similarly, research by He et al. (2015) underscores the importance of building trust through effective communication and collaboration, which can help mitigate the negative effects of complexity.

The literature also shows that project managers who possess strong conflict resolution skills are better equipped to manage the tensions that arise from complexity. Tabassi et al. (2016) found that project managers capable of promoting collaboration and resolving conflicts were more successful in complex projects. These findings align with those of Kroh & Schultz (2023), who demonstrated that conflict management, underpinned by trust and ethical behavior, is a key factor in achieving project success in complex environments.

Project management competencies and project complexity are intricately linked, and both significantly impact project success. The evolving nature of projects, driven by technological advancements and globalization, has made it clear that traditional approaches to project management are no longer sufficient. Instead, there is an increasing emphasis on human-centered competencies, adaptability, and the ability to navigate complex, ambiguous project environments. As research in this area continues to evolve, project management professionals will likely need to develop a more holistic set of competencies to succeed in today's dynamic project landscape.

2.5.3 Project Complexity and Project Performance

On the other hand, project complexity has been identified as a significant factor that can hinder project performance if not properly managed. The limited research available on the relationship between project complexity and project performance suggests that complexity often leads to negative outcomes. For instance, Ye et al. (2015) conducted a comprehensive study on mega-construction projects in China, identifying that complexity driven by technological, organizational, environmental, cultural, and informational factors negatively impacted project performance across these dimensions. The interconnected nature of complex systems makes it challenging for project managers to control all variables, leading to performance degradation.

Further, Kroh & Schultz (2023) focused on how poor decision-making exacerbates the failure of complex projects. Their research emphasized that project managers who excel in interpersonal communication, conflict resolution, and team motivation tend to perform better in complex projects. These competencies support reflective decision-making, which is essential in navigating complex project environments. However, despite the positive influence of these competencies, the inherent challenges posed by complexity, such as coordination breakdowns and misalignment of goals, often overwhelm project teams and lead to reduced performance.

In the software development sector, Trueba et al. (2022) explored the effects of project complexity on performance, finding that agile methodologies while highly flexible were not immune to the negative consequences of complexity. Their findings showed that complexity impeded project performance even in agile environments, highlighting the need for robust complexity management strategies. Despite agile methods being tailored to adapt to change, when complexity becomes too overwhelming, performance suffers.

Contradictory findings also exist in the literature regarding the effect of complexity on project performance. For example, Ye et al. (2015) presented evidence that complexity can, under certain conditions, positively influence project outcomes. According to the study, projects characterized by high complexity encouraged team members to engage in knowledge-sharing and creative problem-solving, which enhanced performance. The findings suggest that complexity is not inherently detrimental to project success. Instead, how complexity is

managed particularly through competencies such as knowledge sharing and adaptive thinking can turn a challenging situation into an opportunity for innovation.

He et al. (2015) also provided insights into the interaction between complexity and project management methodologies, concluding that the use of agile approaches neutralized the negative effects of complexity in certain cases. Their study found that when project managers perceive complexity early and employ adaptive methods such as agile frameworks, the project is more likely to succeed. However, the findings also indicated that traditional project management methods are less effective in dealing with complexity.

Most of the research suggests that while PM competencies are crucial for driving project success, they must be complemented by effective strategies for managing complexity. The evidence points to the dual nature of complexity though often perceived as a barrier to success, it can also catalyze innovation and improved performance if the right competencies are in place. Studies underscore the importance of human-centered, transformational leadership, and collaborative approaches in managing both complexity and enhancing project outcomes. Future research should continue to explore the mechanisms through which project managers can leverage their competencies to turn complexity from a challenge into an opportunity for success.

Despite the increasing use of project management competencies, complexities inherent in projects continue to lead to unmet expectations and failures, as observed by Tabassi et al. (2016). The multifaceted nature of project complexity presents significant challenges that require nuanced management strategies. De Rezende and Blackwell (2019) examined the interplay between project complexity and project success in construction projects. They measured complexity through dimensions such as goal, task, organizational, technological, environmental, and informational complexities, while success was evaluated based on criteria including time, cost, quality, health and safety, environmental performance, participant satisfaction, user satisfaction, and commercial value. Their study revealed a negative correlation between project complexity and success, underscoring the detrimental impact of complexity on achieving desired project outcomes. Other studies echo these findings, associating complexity with poor cost efficiency (Bredillet et al., 2015), reduced effectiveness (Samset & Volden, 2016), and increased risk of delays and budget overruns (Tabassi et al., 2016). This highlights the critical need for effective strategies to manage project complexity in order to mitigate risks and enhance success (Nicholas & Steyn, 2020).

Socio-Organizational Complexity and Project Success

Banihashemi (2017) investigated the effects of socio-organizational complexity, which refers to challenges arising from diverse team interactions and stakeholder relationships. Their research demonstrated that socio-organizational complexity negatively impacts project success, particularly in meeting schedule objectives. This aligns with the concept of "complexity by interaction," introduced by Samset and Volden (2016), which emphasizes the complexities associated with managing people, organizational dynamics, and shifting project environments. Additionally, the dimensions of complexity examined by Fewings and Henjewele (2019) such as goals, tasks, and technologies can be categorized under "complexity by fact," while organizational, environmental, and informational complexities align with "complexity by interaction." These findings highlight the need for robust stakeholder engagement and adaptive organizational practices to address these forms of complexity effectively.

Leadership Competencies and Project Complexity

Leadership is crucial in reducing the adverse impact of project complexity on success. Binder (2016) examined the connections between leadership skills, project complexity, and project outcomes. Leadership skills were categorized into emotional, intellectual, and managerial domains, which were analyzed alongside different dimensions of project complexity such as complexity based on facts, faith, and interactions and success indicators like time, cost, quality, team satisfaction, and customer satisfaction. The findings revealed a negative correlation between project success and both fact-based and interaction-based complexity. Interestingly, complexity by faith, which encompasses uncertainties and unforeseen challenges, did not exhibit a significant relationship with project success. This suggests that certain complexities may require less structured approaches, emphasizing the importance of adaptive leadership styles.

Regional Perspectives on Project Complexity and Success – Iran and China

Several studies conducted in emerging economies, such as Iran and China, emphasize the opposing effects of project complexity on performance. Binder (2016) examined mega-construction projects and reported significant negative correlations between project complexity factors and project performance. The sheer scale of mega projects often involves complex technologies, interdependent tasks, and extensive internal and external interactions, making them difficult to manage effectively. Similarly, Binder (2016) identified factors such as ineffective management, communication breakdowns, lack of trust, policy issues, and cultural differences as major contributors to project complexity. These factors were found to negatively affect joint project outcomes in China, demonstrating how organizational and socio-cultural aspects contribute to the challenges of managing complex projects. Nicholas and Steyn (2020) further identified interdependencies between tasks, reliance on diverse technologies, and challenges in information management as key factors driving complexity in Iranian construction projects, leading to suboptimal success outcomes.

Hungary

In Hungary, Samset and Volden (2016) studied interruptions in building construction projects from the viewpoints of clients, contractors, and consultants. They identified key factors contributing to delays, including payment issues, underestimation of project costs and complexity, resource shortages, poor management, price instability, and insufficient site supervision. These factors reflect "complexity by fact," involving technical and organizational challenges, as well as "complexity by interaction," driven by stakeholder relationships. Environmental factors, such as unfavorable site conditions and weather, were also highlighted as contributors to uncertainty, aligning with "complexity by faith." Silva et al. (2016) corroborated these findings, identifying payment delays resulting from disagreements over valuations and project pacing as additional complexity-related issues.

Dimensions of Complexity and Their Influence on Success

The findings from various studies underscore the multifaceted nature of project complexity, which can be categorized into three dimensions as proposed by Aarseth et al. (2017):

1. Complexity by Fact: Refers to structural elements such as the number of interrelated tasks, technological dependencies, and the sheer size of the project. Studies such as those by Aarseth et al. (2017) and Silva et al. (2016) highlight that increased complexity by fact results in poor project efficiency and reduced adherence to cost and schedule constraints.

2. Complexity by Interaction: Focuses on the social and behavioral dynamics among stakeholders and team members. Tabassi et al. (2016) emphasize the critical role of managing stakeholder relationships, communication, and socio-cultural challenges to minimize the adverse effects of interactional complexity.

3. Complexity by Faith: Encompasses uncertainties, ambiguity, and unforeseen circumstances. While complexity by faith may not directly correlate with project success (Bredillet et al., 2015), it presents unique challenges that require adaptive strategies and innovative problem-solving approaches (Banihashemi et al., 2017).

Link Between Complexity and Project Success

Research consistently demonstrates an inverse relationship between project complexity and project performance, as increased complexity tends to negatively influence efficiency, stakeholder satisfaction, and organizational benefits. For instance, Silva et al. (2016) highlighted the risks of project failure arising from unchecked complexity, while Banihashemi et al. (2017) linked complexity to delays and cost overruns. Similarly, studies conducted in Iran, China, and Ghana emphasize the challenges of managing complexities in emerging economies, where factors such as resource constraints, regulatory barriers, and socio-political dynamics exacerbate project difficulties (Nicholas & Steyn, 2020).

Strategies for Managing Complexity

To address the challenges posed by project complexity, organizations must adopt comprehensive strategies that integrate leadership competencies, stakeholder interest, and adaptive project management competencies. Effective communication, risk management, and technological innovation play a crucial role in mitigating the adverse effects of complexity. Furthermore, regional studies suggest that tailoring project management approaches to local contexts and cultural dynamics is essential for enhancing success outcomes (Zuo et al., 2018).

The body of the literature review highlights the intricate relationship between project complexity and success. Project complexity exerts varying degrees of negative influence on project success metrics, such as cost efficiency, stakeholder satisfaction, and readiness for future initiatives. Effective management of complexity requires a nuanced understanding of these dimensions and the application of adaptive, context-specific strategies. By addressing these complexities, organizations can enhance project outcomes and mitigate risks, ensuring the successful delivery of even the most challenging projects.

2.6 Criticism on Previous Research Approaches

The research approaches employed in preceding studies examining project management competencies, project performance, and its complexity present several limitations and potential biases. Although much of the existing literature has advanced understanding in these areas, the methodologies used in some studies raise concerns about the reliability and generalizability of the findings.

2.6.1 Previous Research Methods

A review of the relevant literature provided an opportunity to evaluate the research methodologies utilized in prior studies on project management. To assess these methodologies comprehensively, a structured categorization of research strategies, approaches, and analytical techniques was developed. Table 2 outlines the detailed classification, linking each publication from the literature review to relevant descriptions for additional examination. This structured

approach allowed for an in-depth critique of the research designs commonly employed in project management studies.

A particular emphasis was placed on identifying emerging trends and analyzing research that focused on the three constructs central to this study: project management competencies, project complexity, and project outcomes. Out of the 90 studies reviewed, 23 were published between 2018 and 2024. These recent publications provided critical insights into the dominant research strategies within the field. The results illustrate the distribution of research strategies used during this period, revealing that 70% of the studies employed either quantitative or qualitative methodologies, while the other 30 percent were divided into two categories: practitioner-oriented studies and theory development literature.

Practitioner-Oriented Studies

The practitioner-based research included overall concepts of project management or stated competencies using descriptive statistics. These publications played an important role in connecting academic research to practical applications in the project management profession. Practitioner studies were classified into two subcategories:

1. Guides for Practitioners: These publications summarize theories, tools, and competencies for professional use.
2. Survey-Based Reports: These studies highlighted trends and competencies in project management based on statistical surveys.

Practitioner-oriented reports were often conducted outside the academic peer-review process, but they offered valuable perspectives on the practical application of project management theories. If these practitioner reports were categorized as academic surveys, the proportion of quantitative studies in the analysis would increase from 65% to 44% of quantitative studies overall. This reinforces the observation that quantitative research remains a dominant approach in project management, as it addresses practical and measurable challenges within the profession (Cicmil et al., 2017).

Theory Development Literature

The second category, theory development literature, highlighted concerns about the theoretical foundations of project management research. Between 2010 and 2015, six influential articles critiqued the state of the field, focusing on the lack of theoretical development and the insufficient integration of theoretical frameworks into research studies (Tabassi et al., 2016). A recurring theme across these articles was the absence of theoretical anchoring in project management research, which limits the academic rigor and depth of insights provided by the studies. This critique aligns with the findings of this dissertation's literature review, where only 37 of the 173 peer-reviewed articles reviewed explicitly referenced or inferred a specific theoretical framework with identifiable theoretical underpinnings, highlighting inconsistencies in the theory application within the field.

Critique of Methodological Issues in Project Management Research

Lack of Theoretical Anchoring

The absence of a clear theoretical foundation in project management research is a recurring challenge. The field's pragmatic nature, with a focus on solving immediate problems, often takes precedence over the exploration of underlying theoretical phenomena. This practical orientation is rooted in the evolution of project management as a business-driven discipline, leading researchers to prioritize competency-based questions and analytical approaches tailored to addressing real-world challenges. While this focus on practical applications is

beneficial, it often limits the scope of research and its ability to contribute to broader theoretical understanding (Zuo et al., 2018).

Two major concerns arise from this competency-driven approach:

1. Isolated Studies: Many studies lack connection to a broader theoretical stream, reducing their ability to provide comprehensive insights into project management phenomena (Bredillet et al., 2015). For example, studies often focus narrowly on specific competencies without exploring their interdependencies with other dimensions, such as complexity and outcomes.
2. Methodology-Driven Research: Research methodologies and analytical techniques often dictate the research process, rather than meaningful research questions or theoretical frameworks guiding the study. This methodology-first approach hinders the development of robust theoretical insights, which are necessary for advancing the field of project management (Banihashemi et al., 2017).

Overemphasis on Quantitative Methods

Although the high prevalence of quantitative research (65% of studies reviewed) demonstrates a strong emphasis on measurable outcomes and statistical analysis, it raises concerns about the neglect of qualitative and mixed methods approaches. While quantitative methods are well-suited to assessing the practical challenges of project management, they may overlook the complexities and contextual factors that qualitative approaches can capture (Silvius, 2021). Mixed-methods research, which combines the strengths of both quantitative and qualitative approaches, remains underutilized, despite its potential to provide an extra universal estimation of project management phenomena (Banihashemi et al., 2017).

2.6.2 Limitations in Measuring Project Management Competencies

Binder (2016) explored the correlation between managerial training and project management personal competencies, finding that executive training can enhance competencies and increase the likelihood of project performance. However, the study's use of the PMI framework as a tool to measure competencies introduces concerns, as this framework has not been rigorously tested or validated across diverse contexts. Furthermore, self-administered competency assessments, which are common in studies of project management skills, have inherent flaws. These frameworks often rely on self-reporting, which can lead to inflated or biased results as participants tend to overestimate their abilities (Ye et al., 2015). As a result, the subjectivity of these assessments can compromise the accuracy of the data and limit the validity of the findings (Ehsani et al., 2017).

Moreover, studies that center on individual countries, such as Bush (2020), are often constrained by resource and budget limitations. While single-nation studies provide useful insights into culturally specific competencies, their findings may not be generalizable to broader contexts. For example, research focused on one country's project management competencies may miss important variations in competencies that arise in different cultural or organizational environments. Thus, there is a need for more cross-cultural and international research to establish a more comprehensive understanding of project management competencies.

2.6.3 Lack of Consensus on Project Complexity Measurement

Another key issue in the literature is the lack of a unified definition and reliable measurement of project complexity. As Mainga (2017) highlighted, project management professionals have not yet agreed on a standardized framework for defining and measuring

complexity. Existing frameworks, such as those proposed by Ahmad et al. (2018), focus heavily on tangible and structural elements of complexity. However, these frameworks are subject to ongoing philosophical debates, with some researchers arguing that complexity encompasses more than just the quantifiable attributes of a project. For example, Monk & Ogolsky (2019) asserted that project complexity is multifaceted and cannot be reduced to simply counting variables like tasks or stakeholders.

The instruments used to measure project complexity remain a contentious issue in the field. Some researchers, such as Cardona-Meza & Olivar-Tost (2017), have questioned the validity of existing tools designed to classify and categorize complexity, arguing that they fail to capture the full scope of the phenomenon. Moreover, perceptions of complexity are inherently subjective, as they are often shaped by the individual project manager's experiences and interpretations (Cleden, 2017). As a result, project managers may approach complex situations differently based on their personal biases or organizational context, further complicating the task of developing a universal complexity measurement tool.

2.6.4 Variability in Definitions of Project Success

Another critique of previous research is the inconsistent and sometimes narrow definitions of project performance. While the literature indicates that project performance should encompass broader dimensions, including project sustainability, team management, and stakeholder management (Monk & Ogolsky, 2019), some studies have relied on traditional measures of success. For instance, He et al. (2015) defined project success solely in terms of remaining within schedule, cost, and scope tolerance levels. While these criteria are important, they fail to capture the full spectrum of outcomes that contribute to long-term project success, such as organizational learning, innovation, and stakeholder satisfaction. By narrowing the interpretation of success, studies may overlook the more nuanced ways in which project management competencies contribute to favorable project outcomes.

2.6.5 Methodological Concerns: Self-Reporting and Standard Method Variance

A critical methodological issue in much of the research is the reliance on self-reported data, which introduces significant validity threats. The self-reporting often results in standard method variance, where individuals embellish or misrepresent their skills and experiences (Cardona-Meza & Olivar-Tost, 2017). This bias is inherent in human nature, as individuals are inclined to view themselves in a more favorable light. Multiple studies have noted this limitation (Rezvani et al., 2016). The tendency for participants to overestimate their competencies can skew results, making it difficult to accurately assess the true impact of project management skills on project performance.

Considering these methodological concerns, it is clear that future research must address the limitations of self-reporting by incorporating more objective measures of competencies and performance. This could involve triangulating self-reported data with external assessments or performance metrics to ensure a more balanced and accurate portrayal of project management competencies. Additionally, efforts should be made to standardize the definitions and measurement of key variables, such as project complexity and success, to enhance comparability across studies and build a more cohesive body of knowledge in the field.

While previous research has contributed valuable insights into the relationship between PM competencies, project complexity, and project performance, several methodological flaws limit the robustness of these findings. The reliance on self-reported data, the lack of standardized measures for project complexity, and the inconsistent definitions of project success all point to areas where future research can improve. By addressing these issues, researchers can develop

more reliable and generalizable models for understanding the factors that contribute to project success in increasingly complex environments.

Limitations in Measuring Project Management Competencies

Research on project management competencies has made significant strides in identifying factors that contribute to project success. However, several limitations in the methodologies and frameworks used to measure these competencies persist, undermining the reliability and applicability of findings.

Inadequacies of the PMI Framework

Studies such as Binder (2016) have examined the connection between executive coaching and PM competencies, concluding that executive training enhances skills and improves project outcomes. However, these findings often rely on frameworks like the Project Management Institute's (PMI) competency framework, which has not been rigorously tested across diverse contexts. Critics argue that the PMI framework is heavily influenced by Western-centric management paradigms, which may not adequately account for cultural, organizational, and industry-specific nuances (Fewings & Henjewele, 2019). Furthermore, while the PMI framework provides a comprehensive list of competencies, it is often perceived as prescriptive rather than adaptive, limiting its applicability in dynamic and complex project environments (Binder, 2016).

Flaws in Self-Reported Assessments

Self-reported assessments remain a common method for measuring project management competencies, yet they are fraught with challenges. Participants often overestimate their abilities, leading to inflated or biased results (Banihashemi et al., 2017). This bias, referred to as self-enhancement bias, is a psychological phenomenon wherein individuals tend to view themselves in a more favorable light, particularly when evaluating their skills and performance (Conforto & Amaral, 2016). For instance, studies have found that project managers frequently rate themselves higher in competencies such as leadership and communication than their peers or subordinates do (Tabassi et al., 2016).

The overreliance on self-reported data also introduces standard method variance, a form of bias that occurs when both independent and endogenous variables are measured using the same method, leading to artificially inflated correlations (Aarseth et al., 2017). This methodological flaw diminishes the validity of conclusions drawn from such studies, making it difficult to ascertain the actual impact of project management competencies on project outcomes.

Limited Generalizability of Single-Nation Studies

Another limitation in the literature is the overemphasis on single-nation studies, which are often constrained by budgetary and resource limitations. While these studies provide valuable insights into culturally specific competencies, their findings may not be generalizable to other cultural or organizational contexts (Bredillet et al., 2015). For example, research conducted in countries with collectivist cultures, such as China or Japan, may emphasize group-oriented competencies, whereas studies in individualistic cultures, like the United States, may prioritize individual leadership skills (Fewings & Henjewele, 2019). The absence of cross-cultural

studies limits the field's ability to identify universally applicable competencies and their role in achieving project success (Binder, 2016).

Need for Cross-Cultural and Global Perspectives

To address this gap, more cross-cultural and international research is needed to establish a comprehensive understanding of project management competencies. Such studies could explore how competencies vary across industries, regions, and organizational contexts, shedding light on the interplay between cultural factors and competency development (Aarseth et al., 2017). By integrating perspectives from diverse settings, future research can enhance the global applicability of project management frameworks.

Lack of Consensus on Project Complexity Measurement

Measuring project complexity remains another significant challenge in the field. While numerous frameworks have been proposed, there is no universally accepted definition or measurement tool for project complexity. As Aarseth et al. (2017) highlighted, the absence of standardization in defining and measuring complexity has led to inconsistencies in research findings.

Focus on Tangible Attributes

Existing frameworks, such as those developed by Tabassi (2016), tend to focus on tangible and structural aspects of stakeholder management, and project complexity, such as the number of tasks, or interdependencies. While these quantifiable elements provide a useful starting point, they fail to capture the intangible and dynamic dimensions of complexity, such as uncertainty, ambiguity, and emergent behaviors (Binder, 2016). For instance, a project with fewer tasks but higher uncertainty in stakeholder expectations may be more complex than one with a larger number of straightforward tasks (Fewings & Henjewele, 2019).

Subjectivity in Perceptions of Complexity

The subjective nature of complexity further complicates its measurement. Project managers' perceptions of complexity are shaped by their individual experiences, expertise, and organizational contexts, leading to variability in how complexity is understood and addressed (Samset & Volden, 2016). For example, a highly experienced project manager may perceive a technically demanding project as manageable, whereas a novice manager may view the same project as highly complex. This subjectivity underscores the need for more objective and standardized tools to assess project complexity (Banihashemi et al., 2017).

Critiques of Existing Tools

Several researchers have criticized existing tools for measuring project complexity. For example, Banihashemi (2017) questioned the validity of widely used instruments, arguing that they fail to account for the multifaceted nature of complexity. Similarly, Fewings and Henjewele (2019) emphasized that complexity is not static but evolves throughout a project, necessitating dynamic measurement approaches.

Variability in Definitions of Project Success

The literature on project success has been plagued by inconsistent and narrow definitions. While traditional measures of success, such as cost, schedule, and scope, remain dominant, they fail to capture the broader dimensions of success that are increasingly recognized as critical in contemporary project management.

Expanding the Scope of Success Metrics

Studies have called for a more comprehensive approach to defining project success, incorporating dimensions such as stakeholder satisfaction, team development, innovation, and long-term organizational impact (Banihashemi et al., 2017). For example, Tabassi (2016) focused exclusively on cost, schedule, and scope adherence, overlooking factors such as employee learning, knowledge transfer, and alignment with strategic objectives. Such narrow definitions risk neglecting the intangible and long-term benefits of successful project management.

Sustainability and Organizational Learning

Recent research has emphasized the importance of sustainability and organizational learning as components of project success. Projects that deliver environmentally and socially responsible outcomes, while fostering a culture of continuous improvement within the organization, are increasingly viewed as successful (Banihashemi et al., 2017). By broadening the definition of success, future research can better capture the multifaceted contributions of project management to organizational and societal goals.

Methodological Concerns: Self-Reporting and Standard Method Variance

The reliance on self-reported data in project management research poses significant methodological challenges. Self-reported assessments often result in social desirability bias, where participants provide responses they believe are more socially acceptable rather than truthful. This issue is particularly problematic in studies measuring competencies, as individuals are likely to overstate their abilities to align with perceived professional standards (Fewings & Henjewele, 2019).

Addressing Methodological Biases

To mitigate these biases, researchers should incorporate more objective measures of competencies and performance. This could involve triangulating self-reported data with third-party evaluations, performance metrics, or observational data (Gido et al., 2018). For example, project outcomes could be assessed using metrics such as on-time delivery rates, cost efficiency, and stakeholder satisfaction surveys conducted independently of the project manager.

Standardization of Definitions and Measurement Tools

Standardizing the definitions and measurement tools for key variables, such as project complexity and success, is essential for enhancing comparability across studies. By adopting consistent frameworks and methodologies, researchers can build a more cohesive and reliable project management body of knowledge (Banihashemi et al., 2017).

While prior research has provided valuable insights into the relationships between project management competencies, project complexity, and project success, significant methodological limitations remain. These include the overreliance on self-reported data, the lack of standardized tools for measuring project complexity, and the inconsistent definitions of project success. Addressing these limitations requires a shift toward more objective, standardized, and comprehensive research methodologies. By embracing these changes, future studies can contribute to a deeper and more reliable understanding of the factors driving project success in increasingly complex environments.

2.7 Recommendations in Literature for Future Research

To address the critiques outlined above, project management research must adopt more consistent and theoretically grounded frameworks. These recommendations include:

1. Developing Ontological and Epistemological Foundations: Establishing consistent philosophical underpinnings is essential for supporting the development of theories and research questions. By aligning studies with robust ontological and epistemological principles, researchers can provide more meaningful insights into project management phenomena (Conforto & Amaral, 2016).

2. Integrating Theory and Practice: Future research should strive to bridge the gap between theoretical development and practical application. This requires not only testing theories in real-world contexts but also using practical insights to refine theoretical models, fostering a dynamic interplay between academia and practice (Binder, 2016).

3. Exploring Mixed-Methods Approaches: The inclusion of mixed-methods research can offer a more comprehensive understanding of project management challenges. For example, combining qualitative case studies with quantitative surveys can uncover both the measurable impact of competencies and the contextual factors influencing their effectiveness (Gido et al., 2018).

4. Expanding the Scope of Theoretical Inquiry: Researchers should move beyond competency-based studies and explore the underlying mechanisms and interdependencies between project management competencies, complexity, and outcomes. For instance, investigating the mediating or moderating effects of leadership styles, team dynamics, or cultural factors can provide richer insights (Aarseth et al., 2017).

5. Fostering Interdisciplinary Collaboration: Project management research can benefit from incorporating perspectives from related disciplines, such as organizational behavior, systems theory, and sociology. This interdisciplinary approach can enhance the theoretical depth and practical relevance of project management studies (Nicholas & Steyn, 2020).

The critique of previous research methods in project management highlights several limitations, including the lack of theoretical anchoring, the prevalence of methodology-driven studies, and the underrepresentation of qualitative and mixed-methods approaches. To advance the field, researchers must adopt consistent theoretical frameworks, embrace interdisciplinary collaboration, and balance practical and theoretical objectives. By addressing these challenges, future studies can provide more wide-ranging insights into the relations between PM competencies, project performance, and project complexity, ultimately contributing to the evolution of project management as a mature academic discipline and professional practice.

2.8 Summary of the reviewed literature

The reviewed literature largely supports the relational framework between project management competencies, project complexity, and project success. It is widely recognized that project management competencies are integral to project success, as they encompass the finest competencies and skill sets that positively impact project performance. Similarly, project complexity has been shown to disrupt the conventional project management models, thereby influencing the success of a project, especially when complexity levels exceed the capacity of standard approaches (Geraldi & Söderlund, 2018).

However, the changing global landscape, marked by rapid technological advancements, increasing ambiguity, and evolving stakeholder expectations, has complicated traditional descriptions of project complexity, PM competencies, and project performance. While competencies are still seen as clusters of best competencies that drive project success (Kroh & Schultz, 2023), the literature emphasizes the growing importance of human-centered

competencies, such as leadership and communication, in fostering successful project outcomes (Ahmad et al., 2018). At the same time, the relationship between project complexity and performance is less straightforward, with some studies demonstrating a negative impact, while others suggest that complexity can spur creativity and knowledge sharing, ultimately benefiting the project.

One recurring theme in the literature is the role of ambiguity and misinterpretation in heightening project complexity (Bredillet et al., 2015). As projects grow more complex and ambiguous, the skills required to navigate this complexity become even more critical. The concept of project success has also expanded, now taking into account not just the traditional metrics of scope, cost, and time but also the quality of relationships between the project stakeholders and project manager and the long-term value of project outcomes.

Concerning the research problem which addresses the gap in understanding how PM competencies and complexity influence project success the literature confirms the significant relationships between these variables. It is evident that project management competencies and complexity both play essential roles in determining project success, particularly in complex environments. However, the reviewed literature reveals a gap in the specific interactions between competencies and complexity on project outcomes, as few studies have explored this relationship in depth (Trueba et al., 2022).

In conclusion, while the literature validates the importance of both project management competencies and complexity, the specific interactions between these two factors and their combined impact on project success remain underexplored. This gap in the existing research highlights the need for further investigation, particularly in the context of complex projects.

3. MATERIALS AND METHODS

The methodological design of this study was developed to address the research objectives, to to analyze the relationship between project management competencies and project performance across various levels of project complexity within Hungarian IT organizations. Building upon existing literature, the research seeks to explore how project complexity mediates the impact of project management competencies on project outcomes in this specific context. The extension of the standard model suggests that project complexity acts as a mediator in the relationship between the competencies of project managers and project performance. This study examines the expanded model by integrating findings from three previous studies that assessed project management competencies, complexity, and performance. It applies these frameworks of measurement for the constructs used and recommended by Dartey-Baah and investigates the relationships of related variables.

Project complexity is operationalized using the three-factor model introduced by Dartey-Baah (2022), project management competencies are based on the framework by Joseph & Marnewick (2022), and project outcomes are operationalized according to Butler et al. (2020). While the literature review indicates that the constructs for project complexity, PM competencies, and performance may not fully capture every dimension of each variable, the selected frameworks represent the most comprehensive and research-supported operationalizations available.

The methodology adopted in this study follows a structured process beginning with the formulation of research questions and hypotheses, continuing with data collection and measurement model development, and concluding with structural modeling and interpretation of results. This process is summarized in Figure 3.

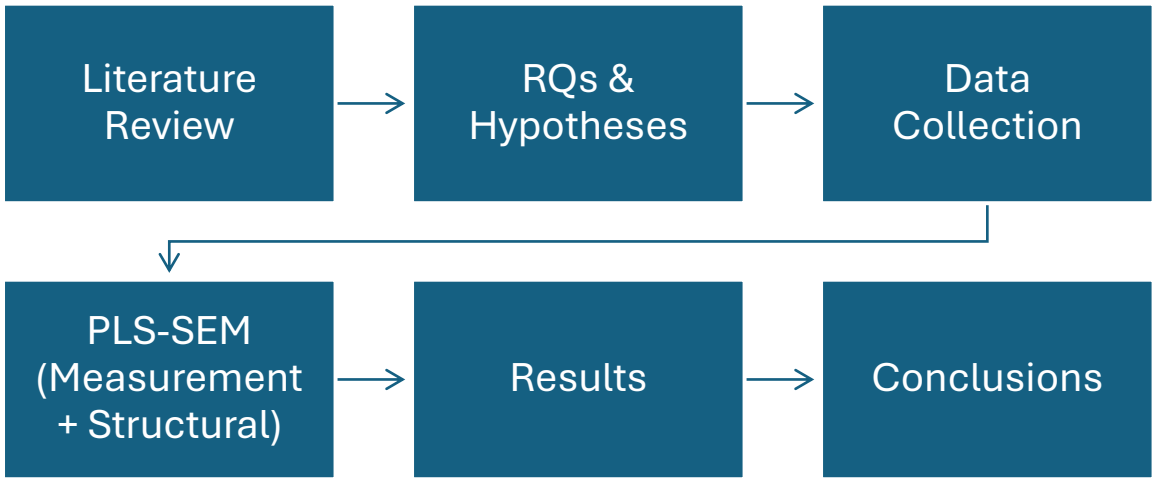

Figure 3: Research process from formulation of research questions to analysis and results
Source: own research

3.1 Research Questions

The foundation of this study's research questions is grounded in insights from existing literature, particularly the work of Geraldi and Joana (2021), who suggested that project complexity may function as an intermediary between project management competencies and project performance. Building on this perspective, the central research question and its related sub-

questions summarized in Table 3 are designed to investigate the dynamics of this mediating relationship.

To develop these questions, the study draws from the methodological guidance of Kroh and Schultz (2023), who outlined a structured three-step framework for examining mediation. This process involves first assessing the link between the independent and endogenous variables, then exploring the connection between the independent and the mediating variable and finally analyzing how the mediating variable relates to the outcome. This logical sequence ensures a thorough investigation of how project management competencies may influence performance through the lens of complexity.

The approach adopted here also reflects the methodological clarity recommended by Tehseen et al. (2017), aligning theoretical constructs with empirical testing procedures. Together, these frameworks support a rigorous exploration of the potential mediating effect of complexity in project environments.

Table 3: Primary Research Questions

Q. Number	***Research Question***
Q 1	How does project complexity act as a mediator in the relationship between project management competencies, as they, and project performance, as the endogenous variable?
Q 1.1	What is the extent of the relationship between the exogenous variable, project management competencies, and the variation observed in the endogenous variable, project performance?
Q 1.2	To what degree does the exogenous variable, project management competencies, account for the variance in the mediating variable, project complexity?
Q 1.3	To what extent does the mediating variable, project complexity, contribute to explaining the variance in the endogenous variable, project performance?

Source: own research

The study conceptualized PM competencies, project performance, and complexity as overarching constructs (Ahmad et al., 2018). To explore their interrelations, a two-level HCM (Hierarchical Component Model) was utilized (Martinez Avila et al., 2021). This approach preserved the core structure of the model while incorporating more thorough descriptions of the constructs, ensuring a balance between complexity and simplicity in model specification. The HCM method allowed for a focused exploration of the primary relationships of interest without overcomplicating the structural model.

Expanding on previous scholarly contributions, this study incorporated project complexity as a core variable and examined how its specific dimensions influence the overall research model. The classification of complexity was guided by Geraldi's (2021), who categorized it into three main types: structural, socio-political, and emergent complexity. Due to the study's cross-sectional design, emergent complexity focused on how complexity evolves was not included, as capturing such temporal shifts would require a longitudinal approach, which was outside the study's scope.

The research questions presented in Table 4 were shaped with these dimensions in mind, offering a deeper perspective on how various facets of project management competencies interact with project performance through the lens of complexity. This approach allowed for a more nuanced exploration of the mediating role complexity plays in shaping project outcomes.

Table 4: Secondary Research Questions

Q. Number	*Research Question*
Q 2	To what degree does project complexity mediate the relationship between the exogenous variable soft skills and personal competencies and the endogenous variable project performance?
Q 2.1	To what degree do soft skills and personal competencies explain the variation in project performance?
Q 2.2	To what degree do soft skills and personal competencies explain the variation in project complexity?
Q 2.3	To what degree does project complexity account for the variation in project performance?
Q 3	To what degree does project complexity mediate the relationship between the exogenous variable technical and professional competencies and the endogenous variable project performance?
Q 3.1	To what degree do technical and professional competencies explain the variation in project performance?
Q 3.2	To what degree do technical and professional competencies explain the variation in project complexity?
Q 3.3	To what degree does project complexity account for the variation in project performance?

Source: own research

These research inquiries held particular importance as they aimed to critically assess one of the foundational beliefs in project management: that project management competencies are central to achieving successful outcomes. By formulating questions that delve into the nuanced interactions between competencies, complexity, and performance, the study not only tested this long-held assumption but also expanded upon it. This critical examination provided an opportunity to challenge conventional thinking and offered new insights into how different competency dimensions function under varying levels of complexity (Aarseth et al., 2017).

3.2 Conceptual Framework

Based on the formulated research questions and hypotheses, the conceptual model for this study is presented in Figure 4. The model depicts project management competencies, comprising soft/personal and technical/professional dimensions, as exogenous variables. Project complexity is modeled as a mediating construct, while project performance serves as the endogenous outcome. The hypothesized relationships reflect both direct effects of competencies on performance and indirect effects mediated by project complexity.

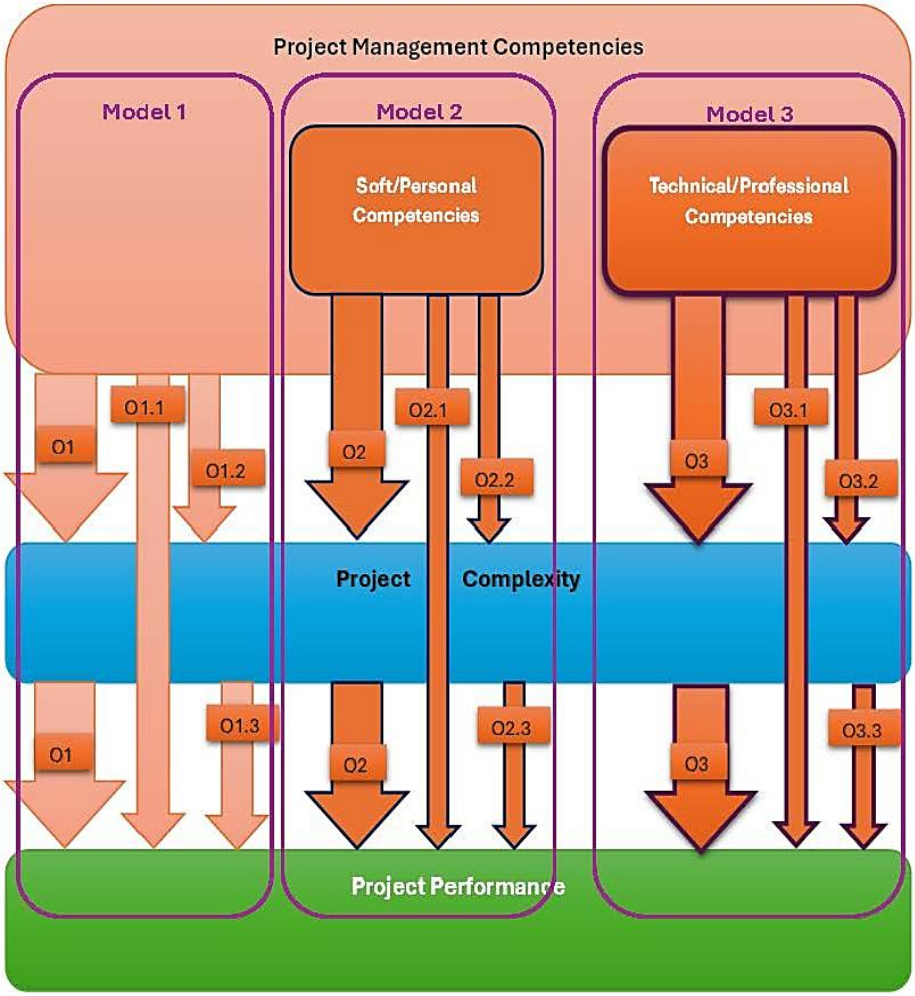

Figure 4: Conceptual Model
Source: own research

3.3 Hypotheses

Figure 5 illustrates a path diagram that outlines the associations between the constructs investigated in this study, with labeled paths corresponding to the research questions. The hypotheses detailed in Table 5 align with related research questions, designed to examine main relationships like the project complexity mediating role for the dependency of project performance on project management competencies (paths a and b) and the second question about the dependency of project performance on project management competencies (path c). The constructs in the model included latent variables: project management competencies comprised two latent variables at the third level and eleven at the second level, project complexity included two latent variables at the second level, and project performance contained a single latent variable.

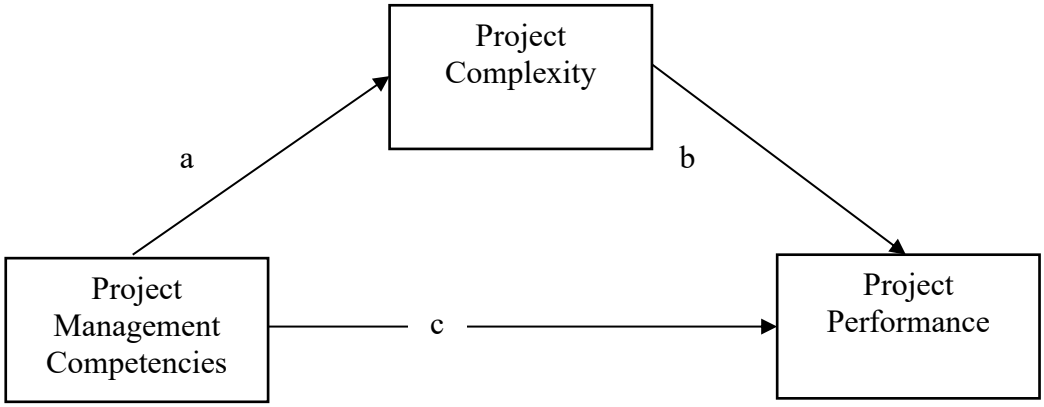

Figure 5: Extended Standard PM Model

Source: own research

Due to the intricate structure and numerous underlying relationships, the results of the hypothesis testing were presented in a tabular format for clarity in Table 5.

Table 5: Questions and Hypotheses

Q/ H Number	***Question & Hypothesis***
Q 1	How does project complexity act as a mediator in the relationship between project management competencies, as the exogenous variable, and project performance, as the endogenous variable?
$H_0.1$	*There are no significant relationships between the exogenous variable project management competencies, the mediating variable project complexity, and the* endogenous *variable project performance.*
$H_1.1$	*There are significant relationships between the exogenous variable project management competencies, the mediating variable project complexity, and the* endogenous *variable project performance.*
Q 1.1	What is the extent of the relationship between the exogenous variable, project management competencies, and the variation observed in the endogenous variable, project performance?
$H_0.1.1$	*There are no significant relationships between the exogenous variable project management competencies and the endogenous variable project performance.*
$H_1.1.1$	*There are significant relationships between the exogenous variable project management competencies and the endogenous variable project performance.*
Q 1.2	To what degree does the exogenous variable, project management competencies, account for the variance in the mediating variable, project complexity?
$H_0.1.2$	*There are no significant relationships between the exogenous variable project management competencies and the mediating variable, project complexity.*
$H_1.1.2$	*There are significant relationships between the exogenous variable project management competencies and the mediating variable, project complexity.*

Q/ H Number	***Question & Hypothesis***
Q 1.3	To what extent does the mediating variable, project complexity, contribute to explaining the variance in the endogenous variable, project performance?
$H_0.1.3$	*There are no significant relationships between the mediating variable, project complexity, and the endogenous variable, project performance.*
$H_1.1.3$	*There are significant relationships between the mediating variable, project complexity, and the endogenous variable, project performance.*
Q 2	To what degree does project complexity mediate the relationship between the exogenous variable soft skills and personal competencies and the endogenous variable project performance?
$H_0.2$	*There are no significant relationships between the exogenous variable Soft Skills and Personal Competencies and the endogenous variable project performance.*
$H_1.2$	*There are significant relationships between the exogenous variable Soft Skills and Personal Competencies and the endogenous variable project performance.*
Q 2.1	To what degree do soft skills and personal competencies explain the variation in project performance?
$H_0.2.1$	*There are no significant relationships between the exogenous variable Soft Skills and Personal Competencies and the endogenous variable project performance.*
$H_1.2.1$	*There are significant relationships between the exogenous variable Soft Skills and Personal Competencies and the endogenous variable project performance.*
Q 2.2	To what degree do soft skills and personal competencies explain the variation in project complexity?
$H_0.2.2$	*There are no significant relationships between the exogenous variable Soft Skills and Personal Competencies and the mediating variable project complexity.*
$H_1.2.2$	*There are significant relationships between the exogenous variable Soft Skills and Personal Competencies and the mediating variable project complexity.*
Q 2.3	To what degree does project complexity account for the variation in project performance?
$H_0.2.3$	*There are no significant relationships between the mediating variable project complexity and the endogenous variable project performance.*
$H_1.2.3$	*There are significant relationships between the mediating variable project complexity and the endogenous variable project performance.*
Q 3	To what degree does project complexity mediate the relationship between the exogenous variable technical and professional competencies and the endogenous variable project performance?
$H_0.3$	*There are no significant relationships between the exogenous variable Technical and Professional Competencies and the endogenous variable project performance.*
$H_1.3$	*There are significant relationships between the exogenous variable Technical and Professional Competencies and the endogenous variable project performance.*

Q/ H Number	*Question & Hypothesis*
Q 3.1	To what degree do technical and professional competencies explain the variation in project performance?
$H_0.3.1$	*There are no significant relationships between the exogenous variable Technical and Professional Competencies and the endogenous variable project performance.*
$H_1.3.1$	*There are significant relationships between the exogenous variable Technical and Professional Competencies and the endogenous variable project performance.*
Q 3.2	To what degree do technical and professional competencies explain the variation in project complexity?
$H_0.3.2$	*There are no significant relationships between the exogenous variable Technical and Professional Competencies and the mediating variable project complexity.*
$H_1.3.2$	*There are significant relationships between the exogenous variable Technical and Professional Competencies and the mediating variable project complexity.*
Q 3.3	To what degree does project complexity account for the variation in project performance?
$H_0.3.3$	*There are no significant relationships between the mediating variable project complexity and the endogenous variable project performance.*
$H_1.3.3$	*There are significant relationships between the mediating variable project complexity and the endogenous variable project performance.*

Source: own research

3.4 Research Design

This study adopted a quantitative, non-experimental research strategy, designed to explore and predict relationships among variables using a Partial Least Squares Structural Equation Modeling (PLS-SEM) framework. The approach was exploratory in nature, aimed at identifying the influence and mediation effects among the studied constructs. Data collection was conducted through a structured, multi-section questionnaire, enabling the measurement of latent variables relevant to the research model (Martinez Avila et al., 2021). This investigation aimed to assess the extent to which project complexity serves as a mediator in the association between project management competencies and project performance. Analysis of these relationships was conducted post-project completion, involving randomly assigned participants. Given the constraints precluding precise conditions typical of quasi-experimental or experimental designs (Tehseen et al., 2017), a non-experimental design proved optimal for elucidating the hypothesized associations between the variables under investigation.

The chosen research methodology for the study entailed a non-experimental, quantitative, and correlational approach. This research design was deemed the most suitable given the impracticality of implementing quasi-experimental or experimental designs to explore the interplay between PM competencies, project complexity, and project performance.

3.4.1 Population

The research population comprised individuals residing in Hungary aged 18 years and above, currently engaged in employment, and overseeing projects meeting the PMI definition of a project as "a temporary endeavor undertaken to create a unique product, service, or result" (Deterding & Waters, 2021; Institute, 2021). The study participants were requested to respond with respect to their project management experience.

3.4.2 Sample

The sampling framework for this study encompassed people involved in managing projects that delivered distinct goods or services, participating across various project management tiers. The sample comprised panel members proficient in either English or Hungarian, accountable for project performance. Potential respondents were excluded from receiving the survey if they did not meet the specified standards. All participants furnished general demographic details, utilized for characterizing the sample and establishing the external validity. The information collected was reviewed in the follow-up data analysis stage.

3.4.3 Power Analysis

An a priori power analysis was conducted to determine the appropriate sample size for this study based on guidelines from PLS-SEM literature. Following the recommendations of Faber and Fonseca (2014), a minimum sample size was set to ten times the maximum number of indicators on any single latent variable. Since "Structural Complexity" had the highest number of indicators (22), the target sample size was 220.

To further confirm sample adequacy, G*Power 3 was used for statistical power analysis, consistent with methods by Cardona-Meza & Olivar-Tost (2017). Effect size parameters were drawn from studies of Montgomery (2021), which reported relevant effect sizes around 0.05. G*Power analysis indicated a least requirement of 221 responses, which aligned closely with the Cardona-Meza's (2017) guideline of 220.

The study ultimately achieved a sample size of 243 participants (229 valid), allowing for a robust power analysis on each model path in this study.

3.5 Procedures

3.5.1 Participant Selection

The recruitment process for the sample involved utilizing various platforms, including Google Forms, email, Facebook groups, LinkedIn, and printed paper-based surveys. A randomized selection of panel participants meeting the predefined sample frame criteria was requested to partake in the research endeavor. The selected contributors were provided with a standardized invitation outlining the survey's purpose, privacy protocols, and the anticipated timeline for the study. Further details regarding the sample recruitment email can be found in Appendixes 3 and 4 of this research.

Subsequently, only those individuals who expressed their willingness to participate proceeded to access the designated website to complete the survey.

3.5.2 Data Protection of Participants

The survey did not incorporate any specific personal details beyond basic demographic information, aimed at mitigating the risk of reconstructing respondents' identities from the collected data. This approach, coupled with the format and structure of the survey questions, adhered to the three fundamental principles outlined in Hanushek & Jackson (2013) concerning research involving human subjects: respect for persons, beneficence, and justice.

3.5.3 Data Collection

A systematic 3 stage data collection approach was implemented to uphold the integrity and reliability of the findings in this research. The initial stage involved conducting a preliminary study to check for any modifications done to the research tools and instruments. Subsequently, the second stage comprised an instrument validation study conducted with a limited sample size to validate the effectiveness of the instruments and procedures. Finally, the 3rd stage entailed the collection of data from the complete sample for study, ensuring comprehensive data acquisition for robust analysis and interpretation.

3.5.4 Preliminary Study

To examine the three core constructs in this research, measurement tools from previously published studies were adapted and integrated. The instrument used to assess project management competencies required several modifications, while the tools evaluating project performance and project complexity were adjusted for contextual alignment. These modifications were carried out in close consultation with Dr. Anna Dunay, a collaborator in the development of the original instrument. Based on recommendations from Geraldi (2018), the wording of items was revised from present to past tense to better suit the retrospective nature of the data collection.

Since the final version of the instrument represented a combination of elements from multiple validated sources, it was essential to conduct both a preliminary study and an instrument validation test to ensure reliability and validity. The field testing was executed in two phases. First, Dr. Dunay reviewed the revised version to assess its appropriateness. In the second phase, a panel of academic experts and practitioners in project management evaluated the clarity of the instrument and the suitability of the scales used. Feedback from these reviews was incorporated into the final version. The complete instrument with applied revisions is available in Appendix 5.

3.5.5 Instrument Validation Study

The instrument utilized in this research comprised a compound of instruments employed in previous research, with slight adjustments made to certain indicators to ensure the phrasing and scale alignment with the present study context. Given that the instrument was a composite, a pilot test was conducted before commencing data collection for the full study. The pilot test adhered to the guidelines delineated by Kroh and Schultz (2023). The survey administrator aimed to secure a sample of 20 respondents, resulting in 22 valid responses. Subsequently, the data obtained via Google Forms underwent analysis to compute descriptive statistics and assess instrument reliability.

The reliability of the revised instrument was evaluated by comparing the results from the instrument validation study with the established reliability metrics reported in the original studies. The findings from the pilot test confirmed that the adapted instrument maintained a consistent level of reliability, thereby validating its appropriateness for use in the current research context, and obviating the need for further modifications. Consequently, the instrument remained unchanged following the instrument validation study assessment.

3.5.6 Full Study

Data collection involved the utilization of a composite survey instrument. The researcher disseminated participation invitations via email and personal messages to the target population, each containing a hyperlink to the survey. Upon receipt, participants exercised their discretion to engage in the study by clicking on the provided link. Concurrently, the reception of the instrument, consent for participation, and submission were monitored and documented. Subsequently, reminders were dispatched to participants to maximize their engagement in the study.

3.5.7 Data Analysis

This research utilized the Hierarchical Component Model (HCM) within the framework of Partial Least Squares Structural Equation Modeling (PLS-SEM), a method that has been recognized in prior studies for its robustness in handling complex relationships (Martinez Avila et al., 2021). The HCM approach involves the development of two interconnected models, as suggested by Tehseen et al. (2017).

The **first component**, the **measurement model**, defines how observed indicators (also known as manifest variables) are linked to their respective unobserved constructs (latent variables). This component supports the formation of multi-item latent constructs, thereby enabling a nuanced understanding of how various observed factors collectively represent a theoretical concept.

The **second component**, the **structural model** or **path model**, maps the interrelations among the latent variables based on the study's proposed hypotheses and research questions. When combined, these two models constitute the comprehensive structural framework evaluated in the analysis.

What sets the PLS-SEM methodology apart from traditional SEM approaches is its flexibility in model estimation, its ability to handle complex hierarchical constructs, and its suitability for predictive modeling. This made it particularly appropriate for testing the expanded project management framework explored in the current study.

PLS-SEM estimates indicator and latent variable coefficients akin to Ordinary Least Squares (OLS) linear regression, rendering it particularly suitable for studies requiring causal prediction or those characterized by high model complexity but limited theoretical underpinnings (Hanushek & Jackson, 2013). This study aligns with the latter type of PLS-SEM study, given its complexity and paucity of theoretical information.

The mediation model employed in this study necessitated a comprehensive analytical approach. While constructing three separate Ordinary Least Squares (OLS) regression models could test the mediation, this approach was deemed impractical due to the latent nature of the constructs and the multiple underlying factors and indicators associated with each construct. Instead, a structural equation modeling (SEM) approach was deemed most appropriate, given its capacity to study large models such as the one used by Geraldi & Söderlund (2018) in their research. After deliberation between Covariance Based (CB) Structural Equation Modeling (SEM) and Partial Least Squares (PLS) SEM, the PLS-based approach was selected, aligning with the study's emphasis on causal predictive analysis and its complex yet theoretically sparse nature (Martinez Avila et al., 2021). The subsequent analysis of hypotheses employed a PLS-SEM approach utilizing software packages such as SmartPLS and SPSS, encompassing multiple steps including data preparation, instrument validation, SEM, hypothesis testing, and Follow-up data analysis.

In this study, the use of second- and third-order constructs reflects the hierarchical nature of project management competencies and complexity dimensions as outlined in the PMCQ and CAT frameworks. First-order constructs represent specific, measurable skill areas or complexity factors. These are grouped into broader second-order constructs, which in turn form third-order constructs representing overall competency or complexity domains. This hierarchical modeling captures both the detailed structure of the constructs and their higher-level conceptual integration, aligning with complexity theory and established competency models. Operationalization followed a two-stage HCM procedure: first, items from validated instruments were assigned to first-order reflective constructs; second, these constructs were aggregated into formative higher-order constructs using latent variable scores in SmartPLS.

3.5.8 Data Structuring and Statistical Description

The initial phase of the data analysis process involved scrutinizing the collected data for any instances of missing data. Fortunately, the sample exhibited no instances of missing data, ensuring the completeness of the dataset. Subsequently, the demographic information of the sample

underwent descriptive statistical analysis to gain insights into its composition and characteristics. Finally, the data underwent normality testing, employing well-established tests such as the Kolmogorov-Smirnov and Shapiro-Wilk tests. While Partial Least Squares Structural Equation Modeling (PLS-SEM) does not mandate adherence to a normal distribution of data, conducting these tests, as recommended by (Martinez Avila et al., 2021), serves to ascertain the distributional properties of the dataset. This information is crucial for the subsequent utilization of the PLS-SEM bootstrap model, which generates t-scores for hypothesis testing, thus ensuring the robustness and validity of the analytical process.

3.5.9 Hypothesis testing

The central research question in this study was formulated based on a comprehensive analysis of literature in the field of project management competencies, notably influenced by the work of Geraldi and Söderlund (2018). Their research emphasized the mediating influence of project complexity in the dynamic between project management competencies as the independent (exogenous) variable and project performance as the dependent (endogenous) outcome. In alignment with this conceptual framework, the research questions were designed to investigate the expanded version of the standard project management model. The methodology for testing this mediation followed the structured three-step approach suggested by Banihashemi et al. (2017), which entails evaluating: (1) the link between the independent and dependent variables, (2) the association between the independent variable and the mediator, and (3) the effect of the mediator on the dependent variable.

To capture the intricate nature of the constructs under study namely project management competencies, project complexity, and project performance these elements were treated as higher-order constructs comprising various underlying dimensions and indicators (Geraldi & Söderlund, 2018). As such, the study employed a two-tier Hierarchical Component Model (HCM), a method suited for analyzing multi-layered constructs (Hanushek & Jackson, 2013). Developing the conceptual framework required a two-phase process: first, to define the hierarchical relationships among the constructs and their indicators, and second, to simplify the structure into a first-order model appropriate for hypothesis testing and path analysis.

In the first step, a two-layer model was created using SmartPLS 4, with the outer layer containing latent variables and indicators, and the inner layer comprising constructs and their associated indicators. The PLS Algorithm was applied to extract latent variable scores, which were then reintegrated into the dataset as new indicators for every first-order construct. This facilitated the creation of a new model for further analysis.

The procedure employed to test the hypotheses related to Research Question Q.1 was replicated for Research Questions Q.2 and Q.3. Testing these hypotheses necessitated the creation of two additional analytical models. The key distinction between the model utilized for Q.1 and those for Q.2 and Q.3 lay in the representation of project management competencies. In the Q.2 and Q.3 models, the latent value scores for 'Soft Skills & Personal Development' and 'Technical & Professional Competencies' were substituted for the PM Competencies indicators in the latent variables. Subsequently, the model underwent rerunning and bootstrapping procedures, yielding the requisite t-scores, as illustrated in Figure 6.

Model 1: PLS Model (Formative- Formative Hierarchical) with 1st, 2nd and 3rd level LVs with indicators

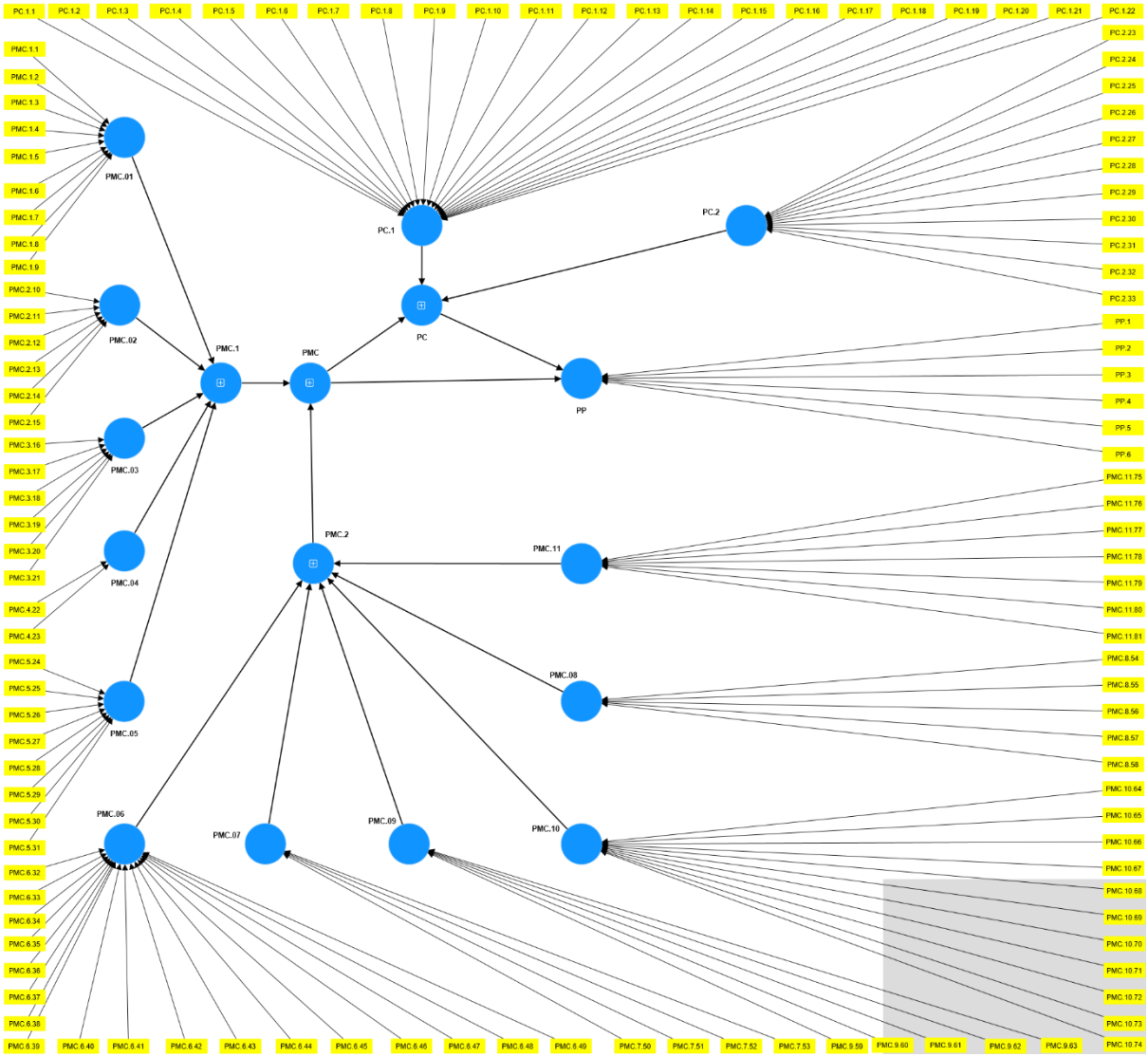

Figure 6: PLS-SEM with 1st, 2nd and 3rd order LVs with related indicators

Source: own research

In Figure 6 (Model 1), the full structural model is presented, illustrating the formative–formative hierarchical PLS-SEM structure with 1st, 2nd, and 3rd-level latent variables (LVs) along with their corresponding indicators. Due to the complexity of the three-level model, the textual elements, particularly the indicator labels, appear relatively small, making it challenging to view the overall structure clearly.

To address this, Figure 7 (Model 1.1) presents the same hierarchical model but with the indicators hidden, displaying only the 2nd and 3rd-order constructs. This modification provides a clearer, high-level visual representation of the model, enabling a quick and intuitive understanding of the relationships between the higher-order constructs without the visual clutter of the numerous first-order indicators. This condensed depiction facilitates a more accessible interpretation of the structural relationships while still reflecting the theoretical model tested in the study.

Model 1.1: Study for Formative- Formative Hierarchical PLS Model with 2nd level LV scores as indicators

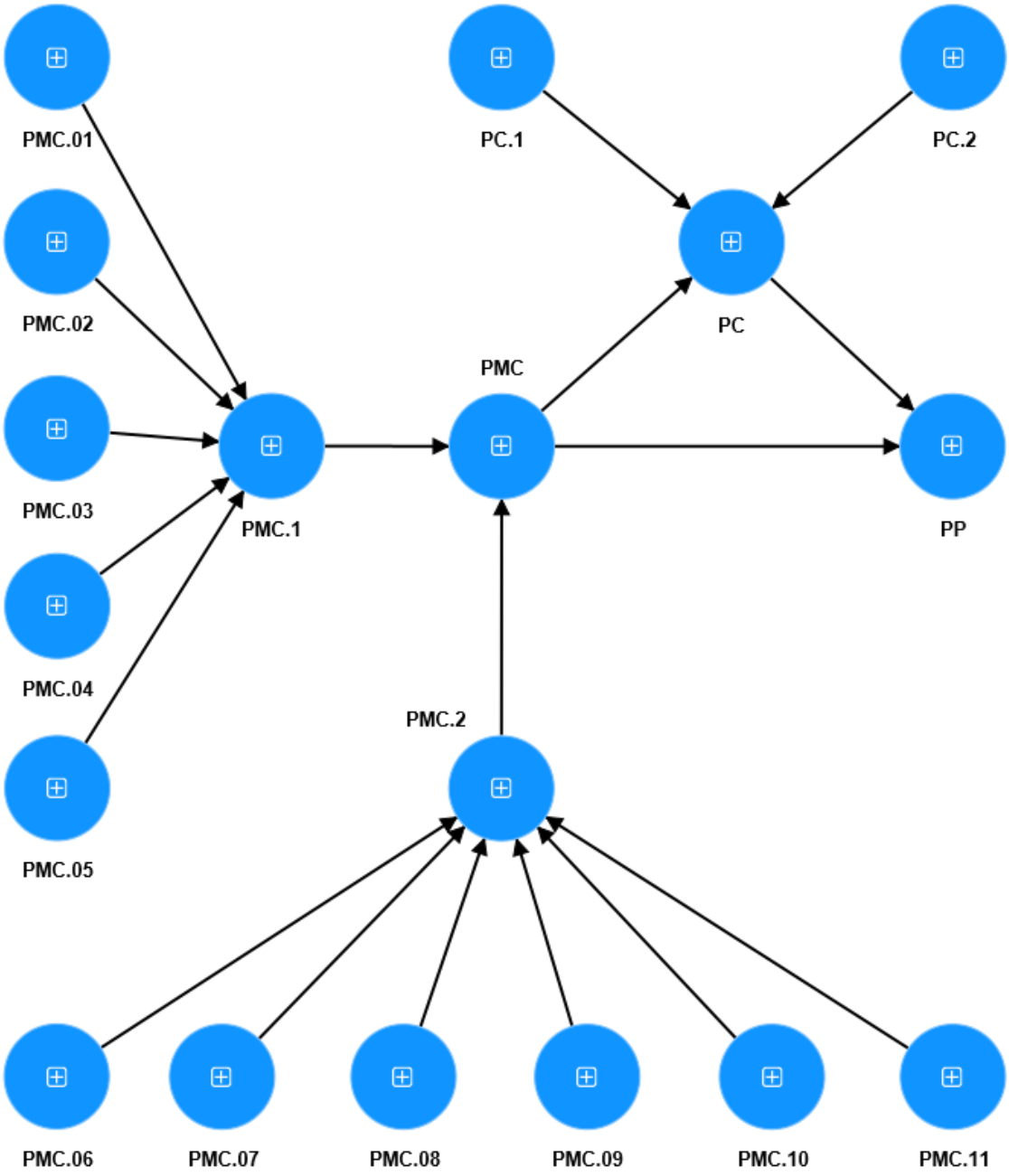

Figure 7: PLS-SEM with 2nd and 3rd-order constructs (Indicators hidden)

Source: own research

Figure 8 shows the same model with 3rd level LV scores as indicators.

Model 1.2: Study for Formative- Reflective Hierarchical PLS Model with 3rd level LV scores as indicators

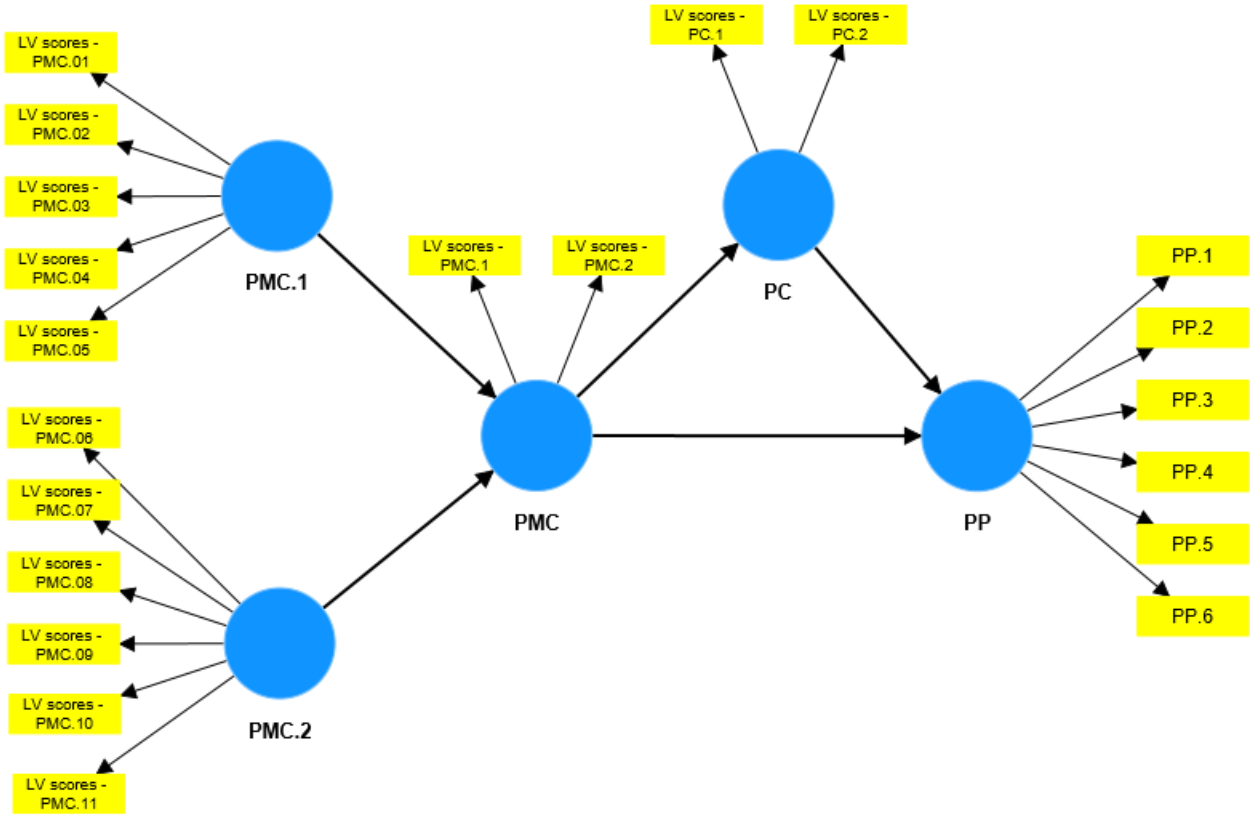

Figure 8: PLS-SEM with scores of 2nd and 3rd-order constructs

Source: own research

Figure 9 shows the PLS model showing the 3rd level LV scores as indicators.

Model 1.3: Study for Formative- Formative Hierarchical PLS Model with 2nd level LV scores as indicators

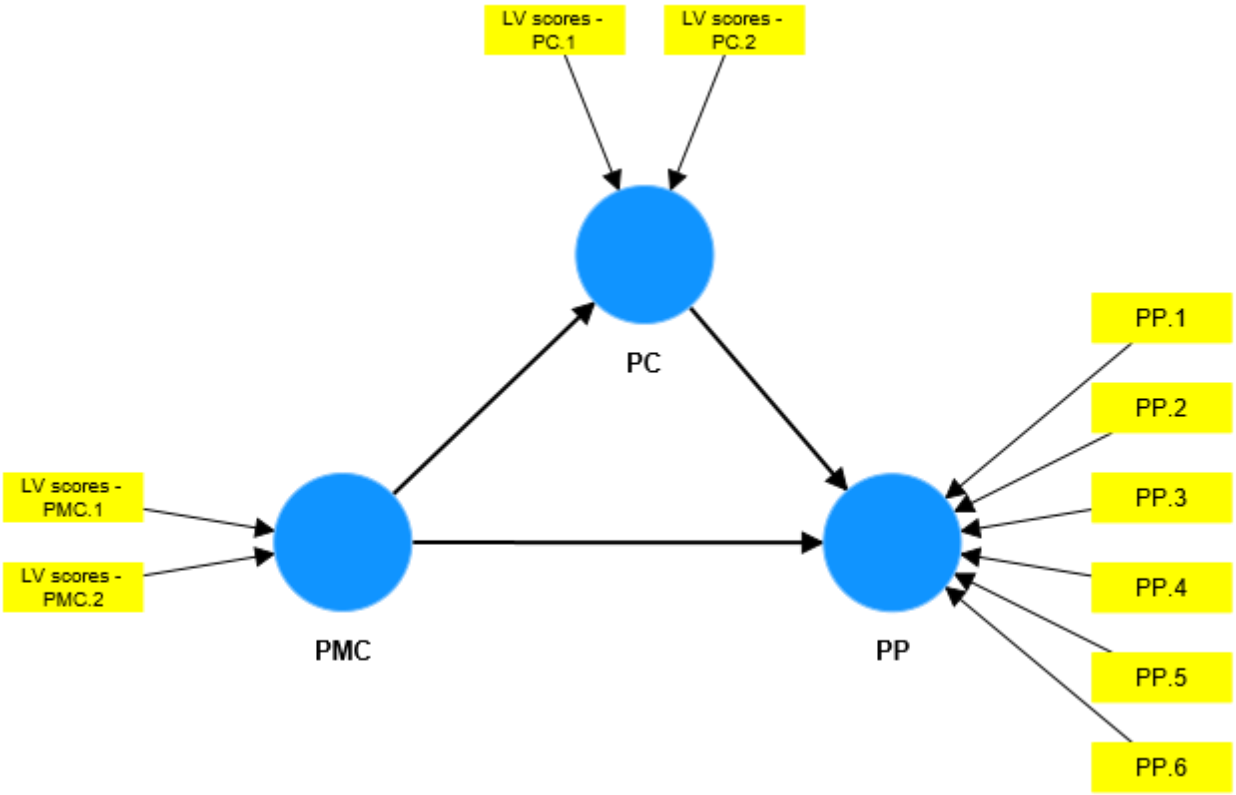

Figure 9: PLS-SEM for hypotheses testing for question Q.1

Source: own research

The second step involved repeating this process for Research Questions Q.2 and Q.3, necessitating the development of two additional analytical models. These models retained the same analytical approach but replaced the indicators for project management competencies with latent variable scores for 'Soft Skills & Personal Development' and 'Technical & Professional Competencies'. The resulting models were subjected to bootstrapping to obtain t-scores for hypothesis testing.

Research Questions Q.2 and Q.3 followed a similar analytical approach to Research Question Q.1, with adjustments made to the PM competencies construct indicators. The modified models shown in Figure 10 and 11, underwent analysis using the PLS algorithm and bootstrap values to derive t-scores.

Model 2: Study for PLS Model (Formative- Reflective Hierarchical) with LV scores for PM Soft Skills and Personal Competencies and scores for Project Complexity LVs.

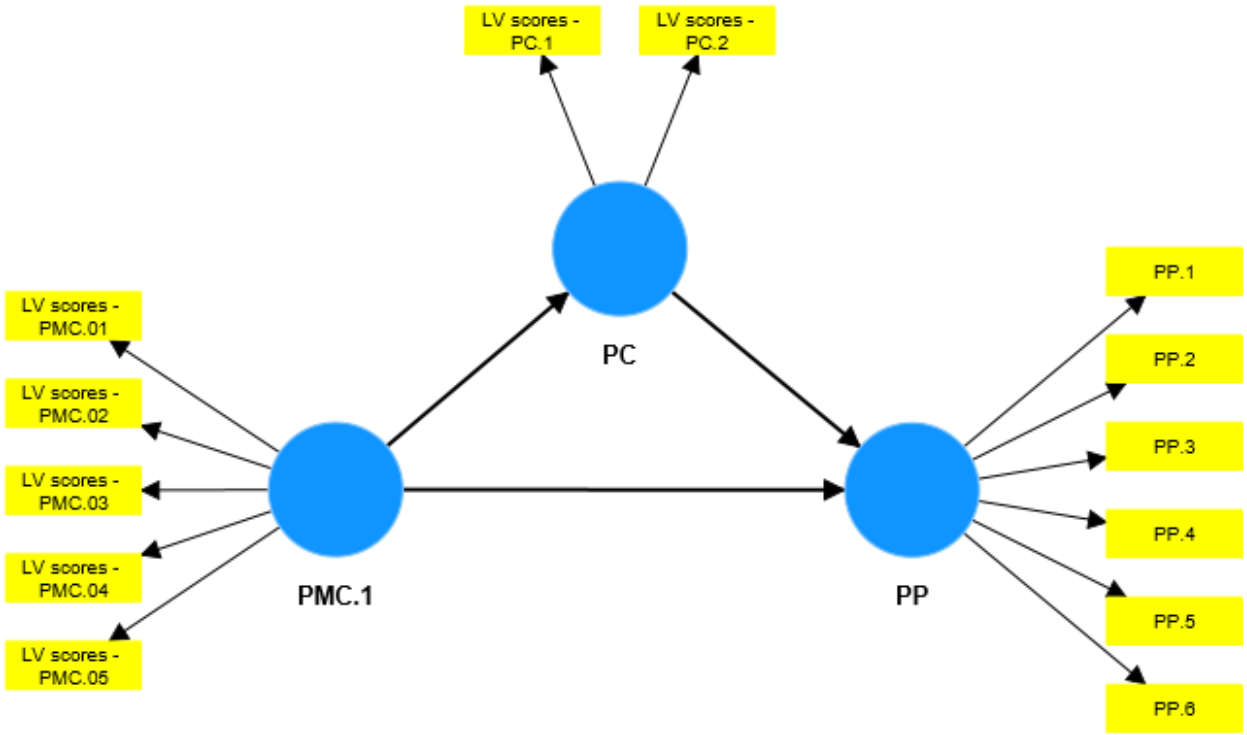

Figure 10: PLS-SEM for hypotheses testing for research question Q.2

Source: own research

Model 3: Study for Formative- Reflective Hierarchical PLS Model with LV scores for PM Technical and Professional Competencies and scores for Project Complexity LVs.

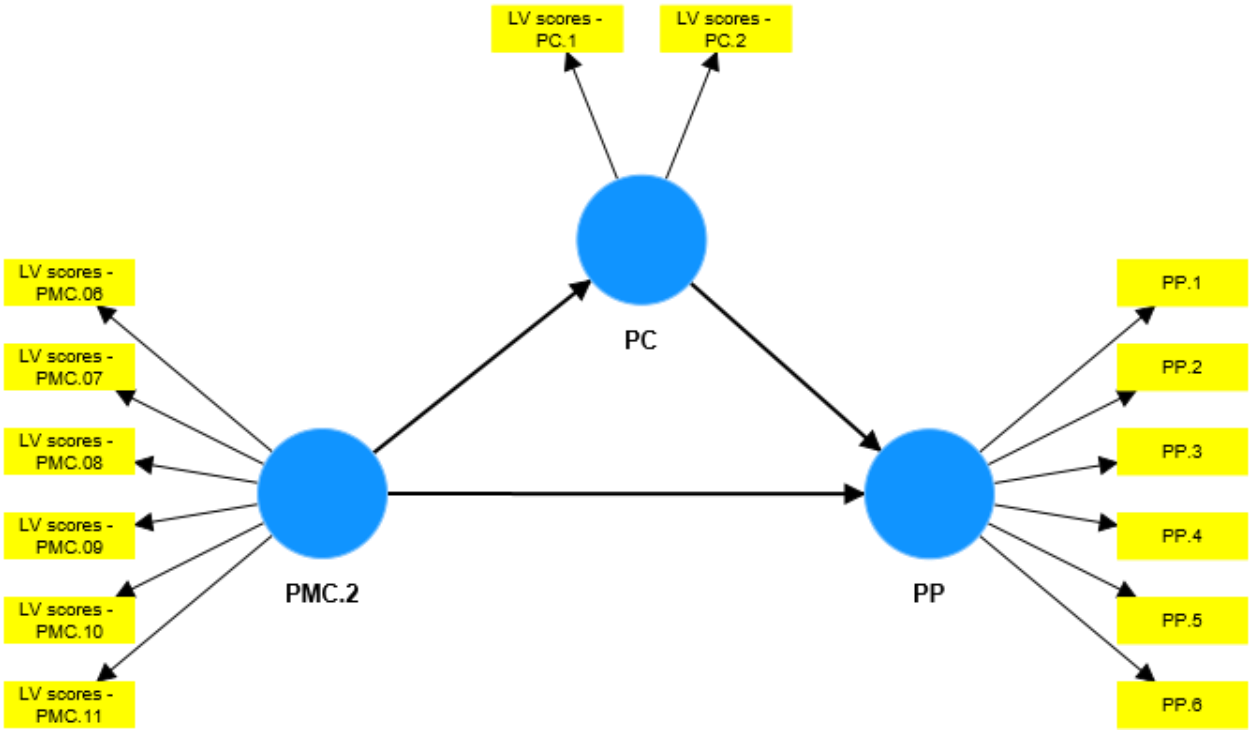

Figure 11: PLS-SEM for hypotheses testing for research question Q.3

Source: own research

The bootstrapping parameters applied in the process adhere to the procedures outlined by Gido (2018), as detailed in the following Table 6.

Table 6: Bootstrap Parameters

Bootstrap Input Parameters	***Settings***
Basic	5000
Subsamples	No Sign Changes
Sign Changes	Amount of Results
Amount of results	Complete Bootstrapping
Advanced Settings	
Confidence Interval Method	Bias-Corrected and Accelerated (BCA) Bootstrap
Test Type	Two-Tailed
Significance Level	0.05

Source: own research

Follow-up analysis in this study was directed towards three distinct areas. Firstly, it involved further examination of the demographic data collected during the study. The supplementary demographic information was categorized into three distinct groups, as outlined in Table 7, which defines the data collected to characterize the sample. The Follow-up analysis of this data focused on descriptive statistics.

Table 7: Demographic Information of Respondents

Category	***Info***
Personal	Gender Age Education Level Project Management Experience Industry Type
Organization	Position in Organization Number of Employees

Source: own research

Secondly, the study examined the distributional properties of the latent variable constructs by testing for normality. Although the initial research design planned to perform normality assessments exclusively on the indicator values, complications emerged when applying these tests directly to the scales of the indicators. Since the scores of the latent variables were derived from transforming individual indicator responses into a quasi-continuous format, it became essential to verify whether these transformed values met the assumptions of normality. This was especially important because these scores served as the basis for generating t-statistics used in testing significance. To evaluate normality, both the Kolmogorov-Smirnov and Shapiro-Wilk tests were applied.

The third analytical focus involved constructing and analyzing a simplified version of the Partial Least Squares Structural Equation Model (PLS-SEM) to re-examine the hypotheses related to research question Q.1. This step was prompted by notable discrepancies observed in the mediation testing results across research questions Q.1, Q.2, and Q.3. To further explore these inconsistencies, an alternative model was developed by removing the first-order latent variables from the original Hierarchical Component Model (HCM). The revised model was then subjected to the PLS algorithm and PLS-SEM Multi-Group Analysis (MGA) with bootstrapping, enabling the recalculation of t-values and providing additional clarity on the sources of variance in mediation outcomes.

3.6 Instrument Development

To facilitate accurate data collection, this study utilized three adapted instruments corresponding to the key variables under investigation: project management competencies, project complexity, and project performance. After rigorous changes and validity/normality tests the questionnaire was finalized showed in Appendix 5.

3.6.1 Project Management Competencies Questionnaire (PMCQ):

The PMCQ was employed to evaluate the competencies of project managers, drawing from the framework originally developed by Sugden et al. (2021). This tool aligns with the Project Management Institute's competency framework, which underscores both technical expertise and soft/personal competencies (Institute, 2017). Even though originally tailored to IT project contexts, its structure proved suitable for application across a broader range of industries. The PMCQ comprised 33 questions answered using a five-point Likert scale ranging from 5 (Strongly agree) to 1 (Strongly disagree). Despite representing an ordinal response, the Likert scale's values were treated as approximately continuous due to containing five or more values (Theron & Roodt, 2001). Responses were collected on an ordinal scale and later summed to yield interval data. Scores ranged from 33 to 165, with higher totals indicating a greater level of competency in project management.

Validity: Discriminant validity was confirmed by calculating the average variance extracted (AVE), yielding a value of .632, indicating discriminant validity (Rönkkö & Cho, 2022).

Reliability: Cronbach's alpha coefficient was .90, demonstrating internal consistency.

3.6.2 Complexity Assessment Tool (CAT):

To measure project complexity, the study adopted the Complexity Assessment Tool, which integrates elements from structural, socio-political, and emergent dimensions of complexity, based on the work of Maylor and Turner (2017). This tool, developed concerning complexity theory, aimed to capture perceptions of complexity through a set of 31 items rated on a five-point Likert scale (1 = Strongly disagree to 5 = Strongly agree). Total scores spanned from 31 to 155, with lower scores reflecting higher perceived complexity.

Validity was assessed through expert consultation, ensuring face validity under previous work by Rönkkö & Cho (2022), though published validity data were not available.

Reliability was evaluated using Cronbach's alpha, which demonstrated strong internal consistency ($\alpha = .90$), as reported by Qiu et al. (2016).

3.6.3 Project Success Questionnaire (PSQ):

Project success was assessed using the PSQ, adapted from the work of Saharan et al. (2020). This instrument captured participants' evaluations of completed projects based on usability, sustainability, and customer satisfaction dimensions (Banihashemi et al., 2017). It consisted of 14 items rated on a five-point Likert scale, with total scores ranging from 14 to 70. Higher scores indicated greater perceived project success (Banihashemi et al., 2017).

The **construct validity** of the PSQ was confirmed via the Average Variance Extracted (AVE), which yielded a value of 0.642 meeting the threshold for acceptable discriminant validity (Rönkkö & Cho, 2022).

Reliability testing revealed high internal consistency, with a Cronbach's alpha of 0.93.

A summary of the variables used in this research is presented in Table 8.

Table 8: Summary of the instruments used for variables

Variables	***ExV/EnV***	***Type of Data***	***Instrument***
Project Management Competencies	Exogenous variable	Interval	PMCQ
Project Complexity	Mediating Variable	Interval	CAT
Project Performance	Endogenous variable	Interval	PSQ

Source: own research

Table 9 shows the summary for the reliability test validated through SPSS.

Table 9: Reliability Statistics (instrument validation Study) SPSS

Cronbach's Alpha	***Cronbach's Alpha Based on Standardized Items***	***N of Items***
.90	.90	33
.90	.90	31
.93	.93	14

Source: own research

3.7 Ethical Considerations

This study adhered to the ethical principles outlined in The Belmont Report (2022), which emphasize respect for people, project stakeholders, and equality. Respect for people was ensured by employing Google Forms and social media platforms as data collection tools, thereby facilitating participants' autonomy and privacy.

To further uphold respect for people, data was securely saved and downloaded, and the platforms utilized were protected with passwords. The implementation of informed consent procedures addressed concerns regarding beneficence, ensuring that participants were adequately informed about the study's purpose and procedures.

Justice was addressed through self-selection randomization, which aimed to distribute participation opportunities fairly among potential participants. Participation in this research posed minimal risk to respondents, comparable to the types of experiences individuals encounter in everyday life. The study involved no physical or psychological harm, and no sensitive or intrusive questions were included. All participants were informed of the voluntary nature of their involvement, with the option to withdraw at any stage without consequence. Anonymity and confidentiality were assured throughout the data collection and analysis process, and ethical protocols were followed under institutional and academic standards for social science research. Ethical oversight and approval for this study were obtained from the Hungarian University of Agriculture and Life Sciences, Hungary.

3.8 Chapter Summary

This study employed a rigorous methodological framework. The target population comprised project managers with project management professional certification residing in Hungary. Sampling was conducted via Project Management LinkedIn pages and PMI Budapest, and data were collected using Google Forms and emails.

Multiple linear regression analysis was utilized to explore the predictive relationship between project management competencies and project success, while also examining the mediating effect of project complexity. Validated and reliable instruments, including the Project Management Competencies Questionnaire (PMCQ), the Complexity Assessment Tool (CAT), and the Project Success Questionnaire (PSQ), were employed to measure the study variables.

The research methodology adhered to the ethical principles outlined in The Belmont Report (2022), which encompass respect for persons, beneficence, and justice.

4. RESULTS AND DISCUSSIONS

This study aimed to explore the relationship between project management competencies and project performance, with a focus on the mediating role of project complexity. Drawing from the expanded standard model of project management proposed by Binder (2016), the study investigated how project complexity mediates the association between project management competencies and project performance. The research question and hypotheses were formulated based on the latent variables proposed by Mainga (2017) for project complexity, Silva et al. (2016) for project management competencies, and Banihashemi et al. (2017) for project performance. Data collection utilized a composite instrument derived from previous work by Maylor & Turner (2017), with rigorous field and instrument validation studies conducted to ensure validity and reliability (Ehsani et al., 2017).

Following the instrument validation study, data collection was carried out, and the collected data were used to construct four Partial Least Squares Structural Equation Modeling (PLS-SEM) models. These models underwent validation to ensure robustness in addressing the research questions and testing the study hypotheses. This chapter presents the findings derived from the models. The debate commences with an overview of the collected sample and the descriptive statistics thereof. Subsequently, the analysis of hypotheses testing is elaborated upon, followed by a Follow-up analysis aimed at providing further insights into the study results.

4.1 Sample Description

4.1.1 Sample Power and Size

An a priori power analysis was conducted to determine the appropriate sample size for this study, guided by Partial Least Squares Structural Equation Modeling (PLS-SEM) literature. Following Faber and Fonseca's (2014) rule, the sample size was set to at least ten times the highest number of indicators on any latent variable. Since "Structural Complexity" had a maximum of 22 indicators, the minimum sample size was established at 220 participants.

To validate this, a power analysis using G*Power 3 was conducted, consistent with methodologies by Montgomery (2021) provided effect size estimates, with relevant values ranging from 0.05 to 0.055.

Table 10 presents the results of an a priori power analysis conducted using G*Power 3 to determine the minimum sample size required for a multiple regression analysis. The analysis used a t-test family with a two-tailed test, focused on estimating a single regression coefficient within a fixed regression model. To ensure adequate power, the analysis targeted a statistical power level of 0.91, meaning a 91% probability of detecting a true effect, thereby reducing the likelihood of a Type II error. An alpha level (significance) of 0.05 was set, allowing a 5% probability of rejecting the null hypothesis incorrectly (Type I error).

*Table 10: Input Parameters of G*Power 3*

	*G*Power Field*	*Input Value*
Input	Test family	t-tests
	Statistical test	Linear multiple regression: Fixed model, single regression coefficient
	Type of power analysis	A priori: Compute the required sample size
	Tail(s)	Two
	Effect size f^2	0.05
	α err prob	0.05
	Power (1-β err prob)	0.91
	Number of predictors	22
Output	Noncentrality parameter δ	3.3241540
	Critical t	1.9720175
	Df	198
	Total sample size	**221**
	Actual power	0.9111747

Source: own research

The effect size f^2 was specified as 0.05, which represents a small effect size based on prior research assumptions. With these parameters, and considering the inclusion of 22 predictor variables, the analysis calculated a minimum required sample size of 221 participants to achieve the desired statistical power. Additional output parameters, such as the noncentrality parameter (δ = 3.3241540) and the critical t-value (1.9720175), provide further validation of this requirement The Figure 12 shows the distribution plot for sample size with critical t-value 1.97. In summary, this power analysis confirms that at least 221 responses are needed to ensure reliable results for detecting small effects with the specified parameters in this study's regression model.

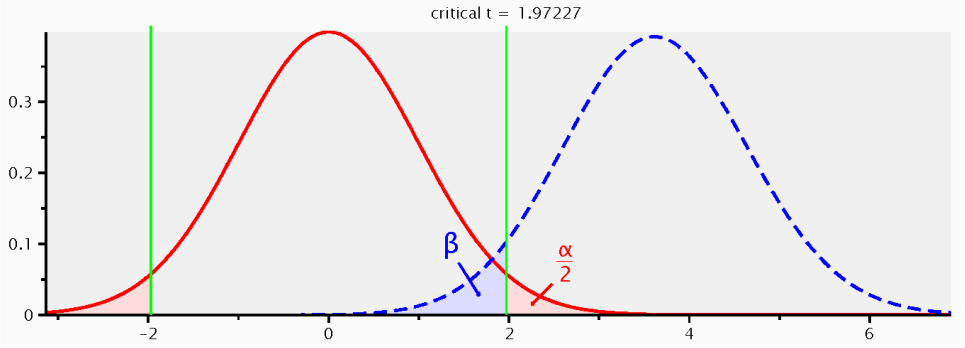

*Figure 12: G*Power 3 Distribution plot for sample size*

Source: own research

4.1.2 Sample Demographics

The demographic data presented in Table 11 offers a detailed overview of the respondents' profiles and highlights their relevance to the expected responses for the research questionnaire. In terms of gender, the majority of respondents are male, comprising 63% (144 individuals), while females account for 37% (85 individuals). This gender distribution may influence perspectives on project management competencies, as previous studies suggest differing leadership styles and communication preferences between genders.

Regarding age, most participants fall within the 31–40 age range (40.17%), followed closely by those in the 41–50 age group (37.99%). This concentration of respondents in middle adulthood is significant, as individuals in these age groups are likely to have substantial professional experience, which may lead to nuanced insights into the relationship between project management competencies and project performance. A smaller portion of younger respondents (9.17%) may provide fresh perspectives, while the 11.79% in the 51–60 age range can contribute valuable insights based on extensive experience.

As for organization type, a slight majority work in software-related organizations (55.02%), while 44.98% are employed in non-software industries. This diversity in organizational context is critical, as project management competencies can vary significantly between sectors, impacting respondents' experiences and responses to the questionnaire.

Table 11: Personal Demographics of Respondent

Demographics	***Category***	***N***	***Percentage***
Gender	Male	144	63%
	Female	85	37%
Age Group (Years)	Less than 30	21	9.17%
	31 to 40	92	40.17%
	41 to 50	87	37.99%
	51 and 60	27	11.79%
	More than 60	2	0.87%
Organization Type	Software	126	55.02%
	Non-Software	103	44.98%
Education Level	Post-Doc	2	0.87%
	Doctoral	18	7.86%
	Masters	120	52.40%
	Bachelors	88	38.43%
	Others	1	0.44%
Designation Level	Owner/CEO/Shareholder	3	1.31%
	General Manager	6	2.62%
	Middle/Supervisor level	123	53.71%
	Staff/ Worker	97	42.36%
Number of Subordinates	Less than 30	125	54.59%
	30-50	62	27.07%
	50-100	32	13.97%
	More than 100	10	4.37%
Experience in this industry (Years)	Less than 5	34	14.85%
	5-15	92	40.17%
	15-25	93	40.61%
	More than 25	1	0.44%

Source: own research

In terms of educational qualifications, over half of the respondents hold a master's degree (52.4%), with a substantial proportion also holding bachelor's degrees (38.43%). This high level of education is likely to correlate with a deeper understanding of project management theories and competencies, affecting their responses regarding competencies and performance. The educational background may also influence how respondents perceive project complexities, thereby impacting their feedback on the questionnaire.

Regarding designation levels, most respondents occupy middle or supervisory roles (53.71%), which positions them to provide insights based on direct experience with project management processes. Those in staff or worker roles (42.36%) can offer perspectives from the execution level, while the small percentage in senior roles (2.62% general managers and 1.31% owners/CEOs) can provide strategic insights that are crucial for understanding the overall project management landscape.

When considering the number of subordinates managed, the majority oversee fewer than 30 (54.59%), indicating a concentration of respondents in middle management positions, where they likely encounter significant project complexities. This demographic detail is relevant for understanding how project management competencies are applied in competencies and may influence responses related to leadership and team dynamics.

Lastly, the varied levels of experience in the industry 40.61% with 15-25 years and 40.17% with 5-15 years indicate a broad range of insights regarding project management challenges and competencies. The combination of experienced respondents and those newer to the field can enrich the study's findings by capturing a spectrum of viewpoints on the complexities and performance outcomes associated with project management.

Overall, this demographic profile highlights a diverse group in terms of gender, age, organizational type, educational background, and professional experience, which provides a well-rounded base for the study and enhances the relevance of the expected responses to the research questionnaire. The diversity in the sample is likely to yield a comprehensive understanding of the relationship between project management competencies and project performance, particularly in the context of varying project complexities within Hungarian organizations.

4.2 Descriptive Statistics

Descriptive statistics were utilized to examine the dataset, including the calculation of minimum and maximum scores, averages, and standard deviations for all variables measuring project management competencies, project complexity, and project performance. The range (minimum to maximum) captured the full breadth of participant responses, while the mean and standard deviation provided an overview of central tendencies and response variability across the sample (Montgomery et al., 2021).

Detailed in Tables 12, 13, and 14, the results for project performance indicators show that, on average, participants agreed that their projects met the expected goals. A closer look at the distribution of responses revealed a strong tendency toward positive assessments, with around 98% of participants selecting either “agree” or “strongly agree,” indicating a highly favorable perception of project outcomes.

Table 12: Responses Percentage for Latent Variables (Project Performance)

Latent Variable	***Code***	***Strongly Disagree***	***Disagree***	***Neither Agree nor Disagree***	***Agree***	***Strongly Agree***
Project Performance	PP	0.15%	0.29%	0.80%	47.38%	51.38%

Source: own research

Table 13: Responses Frequency Variables Indicators (Project Performance)

Variable Indicators	***Code***	***Strongly Disagree***	***Disagree***	***Neither Agree nor Disagree***	***Agree***	***Strongly Agree***
Schedule Objective (Time Objective)	PP.1	1	0	3	93	132
Cost Objective	PP.2	0	1	1	113	114
Quality Objectives	PP.3	0	1	0	130	98
Technical Specs	PP.4	1	0	1	119	108
Business Goals	PP.5	0	1	3	109	116
Stakeholder Satisfaction	PP.6	0	1	3	87	138

Source: own research

Table 14: Descriptive Statistics (Indicators of Project Performance)

Latent Variable	***Code***	***Indicator Description***	***N***	***Min.***	***Max.***	***Mean***	***S. Dev***
Project Performance	PP.1	Schedule Objective (Time Objective)	229	1	5	4.323	0.852
	PP.2	Cost Objective	229	1	5	4.279	0.867
	PP.3	Quality Objectives	229	1	5	4.354	0.788
	PP.4	Technical Specs	229	1	5	4.437	0.719
	PP.5	Business Goals	229	1	5	4.332	0.864
	PP.6	Stakeholder Satisfaction	229	1	5	4.406	0.818

Source: own research

The analysis of descriptive statistics in Tables 15, 16, and 17 for PM competencies revealed that Empathy in emotional skills was the least frequently used PM competency, indicating very limited utilization, whereas verbal communication was the most frequently used. The standard deviation of 0.947 indicates a wide range of skill usage, from very limited to extensive, within the sample. These mean and standard deviation values indicate a relatively even distribution of data across the potential response range compared to project outcome indicators.

Table 15: Responses Percentage for Latent Variables (Project Manager Competencies)

Latent Variable	***Code***	***Strongly Disagree***	***Disagree***	***Neither disagree nor agree***	***Agree***	***Strongly Agree***
Project Manager Competencies	PMC	0.19%	0.46%	0.76%	51.61%	46.98%
Soft skills and Personal Competencies	PMC.1	0.09%	0.46%	0.93%	50.91%	47.61%
Technical and Professional Competencies	PMC.2	0.25%	0.47%	0.65%	52.04%	46.60%

Source: own research

Table 16: Responses Frequency Variables Indicators (Project Manager Competencies)

Variable Indicator	***Code***	***Strongly Disagree***	***Disagree***	***Neither disagree nor agree***	***Agree***	***Strongly Agree***
Orientation	PMC.1.1	0	6	14	611	743
Commitment	PMC.1.2	0	6	13	625	730
Initiative	PMC.1.3	0	6	12	633	723
Confidence	PMC.1.4	0	5	12	635	722
Openness	PMC.1.5	0	6	12	627	729
Detailist	PMC.1.6	0	7	15	638	714
Courage	PMC.1.7	0	8	16	635	715
Sense of humor	PMC.1.8	1	7	14	637	715
Multitask and discipline	PMC.1.9	1	7	15	630	721
Leadership	PMC.2.10	1	6	18	633	716
Conflict management	PMC.2.11	2	6	19	654	693
Influence/persuasion	PMC.2.12	2	6	19	660	687
Motivating others	PMC.2.13	3	6	22	684	659
Negotiation	PMC.2.14	2	8	24	697	643
Charisma	PMC.2.15	2	8	24	718	622
Stress management	PMC.3.16	2	8	20	723	621
Interpersonal skills	PMC.3.17	1	8	19	717	629
Interpersonal sensitivity	PMC.3.18	2	8	15	726	623
Self-awareness	PMC.3.19	2	9	13	725	625
Self-motivation	PMC.3.20	2	6	12	738	616
Empathy	PMC.3.21	2	5	9	735	623
Ethics	PMC.4.22	2	5	9	737	621
Accountability	PMC.4.23	3	5	9	758	599
Problem-solving	PMC.5.24	2	5	9	766	592
Creativity and innovativeness	PMC.5.25	1	4	8	774	587
Decision-making	PMC.5.26	1	5	7	758	603
Critical analysis	PMC.5.27	1	6	6	771	590
Strategic perspective and system thinking	PMC.5.28	1	7	4	776	586
Vision and imagination	PMC.5.29	1	7	3	764	599
Intuitiveness	PMC.5.30	1	6	4	758	605
Learning	PMC.5.31	1	5	2	740	626
Manage human resources	PMC.6.32	1	4	2	752	615

Variable Indicator	*Code*	*Strongly Disagree*	*Disagree*	*Neither disagree nor agree*	*Agree*	*Strongly Agree*
Time	PMC.6.33	1	3	4	747	619
Stakeholders	PMC.6.34	2	2	5	761	604
Risk	PMC.6.35	1	2	6	767	598
Quality	PMC.6.36	1	3	4	768	598
Cost	PMC.6.37	1	4	4	792	573
Procurement	PMC.6.38	1	6	5	799	563
Scope	PMC.6.39	1	7	4	797	565
Resource	PMC.6.40	1	7	3	789	574
Communication	PMC.6.41	1	7	2	789	575
Requirements	PMC.6.42	2	7	3	786	576
Integration	PMC.6.43	2	7	3	766	596
Methods	PMC.6.44	2	6	5	753	608
Client/customer management	PMC.6.45	3	6	6	749	610
Health and safety management	PMC.6.46	2	6	7	735	624
Knowledge management	PMC.6.47	2	7	8	728	629
Change management	PMC.6.48	3	7	9	731	624
Supply chain management	PMC.6.49	3	8	9	728	626
Technical expertise	PMC.7.50	4	9	8	726	627
Experience	PMC.7.51	4	9	10	727	624
Business expertise	PMC.7.52	5	10	11	737	611
Administrative expertise	PMC.7.53	6	9	11	732	616
Adaptability	PMC.8.54	5	9	10	741	609
Contextual awareness	PMC.8.55	5	8	10	747	604
Strategic alignment	PMC.8.56	6	7	12	732	617
Political awareness	PMC.8.57	5	7	10	723	629
Networking	PMC.8.58	5	6	10	713	640
Monitor and control	PMC.9.59	5	6	13	718	632
Planning	PMC.9.60	6	7	13	688	660
Directiveness	PMC.9.61	6	7	16	672	673
Organization	PMC.9.62	5	6	15	674	674
Coordination	PMC.9.63	5	7	16	675	671
Prioritization	PMC.9.64	5	6	15	662	686
Verbal	PMC.10.65	5	6	11	663	689
Written	PMC.10.66	5	5	11	664	689
Listening	PMC.10.67	5	6	12	669	682

Variable Indicator	*Code*	*Strongly Disagree*	*Disagree*	*Neither disagree nor agree*	*Agree*	*Strongly Agree*
Multi-level	PMC.10.68	5	7	9	681	672
Open	PMC.10.69	6	6	8	675	679
Clear, direct, and concise	PMC.10.70	5	7	8	691	663
Engaging	PMC.10.71	5	8	8	679	674
Multi-cultural	PMC.10.72	3	8	9	662	692
Contextual communication	PMC.10.73	4	6	6	671	687
Presentation skills	PMC.10.74	3	7	9	642	713
Collaboration	PMC.11.75	2	8	10	655	699
Support	PMC.11.76	3	8	11	652	700
Developing others	PMC.11.77	3	6	11	656	698
Team building	PMC.11.78	3	6	14	673	678
Delegation	PMC.11.79	2	6	14	668	684
Escalation	PMC.11.80	3	5	12	681	673
Trustworthiness	PMC.11.81	3	3	13	665	690

Source: own research

Table 17: Descriptive Statistics (Indicators of Project Manager Competencies)

Latent Variable	*Code*	*Indicator Description*	*N*	*Min.*	*Max.*	*Mean*	*S. Dev*
Personal skills and attributes	PMC.1.1	Orientation	229	1	5	4.389	0.832
	PMC.1.2	Commitment	229	1	5	4.472	0.631
	PMC.1.3	Initiative	229	1	5	4.467	0.702
	PMC.1.4	Confidence	229	1	5	4.445	0.720
	PMC.1.5	Openness	229	1	5	4.507	0.652
	PMC.1.6	Detailist	229	1	5	4.415	0.786
	PMC.1.7	Courage	229	1	5	4.515	0.678
	PMC.1.8	Sense of humor	229	1	5	4.463	0.708
	PMC.1.9	Multitask and discipline	229	1	5	4.524	0.690
Influencing skills	PMC.2.10	Leadership	229	1	5	4.520	0.751
	PMC.2.11	Conflict management	229	1	5	4.537	0.657
	PMC.2.12	Influence/persuasion	229	1	5	4.511	0.691
	PMC.2.13	Motivating others	229	1	5	4.511	0.703
	PMC.2.14	Negotiation	229	1	5	4.502	0.697
	PMC.2.15	Charisma				4.480	0.780

Latent Variable	*Code*	*Indicator Description*	*N*	*Min.*	*Max.*	*Mean*	*S. Dev*
Emotional skills	PMC.3.16	Stress management	229	1	5	4.511	0.697
	PMC.3.17	Interpersonal skills	229	1	5	4.520	0.697
	PMC.3.18	Interpersonal sensitivity	229	1	5	4.507	0.722
	PMC.3.19	Self-awareness	229	1	5	4.528	0.684
	PMC.3.20	Self-motivation	229	1	5	4.550	0.629
	PMC.3.21	Empathy	229	1	5	4.533	0.671
Professionalism	PMC.4.22	Ethics	229	1	5	4.472	0.762
	PMC.4.23	Accountability	229	1	5	4.502	0.745
Cognitive skills	PMC.5.24	Problem-solving	229	1	5	4.528	0.651
	PMC.5.25	Creativity and innovativeness	229	1	5	4.559	0.635
	PMC.5.26	Decision-making	229	1	5	4.528	0.703
	PMC.5.27	Critical analysis	229	1	5	4.603	0.609
	PMC.5.28	Strategic perspective and system thinking	229	1	5	4.524	0.678
	PMC.5.29	Vision and imagination	229	1	5	4.520	0.709
	PMC.5.30	Intuitiveness	229	1	5	4.476	0.678
	PMC.5.31	Learning	229	1	5	4.450	0.750
Project management knowledge	PMC.6.32	Manage human resources	229	1	5	4.511	0.739
	PMC.6.33	Time	229	1	5	4.555	0.669
	PMC.6.34	Stakeholders	229	1	5	4.581	0.598
	PMC.6.35	Risk	229	1	5	4.524	0.678
	PMC.6.36	Quality	229	1	5	4.572	0.648
	PMC.6.37	Cost	229	1	5	4.389	0.719
	PMC.6.38	Procurement	229	1	5	4.432	0.742
	PMC.6.39	Scope	229	1	5	4.424	0.770
	PMC.6.40	Resource	229	1	5	4.428	0.804
	PMC.6.41	Communication	229	1	5	4.415	0.845
	PMC.6.42	Requirements	229	1	5	4.450	0.806
	PMC.6.43	Integration	229	1	5	4.419	0.798
	PMC.6.44	Methods	229	1	5	4.432	0.771
	PMC.6.45	Client/customer management	229	1	5	4.358	0.927
	PMC.6.46	Health and safety management	229	1	5	4.450	0.838
	PMC.6.47	Knowledge management	229	1	5	4.284	0.926
	PMC.6.48	Change management	229	1	5	4.380	0.825

Latent Variable	*Code*	*Indicator Description*	*N*	*Min.*	*Max.*	*Mean*	*S. Dev*
	PMC.6.49	Supply chain management	229	1	5	4.341	0.890
Knowledge and experience	PMC.7.50	Technical expertise	229	1	5	4.393	0.868
	PMC.7.51	Experience	229	1	5	4.415	0.835
	PMC.7.52	Business expertise	229	1	5	4.389	0.897
	PMC.7.53	Administrative expertise	229	1	5	4.384	0.847
Contextual skills	PMC.8.54	Adaptability	229	1	5	4.406	0.791
	PMC.8.55	Contextual awareness	229	1	5	4.419	0.840
	PMC.8.56	Strategic alignment	229	1	5	4.328	0.883
	PMC.8.57	Political awareness	229	1	5	4.450	0.883
	PMC.8.58	Networking	229	1	5	4.410	0.797
Management skills	PMC.9.59	Monitor and control	229	1	5	4.393	0.931
	PMC.9.60	Planning	229	1	5	4.472	0.774
	PMC.9.61	Directiveness	229	1	5	4.371	0.910
	PMC.9.62	Organization	229	1	5	4.345	0.803
	PMC.9.63	Coordination	229	1	5	4.279	0.902
	PMC.9.64	Prioritization	229	1	5	4.371	0.943
Communication skills	PMC.10.65	Verbal	229	1	5	4.301	0.930
	PMC.10.66	Written	229	1	5	4.284	0.931
	PMC.10.67	Listening	229	1	5	4.432	0.788
	PMC.10.68	Multi-level	229	1	5	4.376	0.840
	PMC.10.69	Open	229	1	5	4.336	0.859
	PMC.10.70	Clear, direct, and concise	229	1	5	4.445	0.783
	PMC.10.71	Engaging	229	1	5	4.336	0.923
	PMC.10.72	Multi-cultural	229	1	5	4.371	0.855
	PMC.10.73	Contextual communication	229	1	5	4.336	0.889
	PMC.10.74	Presentation skills	229	1	5	4.341	0.880
Team working skills	PMC.11.75	Collaboration	229	1	5	4.410	0.808
	PMC.11.76	Support	229	1	5	4.397	0.854
	PMC.11.77	Developing others	229	1	5	4.328	0.873
	PMC.11.78	Team building	229	1	5	4.279	0.815
	PMC.11.79	Delegation	229	1	5	4.345	0.809
	PMC.11.80	Escalation	229	1	5	4.328	0.858
	PMC.11.81	Trustworthiness	229	1	5	4.319	0.886
Latent Variable	**Code**	**Indicator Description**	**N**	**Min.**	**Max.**	**Mean**	**S. Dev**

Latent Variable	*Code*	*Indicator Description*	*N*	*Min.*	*Max.*	*Mean*	*S. Dev*
Personal skills and attributes	PMC.1.1	Orientation	229	1	5	4.389	0.832
	PMC.1.2	Commitment	229	1	5	4.472	0.631
	PMC.1.3	Initiative	229	1	5	4.467	0.702
	PMC.1.4	Confidence	229	1	5	4.445	0.720
	PMC.1.5	Openness	229	1	5	4.507	0.652
	PMC.1.6	Detailist	229	1	5	4.415	0.786
	PMC.1.7	Courage	229	1	5	4.515	0.678
	PMC.1.8	Sense of humor	229	1	5	4.463	0.708
	PMC.1.9	Multitask and discipline	229	1	5	4.524	0.690
Influencing skills	PMC.2.10	Leadership	229	1	5	4.520	0.751
	PMC.2.11	Conflict management	229	1	5	4.537	0.657
	PMC.2.12	Influence/persuasion	229	1	5	4.511	0.691
	PMC.2.13	Motivating others	229	1	5	4.511	0.703
	PMC.2.14	Negotiation	229	1	5	4.502	0.697
	PMC.2.15	Charisma				4.480	0.780
Emotional skills	PMC.3.16	Stress management	229	1	5	4.511	0.697
	PMC.3.17	Interpersonal skills	229	1	5	4.520	0.697
	PMC.3.18	Interpersonal sensitivity	229	1	5	4.507	0.722
	PMC.3.19	Self-awareness	229	1	5	4.528	0.684
	PMC.3.20	Self-motivation	229	1	5	4.550	0.629
	PMC.3.21	Empathy	229	1	5	4.533	0.671
Professionalism	PMC.4.22	Ethics	229	1	5	4.472	0.762
	PMC.4.23	Accountability	229	1	5	4.502	0.745
Cognitive skills	PMC.5.24	Problem-solving	229	1	5	4.528	0.651
	PMC.5.25	Creativity and innovativeness	229	1	5	4.559	0.635
	PMC.5.26	Decision-making	229	1	5	4.528	0.703
	PMC.5.27	Critical analysis	229	1	5	4.603	0.609
	PMC.5.28	Strategic perspective and system thinking	229	1	5	4.524	0.678
	PMC.5.29	Vision and imagination	229	1	5	4.520	0.709
	PMC.5.30	Intuitiveness	229	1	5	4.476	0.678
	PMC.5.31	Learning	229	1	5	4.450	0.750
Project management knowledge	PMC.6.32	Manage human resources	229	1	5	4.511	0.739
	PMC.6.33	Time	229	1	5	4.555	0.669

Latent Variable	*Code*	*Indicator Description*	*N*	*Min.*	*Max.*	*Mean*	*S. Dev*
	PMC.6.34	Stakeholders	229	1	5	4.581	0.598
	PMC.6.35	Risk	229	1	5	4.524	0.678
	PMC.6.36	Quality	229	1	5	4.572	0.648
	PMC.6.37	Cost	229	1	5	4.389	0.719
	PMC.6.38	Procurement	229	1	5	4.432	0.742
	PMC.6.39	Scope	229	1	5	4.424	0.770
	PMC.6.40	Resource	229	1	5	4.428	0.804
	PMC.6.41	Communication	229	1	5	4.415	0.845
	PMC.6.42	Requirements	229	1	5	4.450	0.806
	PMC.6.43	Integration	229	1	5	4.419	0.798
	PMC.6.44	Methods	229	1	5	4.432	0.771
	PMC.6.45	Client/customer management	229	1	5	4.358	0.927
	PMC.6.46	Health and safety management	229	1	5	4.450	0.838
	PMC.6.47	Knowledge management	229	1	5	4.284	0.926
	PMC.6.48	Change management	229	1	5	4.380	0.825
	PMC.6.49	Supply chain management	229	1	5	4.341	0.890
Knowledge and experience	PMC.7.50	Technical expertise	229	1	5	4.393	0.868
	PMC.7.51	Experience	229	1	5	4.415	0.835
	PMC.7.52	Business expertise	229	1	5	4.389	0.897
	PMC.7.53	Administrative expertise	229	1	5	4.384	0.847
Contextual skills	PMC.8.54	Adaptability	229	1	5	4.406	0.791
	PMC.8.55	Contextual awareness	229	1	5	4.419	0.840
	PMC.8.56	Strategic alignment	229	1	5	4.328	0.883
	PMC.8.57	Political awareness	229	1	5	4.450	0.883
	PMC.8.58	Networking	229	1	5	4.410	0.797
Management skills	PMC.9.59	Monitor and control	229	1	5	4.393	0.931
	PMC.9.60	Planning	229	1	5	4.472	0.774
	PMC.9.61	Directiveness	229	1	5	4.371	0.910
	PMC.9.62	Organization	229	1	5	4.345	0.803
	PMC.9.63	Coordination	229	1	5	4.279	0.902
	PMC.9.64	Prioritization	229	1	5	4.371	0.943
Communication skills	PMC.10.65	Verbal	229	1	5	4.301	0.930
	PMC.10.66	Written	229	1	5	4.284	0.931
	PMC.10.67	Listening	229	1	5	4.432	0.788

Latent Variable	*Code*	*Indicator Description*	*N*	*Min.*	*Max.*	*Mean*	*S. Dev*
	PMC.10.68	Multi-level	229	1	5	4.376	0.840
	PMC.10.69	Open	229	1	5	4.336	0.859
	PMC.10.70	Clear, direct, and concise	229	1	5	4.445	0.783
	PMC.10.71	Engaging	229	1	5	4.336	0.923
	PMC.10.72	Multi-cultural	229	1	5	4.371	0.855
	PMC.10.73	Contextual communication	229	1	5	4.336	0.889
	PMC.10.74	Presentation skills	229	1	5	4.341	0.880
Team working skills	PMC.11.75	Collaboration	229	1	5	4.410	0.808
	PMC.11.76	Support	229	1	5	4.397	0.854
	PMC.11.77	Developing others	229	1	5	4.328	0.873
	PMC.11.78	Team building	229	1	5	4.279	0.815
	PMC.11.79	Delegation	229	1	5	4.345	0.809
	PMC.11.80	Escalation	229	1	5	4.328	0.858
	PMC.11.81	Trustworthiness	229	1	5	4.319	0.886

Source: own research

Tables 17, 18, 19 and 20 display the descriptive statistical analysis for project complexity, including means and standard deviations for each indicator. The results suggest that, on average, participants perceived their project environments as moderately to minimally complex. Lower standard deviation values further indicate a consistent pattern in responses, pointing toward a shared experience of reduced complexity among the respondents.

Table 18: Responses Percentage for Latent Variables (Project Complexity)

Latent Variable	*Code*	*Strongly Disagree*	*Disagree*	*Neither Agree nor Disagree*	*Agree*	*Strongly Agree*
Project Complexity	PC	0.36%	0.31%	0.95%	47.66%	50.72%
Structural Complexity	PC.1	0.26%	0.33%	0.91%	48.20%	50.23%
Socio-Political Complexity	PC.2	0.33%	0.34%	0.92%	46.43%	51.98%

Source: own research

Table 19: Responses Frequency Variables Indicators (Project Complexity)

Indicator	*Code*	*Strongly Disagree*	*Disagree*	*Neither Agree nor Disagree*	*Agree*	*Strongly Agree*
Vision Clarity	PC.1.1	3	3	14	658	696
Resource Availability	PC.1.2	3	4	15	660	692
Autonomy	PC.1.3	3	4	12	664	691
Scope Clarity	PC.1.4	4	4	15	654	697

Indicator	*Code*	*Strongly Disagree*	*Disagree*	*Neither Agree nor Disagree*	*Agree*	*Strongly Agree*
Cross-Disciplinary Integration	PC.1.5	4	4	14	669	683
Familiar Commercial Arrangements	PC.1.6	5	5	11	695	658
Defined Quality and Regulatory Acceptance Criteria	PC.1.7	5	5	10	685	669
Attainable Pace	PC.1.8	4	4	10	664	692
Managerial Control Over Human Resources	PC.1.9	5	4	14	668	683
Full Dedication of Key Personnel	PC.1.10	4	4	11	656	699
Sufficient Budget Allocation	PC.1.11	4	3	13	668	686
Well-defined schedule and Resource Plan	PC.1.12	4	3	13	641	713
Accessibility of Resources	PC.1.13	4	2	13	647	708
Client-Collaborated Success Measures	PC.1.14	5	3	13	646	707
Established Supply Chain	PC.1.15	5	4	8	649	708
Supportive Management Tools	PC.1.16	7	4	8	669	686
Flexibility of Budget Utilization	PC.1.17	7	4	9	654	700
Familiarity with Technology	PC.1.18	7	4	12	647	704
Feasibility of Data Reporting	PC.1.19	7	5	14	663	685
Defined Lines of Responsibility	PC.1.20	7	5	15	685	662
Single Country/Time Zone/Language/Currency Context	PC.1.21	7	4	20	668	675
Clear Sponsorship	PC.2.22	7	5	22	659	681
Transparent Business Case	PC.2.23	3	3	14	658	696
Alignment with Strategy	PC.2.24	3	4	15	660	692
Senior Management Support	PC.2.25	3	4	12	664	691
Team Collaboration	PC.2.26	4	4	15	654	697
Managerial Experience	PC.2.27	4	4	14	669	683

Indicator	*Code*	*Strongly Disagree*	*Disagree*	*Neither Agree nor Disagree*	*Agree*	*Strongly Agree*
Minimal Organizational Change	PC.2.28	5	5	11	695	658
Unaffected by Change	PC.2.29	5	5	10	685	669
Aligned External Stakeholders	PC.2.30	4	4	10	664	692
Committed External Stakeholders	PC.2.31	5	4	14	668	683
Realistic Understanding among Stakeholders	PC.2.32	4	4	11	656	699
Core Team Decision Authority	PC.2.33	4	3	13	668	686

Source: own research

Table 20: Descriptive Statistics (Indicators of Project Complexity)

Latent Variable	*Code*	*Indicator*	*N*	*Min.*	*Max.*	*Mean*	*S. Dev*
Structural Complexity	PC.1.1	Vision Clarity	229	1	5	4.258	0.891
	PC.1.2	Resource Availability	229	1	5	4.362	0.721
	PC.1.3	Autonomy	229	1	5	4.266	0.827
	PC.1.4	Scope Clarity	229	1	5	4.279	0.799
	PC.1.5	Cross-Disciplinary Integration	229	1	5	4.341	0.775
	PC.1.6	Familiar Commercial Arrangements	229	1	5	4.258	0.925
	PC.1.7	Defined Quality and Regulatory Acceptance Criteria	229	1	5	4.170	0.902
	PC.1.8	Attainable Pace	229	1	5	4.288	0.817
	PC.1.9	Managerial Control Over Human Resources	229	1	5	4.227	0.877
	PC.1.10	Full Dedication of Key Personnel	229	1	5	4.245	0.892
	PC.1.11	Sufficient Budget Allocation	229	1	5	4.249	0.869
	PC.1.12	Well-defined schedule and Resource Plan	229	1	5	4.245	0.816
	PC.1.13	Accessibility of Resources	229	1	5	4.323	0.867
	PC.1.14	Client-Collaborated Success Measures	229	1	5	4.227	0.897
	PC.1.15	Established Supply Chain	229	1	5	4.297	0.753

Latent Variable	*Code*	*Indicator*	*N*	*Min.*	*Max.*	*Mean*	*S. Dev*
	PC.1.16	Supportive Management Tools	229	1	5	4.284	0.816
	PC.1.17	Flexibility of Budget Utilization	229	1	5	4.380	0.787
	PC.1.18	Familiarity with Technology	229	1	5	4.297	0.787
	PC.1.19	Feasibility of Data Reporting	229	1	5	4.345	0.830
	PC.1.20	Defined Lines of Responsibility	229	1	5	4.240	0.856
	PC.1.21	Single Country/Time Zone/Language/Currency Context	229	1	5	4.240	0.876
Sociopolitical Complexity	PC.2.22	Clear Sponsorship	229	1	5	4.306	0.848
	PC.2.23	Transparent Business Case	229	1	5	4.297	0.814
	PC.2.24	Alignment with Strategy	229	1	5	4.310	0.838
	PC.2.25	Senior Management Support	229	1	5	4.424	0.674
	PC.2.26	Team Collaboration	229	1	5	4.284	0.816
	PC.2.27	Managerial Experience	229	1	5	4.179	0.948
	PC.2.28	Minimal Organizational Change	229	1	5	4.293	0.813
	PC.2.29	Unaffected by Change	229	1	5	4.266	0.893
	PC.2.30	Aligned External Stakeholders	229	1	5	4.210	0.856
	PC.2.31	Committed External Stakeholders	229	1	5	4.310	0.828
	PC.2.32	Realistic Understanding among Stakeholders	229	1	5	4.288	0.812
	PC.2.33	Core Team Decision Authority	229	1	5	4.271	0.834

Source: own research

To evaluate the distribution of data for the variables related to project management competencies and project performance, normality assessments were conducted using both the Kolmogorov-Smirnov and Shapiro-Wilk tests. The results from these tests showed statistical significance, indicating deviations from normality. Such outcomes are expected when analyzing ordinal data derived from Likert-type scales. Nonetheless, this deviation is not problematic in the context of this research, as the chosen analytical method Partial Least Squares Structural Equation Modeling (PLS-SEM) is robust against violations of normality assumptions and is particularly well-suited for exploratory studies involving complex models and non-parametric data.

4.3 Instrument Reliability and Structural Model Validity

Beyond confirming the validity and reliability of the data collection instrument, this study also required a rigorous assessment of the structural model's measurement quality. This evaluation adhered to established procedures outlined in recent methodological literature as reported by Rönkkö & Cho (2022), focusing on both indicator-level and construct-level validity.

The hierarchical component model was applied using a formative–reflective specification, with first-order constructs modeled reflectively and aggregated into formative higher-order constructs. Second-order constructs represented broader competency and complexity domains, and in some cases, these were combined into third-order constructs. The two-stage approach in SmartPLS generated latent variable scores for use in the higher-order models, ensuring that the operationalization matched the theoretical framework.

The process began with evaluating indicator validity, where statistical significance (p-values) and collinearity (Variance Inflation Factor or VIF) were examined. For formative constructs, indicator relevance was evaluated via bootstrapped *outer weights*; *outer loadings* were consulted only as a redundancy check, indicators were deemed significant if their p-value was below 0.05, and acceptable collinearity was established at VIF values less than 5 (Rönkkö & Cho, 2022). Based on the PLS Algorithm results (see Appendix 2), VIF values for all indicators fell within acceptable bounds. However, when Outer Weights were examined via PLS Bootstrapping, 18 indicators displayed p-values that did not meet the significance threshold. Following recommendations by Martinez Avila et al. (2021), these indicators were further analyzed using Outer Loadings. Indicators were retained only if their loading exceeded 0.50 and the associated p-value was below 0.05. After applying this criterion, 10 of the 18 initially questionable indicators were excluded from their respective higher-order constructs to enhance construct validity and reduce redundancy in the model.

To check the construct relevancy and validity of the model the new data file was created for the higher-level constructs in SmartPLS4, following the *two-stage* approach which gave the related scores of first and second-order constructs. The same method was used to calculate and set right the relevancy of higher-level constructs. Table 21 shows the results, all the VIF values were in limit but the p-values for three constructs were not in limit so consulted the *outer loadings* as a redundancy check (after testing *outer weights*) and got one construct irrelevant. It was removed from lower and higher-level constructs to get new scores and corrected model.

Table 21: Construct Validity and Reliability

Higher Order Construct	***Lower Order Construct***	***Code***	***VIF***	**p *Values***	***Outer Weights***	***Indicator relevancy***
Soft Skills and Personal Competencies (PMC.1)	Personal skills and attributes	PMC.01	1.464	0.000	0.190	Relevant
	Influencing skills	PMC.02	1.422	0.000	0.907	Relevant
	Emotional skills	PMC.03	1.442	0.000	0.182	Relevant
	Professionalism	PMC.04	1.171	0.000	0.756	Relevant
	Cognitive skills	PMC.05	1.455	0.000	0.836	Relevant

Higher Order Construct	*Lower Order Construct*	*Code*	*VIF*	p *Values*	*Outer Weights*	*Indicator relevancy*
Technical and Professional Competencies (PMC.2)	Project management knowledge	PMC.06	1.292	0.000	0.022	Relevant
	Knowledge and experience	PMC.07	1.057	0.080	0.606	Relevant
	Contextual skills	PMC.08	1.065	**0.066**	**0.171**	**Irrelevant**
	Management skills	PMC.09	1.196	0.000	0.685	Relevant
	Communication skills	PMC.10	1.243	0.000	0.049	Relevant
	Team working skills	PMC.11	1.139	0.000	0.713	Relevant
Structural Complexity		PC.1	1.713	0.000	0.567	Relevant
Socio-Political Complexity		PC.2	1.685	0.000	0.348	Relevant
Project Performance	Schedule Objective (Time Objective)	PP.1	1.015	0.002	0.844	Relevant
	Cost Objective	PP.2	1.029	0.000	0.417	Relevant
	Quality Objectives	PP.3	1.016	0.024	0.913	Relevant
	Technical Specs	PP.4	1.028	0.003	0.568	Relevant
	Business Goals	PP.5	1.009	0.009	0.391	Relevant
	Stakeholder Satisfaction	PP.6	1.024	0.043	0.685	Relevant

Source: own research

The next phase involved testing **construct validity**, which includes nomological validity and the examination of inter-construct correlations. Nomological validity assesses the theoretical coherence of relationships among constructs. Using the PLS Algorithm and Bootstrap procedures in SmartPLS4, the study confirmed that all hypothesized paths were statistically significant, with effect sizes ranging from small to moderate. These results, as depicted in Tables 22 and 23, are consistent with prior empirical studies (Geraldi, 2021; Rönkkö & Cho, 2022), further reinforcing the appropriateness of the model's theoretical framework.

Table 22: Nomological Validity

Model Path	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
PMC»» PC	0.408	0.424	0.066	6.199	0.000
PMC»» PP	0.349	0.324	0.168	2.084	0.037
PC»»»» PP	0.262	0.247	0.145	1.804	0.012

Source: own research

Table 23: Inter-construct Correlations (PLS Algorithm)

Study Construct	PC	PMC	PP
PC	1.000	0.417	0.449
PMC	0.417	1.000	0.305
PP	0.449	0.305	1.000

Source: own research

Finally, the structural validity of the model was evaluated by examining both the coefficient of determination (R^2) and effect sizes (f^2). As shown in Tables 24 and 25, the model demonstrated moderate predictive power. According to criteria provided by Qiu (2016), R^2 values below 0.20 are interpreted as indicating weak explanatory power, while f^2 values in the range of 0.02 to 0.17 signify small but meaningful effects. These findings support the model's adequacy for exploratory research purposes, even though stronger predictive capabilities may be observed in future studies with refined constructs or expanded samples (Rönkkö & Cho, 2022).

Table 24: R^2 (Coefficient of Determination)

Study Construct	R^2	R^2 Adjusted
PC	0.174	0.171
PP	0.198	0.182

Source: own research

Table 25: Effect Size f^2

Study Construct	PMC	PC	PP
PMC		0.011	0.021
PC			0.141
PP			

Source: own research

4.4 Hypothesis Testing

Hypothesis testing involved the use of three distinct structural models. These models underwent analysis using a bootstrapping approach within the PLS-SEM framework to derive t-scores for each path within the expanded standard model of project management. The initial model evaluated pertained to the primary research inquiries.

4.4.1 PLS-SEM Model M1: Hypothesis Testing and Mediation Analysis

This section evaluates the hypotheses linked to Model M1, which is rooted in the extended standard framework of project management as described by Martinez (2021). The core proposition of this framework is that project complexity functions as a mediating variable between project management competencies (independent variable) and project performance (dependent variable). To assess this mediating relationship, a structured three-stage mediation analysis approach was utilized, as recommended by Aria (2018). The process involves: (1) examining the relationship between the predictor and mediator (path a), (2) evaluating the link between the mediator and the outcome variable (path b), and (3) testing the direct association between the independent and dependent variables (path c). If the first two paths demonstrate statistical significance while the third path does not, a mediating effect is confirmed.

In this study, each hypothesis was aligned with one of the three structural paths and tested using the bootstrapped Partial Least Squares Structural Equation Modeling (PLS-SEM) procedure. Table 26 summarizes the specific research questions and corresponding hypotheses that form the basis of Model M1, visually illustrated in Figure 13. The results obtained from the bootstrap analysis are detailed in Table 26.

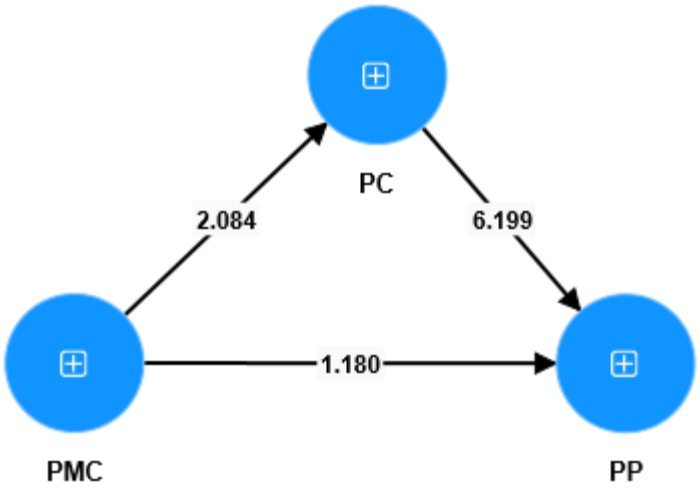

Figure 13: M1 path model with t-scores on paths

Source: own research

Table 26: Hypothesis results for the M1 model

Hypothesis Code	***Path***	***Null Hypothesis***	***Hypothesis***	***Results***
H1	*a-b*	$H_0.1$	*There are no significant relationships between the exogenous variable project management competencies, the mediating variable project complexity, and the dependent variable project performance.*	Rejected Null
		$H_1.1$	*There are significant relationships between the exogenous variable project management competencies, the mediating variable project complexity, and the dependent variable project performance.*	
H1.1		$H_0.1.1$	*There are no significant relationships between the exogenous variable project management competencies and the endogenous variable project performance.*	*Accepted Null*
		$H_1.1.1$	*There are significant relationships between the exogenous variable project management competencies and the endogenous variable project performance.*	
H1.2		$H_0.1.2$	*There are no significant relationships between the exogenous variable project management competencies and the mediating variable, project complexity.*	Rejected Null
		$H_1.1.2$	*There are significant relationships between the exogenous variable project management competencies and the mediating variable, project complexity.*	
H1.3		$H_0.1.3$	*There are no significant relationships between the mediating variable, project complexity, and the endogenous variable, project performance.*	Rejected Null
		$H_1.1.3$	*There are significant relationships between the mediating variable, project complexity, and the endogenous variable, project performance.*	

Source: own research

Table 27 presents the bootstrap results for M1, indicating that paths a and b in the model were statistically significant at the $p < .05$ level. As evidenced by the output, both path a (from project management competencies to project complexity) and path b (from project complexity to project performance) were statistically significant at the $p < 0.05$ level, satisfying the initial two conditions for mediation. In contrast, path c, which measures the direct effect of project

management competencies on project performance without the mediating influence of project complexity, did not reach statistical significance ($p > 0.05$).

Table 27: Bootstrap results of paths of M1

Hypothesis ID	***Path code***	***Model Path***	***t-score***	***p-value***
H1.1	*A*	*PMC »» PC*	2.084	0.037
H1.2	*B*	*PC »»»» PP*	6.199	0.000
H1.3	*C*	*PMC »» PP*	1.180	**0.238**

According to the evaluation standards provided by Montgomery et al. (2021), this pattern of results substantiates the mediating role of project complexity. The significant indirect effect, combined with a non-significant direct effect, reinforces the conclusion that project complexity plays a pivotal role in shaping how project management competencies influence performance outcomes. Thus, the empirical evidence supports the validity of the expanded project management model in the context of this study.

4.4.2 PLS-SEM Model M2 and M3: Advanced Mediation Testing

To further examine the nuanced relationships within the expanded standard model of project management proposed by Rönkkö (2022), two supplementary structural models Model M2 and Model M3 were developed and tested. These models were designed to unpack the individual contributions of the two distinct dimensions of project management competencies: Soft Skills and Personal Competencies, and Technical and Professional Competencies. In Models M2 and M3, these dimensions were tested independently as exogenous variables to determine how each uniquely influences project performance when mediated by project complexity.

The methodology used to assess mediation in both models followed the structured three-step process recommended by Montgomery et al. (2021). This involved assessing the statistical significance of three paths: the path from the exogenous variable to the mediator (path a), the mediator to the outcome (path b), and the direct effect from the exogenous variable to the outcome variable (path c). Mediation was established when paths a and b were significant while path c remained non-significant, suggesting that the effect of the exogenous variable on the dependent variable was transmitted through the mediator.

Model M2: Soft Skills and Personal Competencies

Model M2 evaluated whether project complexity mediated the relationship between Soft Skills, Personal Competencies, and overall project performance. Figure 14 illustrates the PLS-SEM path model employed for M2, and the detailed bootstrap results are provided in Tables 28 and 29.

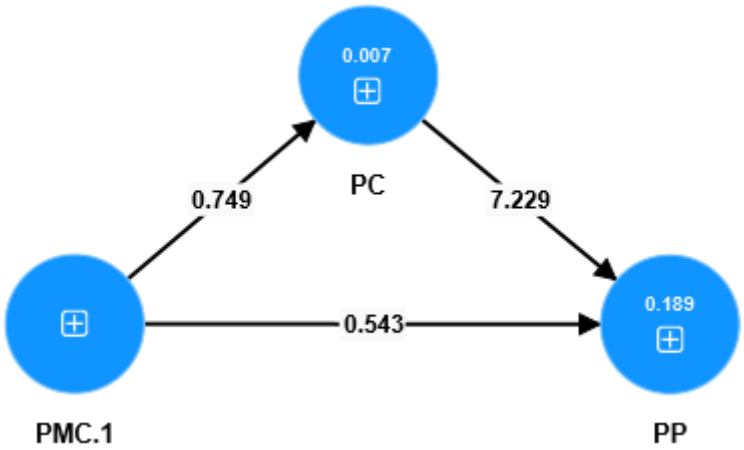

Figure 14: M2 path model with t-scores on paths

Source: own research

Table 28: Hypothesis results for the M2 model

Hypothesis Code	***Path***	***Null Hypothesis***	***Hypothesis***	***Results***
H2		$H_0.2$	*There are no significant relationships between the exogenous variable Soft Skills and Personal Competencies and the endogenous variable project performance.*	Rejected Null
		$H_1.2$	*There are significant relationships between the exogenous variable Soft Skills and Personal Competencies and the endogenous variable project performance.*	
H2.1		$H_0.2.1$	*There are no significant relationships between the exogenous variable Soft Skills and Personal Competencies and the endogenous variable project performance.*	*Accepted Null*
		$H_1.2.1$	*There are significant relationships between the exogenous variable Soft Skills and Personal Competencies and the endogenous variable project performance.*	
H2.2		$H_0.2.2$	*There are no significant relationships between the exogenous variable Soft Skills and Personal Competencies and the mediating variable project complexity.*	Rejected Null
		$H_1.2.2$	*There are significant relationships between the exogenous variable Soft Skills and Personal Competencies and*	

Hypothesis Code	*Path*	*Null Hypothesis*	*Hypothesis*	*Results*
			the mediating variable project complexity.	
H2.3		H_0.2.3	*There are no significant relationships between the mediating variable project complexity and the endogenous variable project performance.*	Rejected Null
		H_1.2.3	*There are significant relationships between the mediating variable project complexity and the endogenous variable project performance.*	

Source: own research

The results demonstrated that both path a (linking Soft Skills and Personal Competencies to project complexity) and path b (connecting project complexity to project performance) were statistically significant at the $p < .05$ level. Conversely, the direct path (path c') between Soft Skills and Personal Competencies and project performance was not statistically significant. These findings align with the conditions for full mediation as outlined by Rönkkö (2022) and support the theoretical model proposed by Qiu (2016). The interpretation of these outcomes suggests that Soft Skills and Personal Competencies do not directly influence project performance; instead, their influence operates through project complexity, underscoring the critical role complexity plays in shaping project outcomes.

Table 29: Bootstrap results of paths of M2

Hypothesis ID	*Path code*	*Model Path*	*t-score*	*p-value*
H2.1	*a*	*PMC1 »» PC*	2.749	0.014
H2.2	*b*	*PC »»»»» PP*	7.229	0.000
H2.3	*c*	*PMC1 »» PP*	0.543	**0.587**

Source: own research

Model M3: Technical and Professional Competencies

Model M3 focused on evaluating the mediating role of project complexity in the relationship between Technical and Professional Competencies and project performance. The structural model for M3 is shown in Figure 15, and the corresponding data results are reported in Tables 30 and 31.

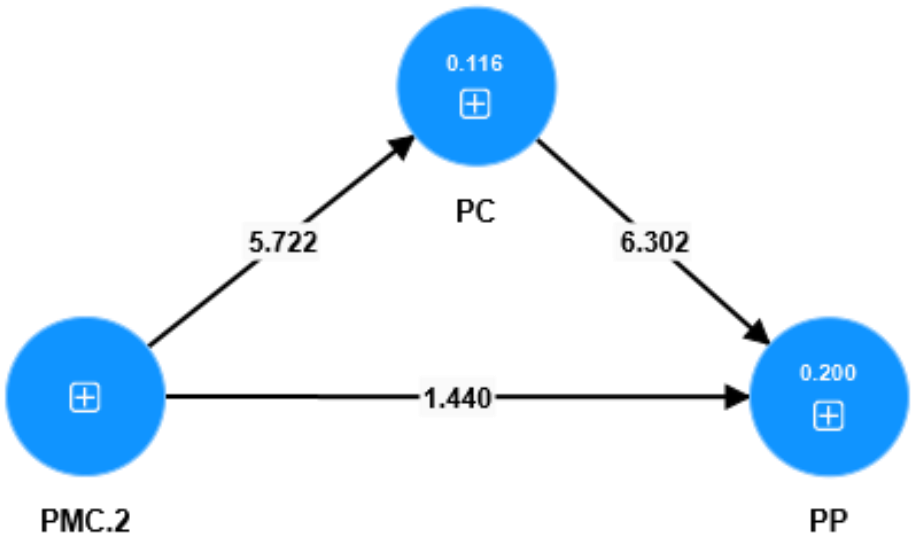

Figure 15: M3 path model with t-scores on paths

Source: own research

Table 30: Hypothesis results for the M3 model

Hypothesis Code	***Null/ Hypothesis***	***Hypothesis***	***Results***
H3	$H_0.3$	*There are no significant relationships between the exogenous variable Technical and Professional Competencies and the endogenous variable project performance.*	Rejected Null
	$H_1.3$	*There are significant relationships between the exogenous variable Technical and Professional Competencies and the endogenous variable project performance.*	
H3.1	$H_0.3.1$	*There are no significant relationships between the exogenous variable Technical and Professional Competencies and the endogenous variable project performance.*	*Accepted Null*
	$H_1.3.1$	*There are significant relationships between the exogenous variable Technical and Professional Competencies and the endogenous variable project performance.*	
H3.2	$H_0.3.2$	*There are no significant relationships between the exogenous variable Technical and Professional Competencies and the mediating variable project complexity.*	Rejected Null
	$H_1.3.2$	*There are significant relationships between the exogenous variable Technical and Professional Competencies and the mediating variable project complexity.*	

Hypothesis Code	*Null/ Hypothesis*	*Hypothesis*	*Results*
H3.3	H_0.3.3	*There are no significant relationships between the mediating variable project complexity and the endogenous variable project performance.*	Rejected Null
	H_1.3.3	*There are significant relationships between the mediating variable project complexity and the endogenous variable project performance.*	

Source: own research

Table 31: Bootstrap results of paths of M3

Hypothesis ID	*Path code*	*Model Path*	*t-score*	*p-value*
H3.1	*a*	*PMC2 »» » PC*	5.722	0.000
H3.2	*b*	*PC »»»»»»» PO*	6.302	0.000
H3.3	*c*	*PMC2 »»» PO*	1.440	**0.150**

Source: own research

Similar to Model M2, the bootstrap analysis for M3 revealed that the indirect paths a and b were statistically significant, while the direct effect from Technical and Professional Competencies to project performance (path c) was not significant at the $p < .05$ threshold. These results corroborate the mediation framework proposed by Aria (2018), providing empirical support for the conclusion that project complexity fully mediates the relationship in this context.

4.5 Follow-up Analysis

This follow-up analysis was conducted to further examine the structure and robustness of Model M1 by simplifying its hierarchical structure. The objective was to determine whether simplifying the PLS-SEM model would lead to any significant changes in the hypothesis testing outcomes. By removing the third-level latent variables and re-estimating the model paths, the analysis provided additional insight into the consistency and reliability of the mediation effects identified in the original model.

4.5.1 Simple Structural Model

Divergent outcomes emerged from the mediation testing conducted for models M1, M2, and M3, prompting a need for deeper data analysis to elucidate potential factors contributing to these discrepancies. A notable distinction between M1 and M2-M3 was the replacement of the overarching project management competency construct with its two primary dimensions, Soft Skills and Personal Competencies, and Technical and Professional Competencies. This allowed a deeper examination of the mediation role of project complexity in distinct competency areas. These variables were analyzed independently in separate models, yielding support for the mediation hypothesis. The inconclusive findings hinted at potential issues with the latent variable construct for project management competencies.

To further scrutinize the study constructs, a simplified model was devised, denoted as M1s, wherein all first-order latent variable indicators were extracted and directly loaded onto the constructs of project management competencies and project complexity. The structure of the simplified model is depicted in Figure 16. Subsequently, the PLS-SEM analysis was re-executed using this simplified model, followed by an assessment of model validity and a reevaluation of the hypotheses about research question Q.1. The outcomes of the model iterations are detailed in Tables 32 and 33.

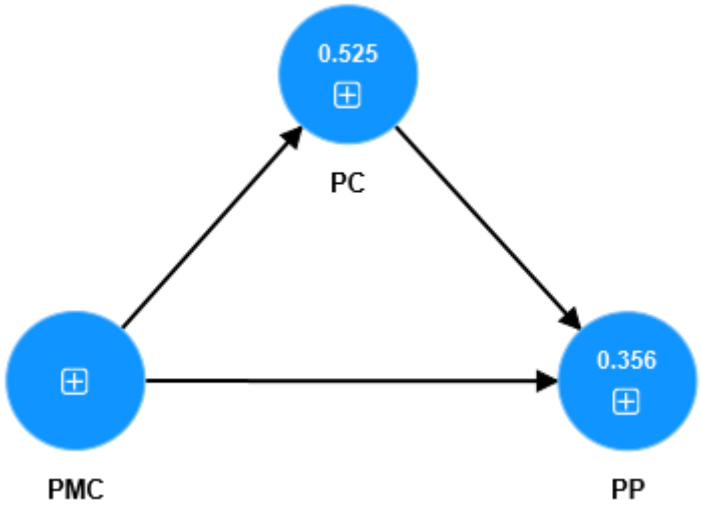

Figure 16: Simple Model (Follow-up Analysis) M1s-related indicators loaded directly on study constructs

Source: own research

Table 32: Model M1s (Follow-up Analysis) Coefficient of Determination R^2

	Model M1		***Model M1s***	
Study Construct	***R^2***	***R^2 Adjusted***	***R^2***	***R^2 Adjusted***
PC	0.174	0.171	0.526	0.524
PP	0.198	0.182	0.351	0.345

Source: own research

Table 33: Model M1s (Follow-up Analysis) Effect Size f^2

	Model M1			***Model M1s***		
Study Construct	***PMC***	***PC***	***PP***	***PMC***	***PC***	***PP***
PMC		0.011	0.021		1.111	0.195
PC			0.141			0.007
PP						

Source: own research

The analysis of Model M1 and Model M1s (Follow-up Analysis) in terms of R^2 and f^2 values shows significant changes in predictive power and effect sizes. According to Table 32, the R^2 value for "PC" (Project Complexity) increased from 0.174 in Model M1 to 0.526 in Model M1s, indicating a substantial improvement in the explanatory power from weak to moderate. Similarly, for "PP" (Project Performance), the R^2 value rose from 0.198 to 0.351, reflecting enhanced predictive strength.

In Table 33, the effect size (f^2) values demonstrate improvements as well. For the relationship between "PMC" (Project Management Competencies) and "PC," the effect size increased from a minimal 0.011 in Model M1 to a large 1.111 in Model M1s. For the relationship between "PMC" and "PP," the f^2 value rose from 0.021 to 0.195, indicating a shift from a small to a moderate effect. However, the effect size for the path between "PC" and "PP" in Model M1s is 0.007, which suggests a small effect size, potentially indicating reduced significance in this path's influence compared to the direct effects of "PMC."

Overall, the enhancements in R^2 and f^2 values across the models highlight an improvement in the model's predictive capability and effect size for key constructs, aligning with the guidelines by Aria (2018) regarding explanatory and effect size thresholds.

Indicator validity, as shown in Table 34, was assessed using the thresholds of $p < 0.05$ and VIF < 5 (Martinez Avila et al., 2021). Examination of indicator relevance revealed certain discrepancies, particularly concerning the outer loadings of indicators associated with the project complexity and project management competencies constructs. The outer loadings were not used as the primary criterion for indicator relevance; they were inspected only as a redundancy check. Nonetheless, analysis of VIF and t-scores indicated that 106 out of 120 indicators for project complexity and project management competencies successfully passed at least one of the tests for indicator relevance.

Table 34: Indicator Validity for Model M1s

Variable Indicator	***Code***	***VIF***	***Outer Weights***	***P value***	***Indicator relevancy***
Orientation	PMC.1.1	1.990	0.864	0.000	Relevant
Commitment	PMC.1.2	1.829	0.538	0.000	Relevant
Initiative	PMC.1.3	1.903	**0.347**	**0.077**	**Irrelevant**
Confidence	PMC.1.4	1.574	0.791	0.000	Relevant
Openness	PMC.1.5	1.668	0.291	0.000	Relevant
Detailist	PMC.1.6	1.990	0.612	0.000	Relevant
Courage	PMC.1.7	1.743	0.902	0.000	Relevant
Sense of humor	PMC.1.8	1.956	0.157	0.000	Relevant
Multitask and discipline	PMC.1.9	1.904	0.315	0.000	Relevant
Leadership	PMC.2.10	1.503	0.789	0.000	Relevant
Conflict management	PMC.2.11	1.652	0.647	0.000	Relevant
Influence/persuasion	PMC.2.12	1.592	0.362	0.000	Relevant
Motivating others	PMC.2.13	1.524	0.058	0.000	Relevant
Negotiation	PMC.2.14	1.741			
Charisma	PMC.2.15	1.552	0.543	0.000	Relevant
Stress management	PMC.3.16	1.690	0.894	0.000	Relevant
Interpersonal skills	PMC.3.17	1.631	0.276	0.000	Relevant

Variable Indicator	*Code*	*VIF*	*Outer Weights*	*P value*	*Indicator relevancy*
Interpersonal sensitivity	PMC.3.18	1.422	0.482	0.000	Relevant
Self-awareness	PMC.3.19	1.656	0.735	0.000	Relevant
Self-motivation	PMC.3.20	1.764	**0.115**	**0.685**	**Irrelevant**
Empathy	PMC.3.21	1.479	0.667	0.000	Relevant
Ethics	PMC.4.22	1.529	0.591	0.000	Relevant
Accountability	PMC.4.23	1.651	0.210	0.000	Relevant
Problem-solving	PMC.5.24	1.636	0.974	0.000	Relevant
Creativity and innovativeness	PMC.5.25	1.568	0.783	0.000	Relevant
Decision-making	PMC.5.26	1.574	0.105	0.012	Relevant
Critical analysis	PMC.5.27	1.490	0.392	0.000	Relevant
Strategic perspective and system thinking	PMC.5.28	1.753	0.840	0.000	Relevant
Vision and imagination	PMC.5.29	1.723	0.668	0.000	Relevant
Intuitiveness	PMC.5.30	1.724	0.249	0.000	Relevant
Learning	PMC.5.31	1.629	0.926	0.000	Relevant
Manage human resources	PMC.6.32	1.763	0.713	0.000	Relevant
Time	PMC.6.33	1.668	**0.389**	**0.070**	**Irrelevant**
Stakeholders	PMC.6.34	1.650	0.406	0.000	Relevant
Risk	PMC.6.35	1.901	0.813	0.000	Relevant
Quality	PMC.6.36	1.810	0.023	0.000	Relevant
Cost	PMC.6.37	1.556	0.547	0.000	Relevant
Procurement	PMC.6.38	1.790	0.456	0.000	Relevant
Scope	PMC.6.39	1.956	0.684	0.000	Relevant
Resource	PMC.6.40	1.679	0.791	0.010	Relevant
Communication	PMC.6.41	1.736	0.359	0.000	Relevant
Requirements	PMC.6.42	1.539	**0.398**	**0.086**	**Irrelevant**
Integration	PMC.6.43	1.603	0.170	0.000	Relevant
Methods	PMC.6.44	1.756	0.989	0.000	Relevant
Client/customer management	PMC.6.45	2.132	0.652	0.000	Relevant
Health and safety management	PMC.6.46	1.995	0.748	0.000	Relevant
Knowledge management	PMC.6.47	1.463	0.332	0.000	Relevant
Change management	PMC.6.48	1.747	0.824	0.000	Relevant
Supply chain management	PMC.6.49	1.459	0.119	0.000	Relevant
Technical expertise	PMC.7.50	1.744	0.301	0.000	Relevant
Experience	PMC.7.51	1.868	0.977	0.000	Relevant
Business expertise	PMC.7.52	1.899	0.408	0.000	Relevant

Variable Indicator	*Code*	*VIF*	*Outer Weights*	*P value*	*Indicator relevancy*
Administrative expertise	PMC.7.53	1.688	0.630	0.000	Relevant
Adaptability	PMC.8.54	1.762	0.298	0.000	Relevant
Contextual awareness	PMC.8.55	1.574	0.521	0.000	Relevant
Strategic alignment	PMC.8.56	1.654	0.256	0.000	Relevant
Political awareness	PMC.8.57	1.642	**0.439**	**0.427**	**Irrelevant**
Networking	PMC.8.58	1.903	0.387	0.000	Relevant
Monitor and control	PMC.9.59	1.593	0.914	**0.087**	**Irrelevant**
Planning	PMC.9.60	1.597	0.019	0.000	Relevant
Directiveness	PMC.9.61	1.621	0.633	0.000	Relevant
Organization	PMC.9.62	1.439	0.854	0.000	Relevant
Coordination	PMC.9.63	1.876	0.279	0.000	Relevant
Prioritization	PMC.9.64	1.732	0.426	0.000	Relevant
Verbal	PMC.10.65	1.609	0.497	0.000	Relevant
Written	PMC.10.66	1.521	0.806	0.000	Relevant
Listening	PMC.10.67	1.598	**0.282**	**0.526**	**Irrelevant**
Multi-level	PMC.10.68	1.564	0.930	0.000	Relevant
Open	PMC.10.69	1.477	0.546	0.000	Relevant
Clear, direct, and concise	PMC.10.70	1.469	0.198	0.000	Relevant
Engaging	PMC.10.71	1.681	0.623	0.000	Relevant
Multi-cultural	PMC.10.72	1.437	0.902	0.000	Relevant
Contextual communication	PMC.10.73	1.517	0.719	0.000	Relevant
Presentation skills	PMC.10.74	1.872	0.285	0.000	Relevant
Collaboration	PMC.11.75	1.653	**0.372**	**0.111**	**Irrelevant**
Support	PMC.11.76	1.789	0.495	0.000	Relevant
Developing others	PMC.11.77	1.462	0.153	0.000	Relevant
Team building	PMC.11.78	1.429	0.783	0.000	Relevant
Delegation	PMC.11.79	1.400	0.415	0.000	Relevant
Escalation	PMC.11.80	1.328	**0.328**	**0.086**	**Irrelevant**
Trustworthiness	PMC.11.81	1.819	0.812	0.000	Relevant
Vision Clarity	PC.1.1	1.430	0.905	0.000	Relevant
Resource Availability	PC.1.2	1.303	0.192	0.000	Relevant
Autonomy	PC.1.3	1.443	0.551	0.000	Relevant
Scope Clarity	PC.1.4	1.220	0.762	0.000	Relevant
Cross-Disciplinary Integration	PC.1.5	1.235	**0.473**	**0.085**	**Irrelevant**
Familiar Commercial Arrangements	PC.1.6	1.226	0.371	0.000	Relevant
Defined Quality and Regulatory Acceptance Criteria	PC.1.7	1.318	0.994	0.000	Relevant
Attainable Pace	PC.1.8	1.225	0.109	0.000	Relevant

Variable Indicator	*Code*	*VIF*	*Outer Weights*	*P value*	*Indicator relevancy*
Managerial Control Over Human Resources	PC.1.9	1.227	0.459	0.000	Relevant
Full Dedication of Key Personnel	PC.1.10	1.362	0.839	0.000	Relevant
Sufficient Budget Allocation	PC.1.11	1.355	0.405	0.000	Relevant
Well-defined schedule and Resource Plan	PC.1.12	1.288	0.120	0.000	Relevant
Accessibility of Resources	PC.1.13	1.182	**0.222**	**0.0710**	**Irrelevant**
Client-Collaborated Success Measures	PC.1.14	1.187	0.456	0.000	Relevant
Established Supply Chain	PC.1.15	1.316	0.642	0.000	Relevant
Supportive Management Tools	PC.1.16	1.277	0.804	0.000	Relevant
Flexibility of Budget Utilization	PC.1.17	1.231	0.331	0.000	Relevant
Familiarity with Technology	PC.1.18	1.273	0.927	**0.099**	**Irrelevant**
Feasibility of Data Reporting	PC.1.19	1.331	0.577	0.000	Relevant
Defined Lines of Responsibility	PC.1.20	1.224	0.215	0.000	Relevant
Single Country/Time Zone/Language/Currency Context	PC.1.21	1.283	0.695	0.000	Relevant
Clear Sponsorship	PC.2.22	1.292	0.482	0.000	Relevant
Transparent Business Case	PC.2.23	1.269	0.153	0.000	Relevant
Alignment with Strategy	PC.2.24	1.262	0.794	0.000	Relevant
Senior Management Support	PC.2.25	1.213	0.295	0.000	Relevant
Team Collaboration	PC.2.26	1.248	**0.160**	**0.098**	**Irrelevant**
Managerial Experience	PC.2.27	1.365	0.278	0.000	Relevant
Minimal Organizational Change	PC.2.28	1.248	0.543	0.015	Relevant
Unaffected by Change	PC.2.29	1.285	0.926	0.000	Relevant

Variable Indicator	*Code*	*VIF*	*Outer Weights*	*P value*	*Indicator relevancy*
Aligned External Stakeholders	PC.2.30	1.225	0.064	0.000	Relevant
Committed External Stakeholders	PC.2.31	1.304	0.380	0.000	Relevant
Realistic Understanding among Stakeholders	PC.2.32	1.259	0.724	0.000	Relevant
Core Team Decision Authority	PC.2.33	1.196	**0.352**	**0.110**	**Irrelevant**
Schedule Objective (Time Objective)	PP.1	1.015	0.196	0.000	Relevant
Cost Objective	PP.2	1.029	0.587	0.000	Relevant
Quality Objectives	PP.3	1.016	0.893	0.000	Relevant
Technical Specs	PP.4	1.028	0.421	0.000	Relevant
Business Goals	PP.5	1.009	0.743	0.000	Relevant
Stakeholder Satisfaction	PP.6	1.024	0.874	0.000	Relevant

Source: own research

Furthermore, Table 35 presents the bootstrap results utilized for re-testing the hypotheses with the simplified model, indicating continued support for mediation. The support for the mediation hypothesis upon restructuring of the structural model suggests two main implications. Firstly, the outcomes of the simplified model underscore concerns regarding certain indicators constituting the latent constructs of project management competencies and project complexity, raising questions about the original first-order latent variables incorporated in the study. Secondly, it highlights the potential necessity for further refinement of the expanded standard model of project management. There may exist additional relationships or paths that could enhance the predictive power of the model. Therefore, a thorough exploration of factor analysis and path definition is warranted to facilitate the development of a comprehensive project management theory.

Table 35: Bootstrap results of paths of M1s

Hypothesis ID	*Path code*	*Model Path*	*t-score*	*p-value*
H1.1	*a*	*PMC»» PC*	9.090	0.000
H1.2	*b*	*PC»»» PP*	3.648	0.000
H1.3	*c*	*PMC»»» PP*	0.753	0.452

Source: own research

To summarize, the results of hypothesis testing revealed that the original proposition, suggesting that project complexity mediates the relationship between project management competencies and project performance, was supported. Upon substituting project management competencies with the lower-level latent variables Soft Skills and Personal Competencies or Technical and Professional Competencies, or simplifying the model, the mediation hypothesis garnered support. These findings prompt inquiries into the structure of the latent variables and the underlying model, which warrant consideration in future research endeavors.

5. CONCLUSIONS AND RECOMMENDATIONS

This study aimed to investigate the role of project complexity in mediating the relationship between project management competencies and project performance. The findings of this study yielded full support for the hypotheses, which are discussed further in this chapter. Specifically, the chapter covers an analysis of sample characteristics, results of hypothesis testing, and PLS-SEM model outcomes for both primary and secondary research questions, study limitations, implications for project management competencies, recommendations for future research, and concluding remarks.

5.1 Analysis of Sample Characteristics

The demographic data provides valuable insights into the respondents' profiles and their potential influence on responses regarding project management competencies and project performance. The gender distribution, with a male majority (63%), could shape perceptions of leadership and communication styles, as previous studies suggest gender-specific approaches to project management. Age distribution indicates that most respondents are in the 31–40 (40.17%) and 41–50 (37.99%) age ranges, suggesting significant professional experience, which may lead to deeper insights into the complexities of project management. Additionally, the presence of younger (9.17%) and older (51–60) respondents (11.79%) brings a range of perspectives, from innovative approaches to seasoned insights.

The industry background, with 55.02% from software-related fields and 44.98% from non-software sectors, provides a balanced view across sectors, which is essential since project management competencies can vary significantly between industries. The high level of education, with over half holding a master’s degree (52.4%) and 38.43% with bachelor’s degrees, likely enhances respondents' understanding of project management theories, potentially affecting their perceptions of competencies and project complexity. Furthermore, the majority of respondents in middle or supervisory roles (53.71%) offer practical insights from direct experience, while those in senior roles, such as general managers and CEOs, provide strategic viewpoints on the project management landscape.

The data also shows that most respondents manage fewer than 30 subordinates (54.59%), aligning with a middle management focus, where project complexities and team dynamics are often encountered directly. Lastly, the range of industry experience, with 40.61% having 15-25 years and 40.17% having 5-15 years, suggests a broad spectrum of insights, combining both seasoned expertise and fresh perspectives on project management challenges. This diversity across gender, age, sector, education, role, and experience creates a comprehensive respondent base, enhancing the study’s ability to capture the nuanced relationship between project management competencies and performance, especially in managing complex projects within Hungarian organizations.

5.2 Results for Primary and Secondary Research Questions

Tables 3 and 27 present the primary research questions and mediation test results. While Model M1, utilizing latent variables from previous studies, supports the mediation hypothesis, restructuring the model without first-order latent variables led to its support. This indicates structural aspects requiring further consideration to fully address the mediation model. Notably, the negative path coefficient between project complexity and project management competencies, suggesting decreased competency usage with increased project complexity, warrants exploration.

Secondary research questions, as outlined in Table 4, aimed to explore the relationships between project complexity, project management competencies, and project performance further. The results in Tables 29 and 31 supported the mediation hypotheses for Soft Skills and Personal Competencies or Technical and Professional Competencies scenarios, supporting M1 model outcomes. Interestingly, similar path coefficients were observed across M1, M2, and M3 models, with a notable increase in relationship strength upon flattening the model structure. This suggests potential complex interactions requiring deeper investigation and highlights the need for further research to understand the model's stability points and underlying dynamics.

To provide a clear overview of hypothesis testing outcomes, Table 36 summarize the verification or rejection of hypotheses across Models M1, M2, and M3. This concise table complements the detailed statistical results and highlights the overall support or rejection status of each tested relationship.

Table 36: Summary of Hypothesis Verification Results

Model	***Hypothesis***	***Description (short)***	***Result***
M1	H1.1	PMC → Performance	Rejected (No sig. rel.)
	H1.2	PMC → Complexity	Supported
	H1.3	Complexity → Performance	Supported
M2	H2.1	Soft Skills → Performance	Rejected
	H2.2	Soft Skills → Complexity	Supported
	H2.3	Complexity → Performance	Supported
M3	H3.1	Tech/Prof Comp. → Performance	Rejected
	H3.2	Tech/Prof Comp. → Complexity	Supported
	H3.3	Complexity → Performance	Supported

Source: own research

While this study provides valuable insights into the interplay between project complexity, project management competencies, and project performance, it also underscores the need for continued research to refine the model and address unresolved questions regarding latent variable structures and complex interactions.

5.3 Conclusions for Research Question Results

This study has yielded three significant findings. Firstly, the hypothesis proposing that project complexity mediates the relationship between project management competencies and project performance is supported when utilizing the latent constructs proposed by Martinez (2021). Secondly, restructuring the model, as seen in the M1s, M2, and M3 models, led to the support of the mediation hypothesis. This suggests that there exist more intricate relationships among the three foundational constructs of this study. Thirdly, the study has validated a positive association between project management competencies and project outcomes. However, it has revealed an inverse relationship between project complexity and project management competencies. This indicates that as project complexity increases, the utilization of project management competencies decreases. This finding carries significant implications for project management competencies, suggesting that focusing on the application of management competencies could enhance performance in complex projects.

5.4 Limitations

This study encountered limitations across four domains: general limitations, sample limitations, instrument limitations, and limitations in study design.

5.4.1 General Limitations

A significant limitation pertained to the evolving definition of project complexity. The study utilized a recently developed instrument for measuring project complexity (Maylor & Turner, 2017), which was one of the first of its kind. However, the results suggest that the factors encompassed in the instrument may require further scrutiny. Notably, the instrument lacked the emergence dimension of project complexity, indicating potential gaps in its coverage. While this study contributes to the understanding of complexity within its defined context, it does not resolve broader issues surrounding the definition and measurement of project complexity.

5.4.2 Sample Limitations

Accessing an appropriate sample posed another limitation. Unlike prior studies that recruited participants primarily from professional organizations such as the Project Management Institute (2021), this study employed online recruitment methods. While this approach enhanced sample diversity, it also introduced self-selection biases common to online surveys, potentially compromising the generalizability of the findings.

5.4.3 Instrument Limitations

The study was constrained by the maturity of the instruments employed. No standardized instrument validated and widely accepted for measuring the constructs under investigation existed. The measurement model amalgamated various instruments, contributing to the ongoing validation of these tools. However, limitations persisted. Additionally, the exclusion of the emergence dimension from the complexity assessment tool left a notable gap in the study's coverage.

5.4.4 Study Design Limitations

Given the absence of an experimental design, causal relationships could not be established. Although structural equation modeling (SEM) offered insights into variable relationships, it lacked the controlled environment necessary for causal inference, a common limitation in social science research.

5.5 Implications for competencies

Despite mixed results, the study indicated a positive relationship between project management competencies and project outcomes. Notably, it revealed a negative relationship between project complexity and the utilization of project management competencies. This underscores an opportunity for practitioners to enhance performance on complex projects by focusing on competency application.

5.5.1 Practical Implications and Application of the Model

To increase the model’s utility for practitioners, the findings have been translated into actionable guidance. The model can serve as a diagnostic tool for project managers to identify competency strengths and gaps in the context of varying project complexities. For example,

when project complexity scores are high in socio-political dimensions, managers may prioritize contextual and stakeholder management skills, while high technical complexity scores may call for reinforcing technical and analytical competencies. Organizations can integrate the model into training programs, competency assessments, and project planning templates, using the constructs as measurable indicators linked to KPIs such as schedule adherence, cost control, and stakeholder satisfaction. A simplified visual version of the model is included in Appendix 6 to facilitate its adoption by non-academic audiences.

5.6 Future Research Directions

Future research should address these limitations by adopting longitudinal designs to explore the dynamics of project management competencies, complexity, and performance over time. Expanding the scope of the study to include other regions and industries can also enhance the generalizability of the findings. Moreover, further refinement of complexity measurement tools is necessary to capture the full spectrum of complexity dimensions and their impact on project outcomes.

This research aimed to assess the model proposed by Geraldi (2021), which posits that project complexity mediates the relationship between project management competencies and project performance. While the primary research question and supporting mediation hypothesis were upheld, secondary questions and hypotheses were also upheld. Subsequent analysis employing a simplified model corroborated the mediation hypothesis, enhancing model quality and producing larger path coefficients. Overall, the findings fully support the mediation hypothesis, although certain issues warrant further investigation.

The study underscores the significance of project management competencies in achieving favourable project outcomes. However, the current model remains overly general for practical application by practitioners. Further theoretical refinement is necessary to provide practitioners with actionable insights into how complexity affects competencies. The study's identification of a negative relationship between project complexity and management competencies offers practitioners valuable insight, prompting increased awareness and potential improvements in competency application to enhance project performance.

6. NEW SCIENTIFIC RESULTS

This doctoral research contributes to the evolving body of knowledge in project management by deepening the understanding of how project complexity mediates the relationship between project management competencies and project performance, particularly within the context of Hungarian organizations. Through empirical investigation and advanced modeling techniques, I present the following new scientific results:

1. Validation of Project Complexity as a Mediator

I proved that project complexity functions as a mediating factor linking project management competencies to project performance outcomes. Building on the theoretical frameworks of Geraldi (2021) and Maylor & Turner (2017), I concluded that complexity significantly shapes how competencies translate into successful project execution. This mediating effect refines the understanding of project dynamics and reinforces complexity theory as a relevant perspective in project-based research.

2. Enhanced Model Structure Supporting Mediation Hypothesis

I tested multiple model structures (M1, M1s, M2, and M3) using Partial Least Squares Structural Equation Modeling (PLS-SEM) and concluded that the mediation hypothesis remains robust across different configurations. I proved that simplified models without hierarchical latent variables (particularly Model M1s) yielded stronger path coefficients. This demonstrates that overly complex model structures may obscure relationships, and I identified the value of iterative model testing for improving best practices in evaluating complex constructs.

3. Inverse Relationship Between Complexity and Competency Application

I identified a negative relationship between project complexity and the utilization of project management competencies. I concluded that as project complexity increases, the application of competencies tends to decrease. This challenges the conventional assumption that more complex projects demand higher competency deployment. I proved that project managers may face barriers in fully applying their competencies in highly complex environments, which has critical implications for project performance.

4. Sector-Based Insights into Competencies and Complexity

I analyzed data across both software and non-software industries and proved that the interaction between competencies and complexity differs by sector. I concluded that sectoral characteristics influence how competencies are applied and perceived. This finding contributes to contextualizing project management practices and lays the groundwork for developing industry-specific competency frameworks.

5. Refinement of Complexity Measurement Tools

I critically evaluated existing complexity measurement instruments and proved that widely used tools, such as the Complexity Assessment Tool (CAT), fail to account for emergent complexity. I concluded that a refined multidimensional approach is necessary to capture structural, socio-political, and emergent aspects of complexity. This contributes to advancing instrument development and supports methodological innovation in complexity research.

7. SUMMARY

This dissertation explores the mediating role of project complexity in the relationship between project management competencies and project performance, focusing on Hungarian organizations. The research was driven by the increasing challenges associated with complex projects and the necessity of understanding how project management competencies interact with such complexities to influence project outcomes. Using a quantitative, non-experimental research design, the study provides valuable insights into these interactions, contributing significantly to the advancement of project management knowledge and competencies.

The primary objective of this study was to address the gap in understanding the combined effects of project management competencies and project complexity on project performance. Grounded in complexity theory and project management competency models, the study hypothesized that project complexity mediates the relationship between project management competencies and project performance.

To achieve this, data was collected via an online survey targeting certified project management professionals (PMPs) or equivalent practitioners in Hungary. The survey utilized three validated instruments: the Project Management Competencies Questionnaire (PMCQ) for assessing project management competencies, the Complexity Assessment Tool (CAT) for evaluating project complexity, and the Project Performance Questionnaire (PSQ) for measuring project outcomes. A total of 229 valid responses were obtained, ensuring a reliable dataset for analysis.

The study employed Partial Least Squares Structural Equation Modelling (PLS-SEM) to analyze the data. A hierarchical component modeling approach was adopted to test the mediation hypothesis. Three structural models (M1, M1s, and M2) were developed to explore the relationships among project management competencies, project complexity, and project performance. These models were used to address both the primary and secondary research questions, offering a nuanced understanding of the constructs and their interrelationships.

The results of the PLS-SEM analysis provided empirical support for the mediation hypothesis across all structural models. The findings demonstrated that project complexity significantly mediates the relationship between project management competencies and project performance. The M1 model, which included all dimensions of the constructs, confirmed full mediation, while the M1s model refined to exclude first-order latent variables, enhanced the mediation relationship, producing stronger path coefficients and improving model quality.

A notable finding of the study was the inverse relationship between project complexity and the application of project management competencies. This indicates that as project complexity increases, the effective utilization of project management competencies decreases, suggesting that complexity may act as a barrier to the application of these competencies. This challenges the traditional assumption that complex projects naturally require a higher level of competency application and highlights the need for adaptive strategies in managing such environments.

The demographic analysis of respondents revealed a diverse and experienced participant base. Most respondents were in the 31–50 age group, held master's or bachelor's degrees, and occupied middle or supervisory management roles. This demographic composition enhanced the credibility of the study, as these respondents brought both practical experience and theoretical knowledge to their assessments of project management competencies and performance. Additionally, the balanced representation of software (55.02%) and non-software (44.98%) industries provided insights into sector-specific variations in project management competencies.

This research offers several novel contributions to the field of project management. Firstly, it validates project complexity as a mediator in the relationship between project management

competencies and project performance. By employing latent constructs from prior studies, such as those by Saharan (2020), the study deepens the theoretical understanding of how complexity influences competency applications and project outcomes. This finding underscores the importance of considering complexity as a central variable in project management research.

Secondly, the study refines structural equation modeling approaches by demonstrating how different model configurations can enhance the explanatory power of mediation hypotheses. The alternative M1s model, which excludes first-order latent variables, revealed stronger mediation relationships, offering a methodological contribution to the use of SEM in analyzing complex project management constructs.

Another significant contribution is the identification of a negative relationship between project complexity and the utilization of project management competencies. This inverse relationship challenges conventional assumptions and suggests that as projects become more complex, the ability of managers to apply their competencies effectively diminishes. This finding has practical implications, emphasizing the need for innovative strategies to overcome these barriers and improve project outcomes in complex environments.

The sector-specific insights provided by the study also represent a unique contribution. By analyzing responses from both software and non-software industries, the research highlights how the nature of project management competencies and the relationship between complexity and competency application vary across sectors. This lays the foundation for future studies to develop tailored competency models that address the specific needs of different industries.

Finally, the study contributes to the refinement of project complexity measurement tools. It identifies limitations in existing instruments, particularly the omission of the "emergence" dimension, and underscores the need for more comprehensive tools that capture the multifaceted nature of complexity in projects. These contributions collectively enhance the understanding of how project management competencies and complexity influence performance, providing both theoretical and practical value to the field.

The findings of this study have significant implications for both theory and competencies. The research advances complexity theory by empirically demonstrating its applicability to project management contexts, particularly in understanding the mediating role of project complexity. It also provides a nuanced perspective on how competencies interact with complexity to influence performance, offering insights for refining project management models.

Practitioners can benefit from these findings by developing strategies to address the barriers posed by project complexity. The inverse relationship between complexity and competency application underscores the importance of equipping project managers with tools and techniques to navigate complex environments effectively. Additionally, the study's sector-specific insights highlight the need for customized competency models that align with the unique challenges of different industries.

Despite its contributions, the study acknowledges several limitations. The reliance on self-reported data may introduce response bias, and the cross-sectional nature of the research restricts the ability to establish causality. Additionally, the study's focus on Hungarian organizations may limit the generalizability of its findings to other cultural or organizational contexts.

This dissertation provides a comprehensive analysis of the mediating role of project complexity in the relationship between project management competencies and project performance. The findings validate the mediation hypothesis, reveal an inverse relationship between complexity and competency application, and offer sector-specific insights into project management competencies. These contributions advance both the theoretical understanding and practical application of project management principles, providing a robust foundation for future research and strategies to improve project success in complex environments.

8. APPENDICES

8.1 Appendix 1: References

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8.2 Appendix 2. Tables

Table 37: Indicator Validity

Construct	*Indicator*	*VIF*	*Outer Weights*	*p-Values*	*Outer Loadings*	*p-Values*	*Indicator relevancy*
Personal skills and attributes	PMC.1.1	1.990	0.994	0.000	0.231	0.000	Relevant
	PMC.1.2	1.377	0.679	0.000	0.874	0.000	Relevant
	PMC.1.3	1.398	0.044	0.005	0.538	0.000	Relevant
	PMC.1.4	1.574	0.777	**0.060**	**0.456**	**0.076**	**Irrelevant**
	PMC.1.5	1.217	0.462	0.017	0.781	0.000	Relevant
	PMC.1.6	1.129	0.548	0.000	0.293	0.000	Relevant
	PMC.1.7	1.743	0.353	0.022	0.612	0.000	Relevant
	PMC.1.8	1.155	0.530	0.025	0.902	0.000	Relevant
	PMC.1.9	1.378	0.413	0.020	0.157	0.000	Relevant
Influencing skills	PMC.2.10	1.387	0.224	0.009	0.315	0.000	Relevant
	PMC.2.11	1.327	0.982	0.035	0.789	0.000	Relevant
	PMC.2.12	1.318	0.978	0.040	0.647	0.000	Relevant
	PMC.2.13	1.193	0.689	0.040	0.362	0.000	Relevant
	PMC.2.14	1.083	0.054	0.012	0.058	0.000	Relevant
	PMC.2.15						
Emotional skills	PMC.3.16	1.668	0.779	0.029	0.543	0.000	Relevant
	PMC.3.17	1.65	0.450	0.046	0.894	0.000	Relevant
	PMC.3.18	1.118	0.248	0.000	0.276	0.000	Relevant
	PMC.3.19	1.045	0.358	0.000	0.482	0.000	Relevant
	PMC.3.20	1.144	0.531	**0.201**	0.735	0.000	Relevant
	PMC.3.21	1.790	0.403	**0.598**	**0.124**	**0.780**	**Irrelevant**
Professionalism	PMC.4.22	1.070	0.225	0.018	0.667	0.000	Relevant
	PMC.4.23	1.024	0.984	0.000	0.591	0.000	Relevant
Cognitive skills	PMC.5.24	1.024	0.256	0.000	0.210	0.000	Relevant
	PMC.5.25	1.038	0.887	0.018	0.974	0.000	Relevant
	PMC.5.26	1.267	0.076	0.000	0.783	0.000	Relevant
	PMC.5.27	1.756	0.023	0.002	0.105	0.012	Relevant
	PMC.5.28	1.281	0.775	0.000	0.392	0.000	Relevant
	PMC.5.29	1.458	0.772	0.000	0.840	0.000	Relevant
	PMC.5.30	1.068	0.967	0.300	0.668	0.000	Relevant
	PMC.5.31	1.091	0.927	0.080	0.249	0.000	Relevant

Construct	*Indicator*	*VIF*	*Outer Weights*	*p-Values*	*Outer Loadings*	*p-Values*	*Indicator relevancy*
Project management knowledge	PMC.6.32	1.24	0.563	0.016	0.926	0.000	Relevant
	PMC.6.33	1.063	0.772	0.000	0.713	0.000	Relevant
	PMC.6.34	1.868	0.806	**0.400**	**0.489**	**0.069**	**Irrelevant**
	PMC.6.35	1.081	0.580	0.000	0.406	0.000	Relevant
	PMC.6.36	1.688	0.995	**0.635**	0.813	0.000	Relevant
	PMC.6.37	1.762	0.971	0.010	0.023	0.000	Relevant
	PMC.6.38	1.104	0.848	0.000	0.547	0.000	Relevant
	PMC.6.39	1.169	0.458	0.000	0.456	0.000	Relevant
	PMC.6.40	1.302	0.280	0.000	0.684	0.000	Relevant
	PMC.6.41	1.170	0.882	0.000	0.791	0.010	Relevant
	PMC.6.42	1.371	0.958	0.005	0.359	0.000	Relevant
	PMC.6.43	1.122	0.308	0.004	0.499	0.000	Relevant
	PMC.6.44	1.107	0.670	0.002	0.170	0.000	Relevant
	PMC.6.45	1.223	0.600	0.000	0.989	0.000	Relevant
	PMC.6.46	1.450	0.364	0.017	0.652	0.000	Relevant
	PMC.6.47	1.149	0.218	0.000	0.748	0.000	Relevant
	PMC.6.48	1.323	0.273	0.000	0.332	0.000	Relevant
	PMC.6.49	1.327	0.331	0.025	0.824	0.000	Relevant
Knowledge and experience	PMC.7.50	1.090	0.994	0.029	0.119	0.000	Relevant
	PMC.7.51	1.564	0.657	**0.081**	0.301	0.000	Relevant
	PMC.7.52	1.477	0.000	0.030	0.977	0.000	Relevant
	PMC.7.53	1.019	0.702	0.040	0.408	0.000	Relevant
Contextual skills	PMC.8.54	1.266	0.838	0.016	0.630	0.000	Relevant
	PMC.8.55	1.233	0.814	0.023	0.298	0.000	Relevant
	PMC.8.56	1.324	0.995	0.045	0.521	0.000	Relevant
	PMC.8.57	1.067	0.788	0.047	0.256	0.000	Relevant
	PMC.8.58	1.370	0.980	**0.920**	**0.439**	**0.427**	**Irrelevant**
Management skills	PMC.9.59	1.789	0.112	0.000	0.387	0.000	Relevant
	PMC.9.60	1.008	0.186	**0.652**	0.914	**0.081**	**Irrelevant**
	PMC.9.61	1.429	0.768	**0.095**	0.019	0.000	Relevant
	PMC.9.62	1.254	0.978	0.020	0.633	0.000	Relevant
	PMC.9.63	1.169	0.809	0.000	0.854	0.000	Relevant
	PMC.9.64	1.561	0.832	0.000	0.279	0.000	Relevant
Communication skills	PMC.10.65	1.032	0.337	0.018	0.426	0.000	Relevant
	PMC.10.66	1.652	0.685	0.000	0.497	0.000	Relevant
	PMC.10.67	1.024	0.574	0.002	0.806	0.000	Relevant
	PMC.10.68	1.267	0.388	**0.052**	**0.282**	**0.526**	**Irrelevant**

Construct	*Indicator*	*VIF*	*Outer Weights*	*p-Values*	*Outer Loadings*	*p-Values*	*Indicator relevancy*
Team working skills	PMC.10.69	1.053	0.325	0.000	0.930	0.000	Relevant
	PMC.10.70	1.552	0.748	**0.250**	0.546	0.000	Relevant
	PMC.10.71	1.366	0.671	0.004	0.198	0.000	Relevant
	PMC.10.72	1.309	0.893	0.019	0.623	0.000	Relevant
	PMC.10.73	1.285	0.477	0.000	0.902	0.000	Relevant
	PMC.10.74	1.656	0.094	0.000	0.719	0.000	Relevant
	PMC.11.75	1.482	0.751	0.000	0.285	0.000	Relevant
	PMC.11.76	1.042	0.596	**0.700**	**0.372**	**0.111**	**Irrelevant**
	PMC.11.77	1.032	0.588	0.011	0.495	0.000	Relevant
	PMC.11.78	1.651	0.894	0.002	0.153	0.000	Relevant
	PMC.11.79	1.636	0.654	0.000	0.783	0.000	Relevant
	PMC.11.80	1.568	0.401	0.003	0.415	0.000	Relevant
	PMC.11.81	1.574	0.126	0.000	0.328	0.000	Relevant
Structural Complexity	PC.1.1	1.225	0.811	0.001	0.812	0.000	Relevant
	PC.1.2	1.218	0.241	0.004	0.905	0.000	Relevant
	PC.1.3	1.184	0.777	0.005	0.192	0.000	Relevant
	PC.1.4	1.177	0.769	0.000	0.551	0.000	Relevant
	PC.1.5	1.194	0.414	0.000	0.762	0.000	Relevant
	PC.1.6	1.171	0.048	**0.101**	**0.473**	**0.085**	**Irrelevant**
	PC.1.7	1.224	0.753	0.021	0.371	0.000	Relevant
	PC.1.8	1.229	0.776	0.024	0.994	0.000	Relevant
	PC.1.9	1.266	0.292	0.029	0.109	0.000	Relevant
	PC.1.10	1.228	0.292	0.031	0.459	0.000	Relevant
	PC.1.11	1.226	0.038	0.032	0.839	0.000	Relevant
	PC.1.12	1.22	0.090	0.030	0.405	0.000	Relevant
	PC.1.13	1.187	0.451	0.040	0.120	0.000	Relevant
	PC.1.14	1.103	0.521	0.049	0.722	0.000	Relevant
	PC.1.15	1.141	0.085	0.041	0.456	0.000	Relevant
	PC.1.16	1.225	0.224	**0.086**	0.642	0.000	Relevant
	PC.1.17	1.227	0.064	0.000	0.804	0.000	Relevant
	PC.1.18	1.362	0.787	0.000	0.331	0.000	Relevant
	PC.1.19	1.174	0.515	**0.308**	0.927	**0.099**	**Irrelevant**
	PC.1.20	1.108	0.055	0.080	0.577	0.000	Relevant
	PC.1.21	1.187	0.233	0.019	0.215	0.000	Relevant
Sociopolitical Complexity	PC.2.22	1.261	0.865	0.000	0.695	0.000	Relevant
	PC.2.23	1.096	0.899	0.000	0.482	0.000	Relevant
	PC.2.24	1.262	0.683	0.015	0.153	0.000	Relevant
	PC.2.25	1.065	0.568	0.003	0.794	0.000	Relevant
	PC.2.26	1.092	0.496	0.002	0.295	0.000	Relevant
	PC.2.27	1.365	0.091	**0.335**	**0.159**	**0.086**	**Irrelevant**

Construct	*Indicator*	*VIF*	*Outer Weights*	*p-Values*	*Outer Loadings*	*p-Values*	*Indicator relevancy*
Project Performance	PC.2.28	1.248	0.685	0.000	0.278	0.000	Relevant
	PC.2.29	1.281	0.925	**0.418**	0.543	0.015	Relevant
	PC.2.30	1.225	0.847	**0.091**	0.926	0.000	Relevant
	PC.2.31	1.05	0.056	0.019	0.064	0.000	Relevant
	PC.2.32	1.259	0.542	0.000	0.380	0.000	Relevant
	PC.2.33	1.196	0.477	0.000	0.724	0.000	Relevant
	PP.1	1.015	0.534	0.000	0.352	0.000	Relevant
	PP.2	1.029	0.252	0.025	0.196	0.000	Relevant
	PP.3	1.016	0.944	0.011	0.587	0.000	Relevant
	PP.4	1.028	0.891	0.000	0.893	0.000	Relevant
	PP.5	1.009	0.808	0.000	0.421	0.000	Relevant
	PP.6	1.024	0.231	0.003	0.743	0.000	Relevant

8.3 Appendix 3. Recruitment Email (English)

Subject: Invitation to Participate in Research on Project Management Competencies and Project Performance

Dear Sir/Mam,

I am reaching out to invite you to participate in an academic study as part of a Ph.D. research dissertation at the Hungarian University of Agriculture and Life Sciences, Hungary. This research aims to analyze the relationship between project management competencies and project performance, with a particular focus on the mediation effect of project complexity within Hungarian organizations.

Your expertise and experience in managing projects within complex environments make you an ideal participant for this study. Your insights will be invaluable in helping us understand the factors that contribute to project success and the role of project management competencies in navigating challenges.

Your participation involves completing a short questionnaire, which includes questions about your project management competencies and experiences. Please rest assured that your responses will remain completely anonymous and confidential. All information provided will be used solely for academic purposes and will not be shared with any third parties.

To participate, please follow this link to the questionnaire:
https://forms.gle/riL7UFybdwcLGhnq8

Thank you in advance for your time and contribution to this research. Your involvement will make a significant impact on the findings and potential recommendations in the field of project management and academia.

If you have any questions or require further information, please do not hesitate to contact me.

Warm regards,
Shahbaz Ahmad Saadi
Ph.D. Candidate
Hungarian University of Agriculture and Life Sciences (Formerly SZIE)

8.4 Appendix 4. Recruitment Email (Hungarian)

Tárgy: Felkérés a projektmenedzsment kompetenciákról és projekt teljesítményről szóló kutatásban való részvételre

Kedves!

Szeretném meghívni Önt, hogy vegyen részt egy akadémiai kutatásban, amely a Magyar Agrár- és Élettudományi Egyetem Ph.D. disszertációjának része. A kutatás célja, hogy elemezze a projektmenedzsment kompetenciák és a projekt teljesítmény közötti kapcsolatot, különös tekintettel a projekt komplexitásának közvetítő hatására a magyar szervezetekben.

Mint projektmenedzser, az Ön szakértelme és tapasztalata a komplex projektek vezetésében ideális résztvevővé teszi Önt a kutatás számára. Az Ön véleménye nélkülözhetetlen lesz annak megértéséhez, hogy mely tényezők járulnak hozzá a projektek sikeréhez, valamint hogy a projektmenedzsment kompetenciák milyen szerepet játszanak a kihívások kezelésében.

A részvétel egy rövid kérdőív kitöltését jelenti, amely kérdéseket tartalmaz a projektmenedzsment gyakorlatairól és tapasztalatairól. Kérem, legyen biztos abban, hogy válaszai teljes mértékben névtelenek és bizalmasak maradnak. Az összes megadott információ kizárólag tudományos célokra kerül felhasználásra, harmadik fél részére nem kerül megosztásra.

A részvételhez kérjük, kattintson a következő linkre a kérdőív kitöltéséhez:
https://forms.gle/riL7UFybdwcLGhnq8

Előre is köszönjük az idejét és hozzájárulását ehhez a kutatáshoz. Az Ön részvétele jelentős hatással lesz a projektmenedzsment területén elérhető eredményekre és ajánlásokra.

Ha bármilyen kérdése van, vagy további információra lenne szüksége, kérjük, forduljon hozzám bizalommal a következő elérhetőségen.

Üdvözlettel,
Saadi Shahbaz Ahmad
Ph.D. hallgató

8.5 Appendix 5. Questionnaire

Analysis of the relationship between Project Management Competencies and Project Performance with the Mediation effect of Project Complexity in the context of Hungarian organizations

This questionnaire is part of a Ph.D. research dissertation conducted at the Hungarian University of Agriculture and Life Sciences, Hungary. The study aims to analyze the relationship between project management competencies and project performance, with a focus on the mediation effect of project complexity within Hungarian organizations. Your honest responses to the following questions will help us gain insights into the factors influencing project success and the role of project management competencies in navigating complex project environments. Your anonymity and confidentiality are of utmost importance, and all information provided will be used for academic purposes only.

Section 1 of 4

1. Demographics

Gender:

○ Male ○ Female

Organization Type:

○ Software/IT ○ Non-Software

Education:

○ Post-Doc ○ Doctoral ○ Master's ○ Bachelor's

Designation/Position in your Organization:

○ Owner/CEO/Shareholder ○ General Manager/Top-level Management ○ Middle/Supervisor level Management

Number of staff (employees) under your supervision:

○ Less than 30 ○ 30-50 ○ 50-100 ○ More than 100

Age (Years) (Select your age group):

○ Less than 30 ○ 30-40 ○ 40-50 ○ 50-60 ○ More than 60

Experience in this Industry (In Years):

○ Less than 1 ○ 1-5 ○ 5-10 ○ 10-20 ○ More than 20

Section 2 of 4

2. Project Management Competencies

Project management competencies refer to the knowledge, skills, and abilities that individuals possess to effectively plan, organize, execute, and control projects to achieve desired outcomes within specified constraints such as time, budget, and scope.

Soft Skills and Personal Competencies

Here are some Soft Skills and Personal Competencies a project manager should possess for better delivery of project performance. Please rate the influence of these Technical Skills/competencies on project success or performance.

Personal skills and attributes

Orientation: Do you demonstrate a clear orientation towards project goals and objectives?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Commitment: Are you committed to achieving project success?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Initiative: Do you take initiative in identifying and addressing project challenges?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Confidence: Do you exhibit confidence in your ability to manage project tasks and responsibilities?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Openness: Are you open to feedback and suggestions for improving project outcomes?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Detailist: Do you pay attention to detail in project planning and execution?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Courage: Do you demonstrate courage in tackling difficult project situations?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Sense of Humor: Do you possess a sense of humor that helps maintain morale within the project team?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Multi-task and Discipline: Are you capable of multitasking and maintaining discipline in project execution?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Influencing skills

Leadership: Do you exhibit leadership qualities that inspire and guide the project team?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Conflict management: Can you effectively manage conflicts that arise during project execution?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Influence/Persuasion: Are you skilled in influencing and persuading stakeholders to support project initiatives?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Motivating others: Do you motivate team members to perform at their best?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Negotiation: Are you proficient in negotiation techniques to resolve project-related issues?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Charisma: Do you possess charisma that enables you to positively influence project stakeholders?

Emotional skills

Stress management: Can you manage stress effectively while handling project challenges?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Interpersonal skills: Are you adept at building and maintaining interpersonal relationships within the project team?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Interpersonal sensitivity: Do you demonstrate sensitivity to the feelings and perspectives of others?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Self-awareness: Are you self-aware of your strengths, weaknesses, and areas for improvement?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Self-motivation: Are you self-motivated to achieve project objectives without external prompting?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Empathy: Do you empathize with the concerns and challenges faced by project team members?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Stress management: Can you manage stress effectively while handling project challenges?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Interpersonal skills: Are you adept at building and maintaining interpersonal relationships within the project team?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Interpersonal sensitivity: Do you demonstrate sensitivity to the feelings and perspectives of others?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Self-awareness: Are you self-aware of your strengths, weaknesses, and areas for improvement?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Empathy: Do you empathize with the concerns and challenges faced by the project team?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Professionalism

Ethics: Do you adhere to ethical principles and standards in project management?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Accountability: Are you accountable for your actions and decisions throughout the project lifecycle?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Cognitive Skills

Problem-solving: Are you proficient in problem-solving techniques to address project challenges?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Creativity and innovativeness: Are you creative and innovative in proposing solutions to project issues?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Decision Making: Do you make decisions promptly and effectively in project situations?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Critical Analysis: Are you capable of critically analyzing project information to inform decision-making?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Strategic perspective and system thinking: Do you possess a strategic perspective and systems-thinking approach to project management?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Vision and imagination: Can you envision and articulate the strategic direction of the project?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Intuitiveness: Are you intuitive in identifying emerging project trends and issues?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Learning: Are you committed to continuous learning and professional development?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Problem solving: Are you proficient in problem-solving techniques to address project challenges?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Creativity and innovativeness: Are you creative and innovative in proposing solutions to project issues?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Decision-making: Do you make decisions promptly and effectively in project situations?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Critical analysis: Are you capable of critically analyzing project information to inform decision-making?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Strategic perspective and system thinking: Do you possess a strategic perspective and systems-thinking approach to project management?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Vision and imagination: Can you envision and articulate the strategic direction of the project?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Intuitiveness: Are you intuitive in identifying emerging project trends and issues?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Technical and Professional Competencies

Here are some technical and professional competencies a project manager should possess for better delivery of project performance. Please rate the influence of these technical skills/competencies on project success or performance.

Project Management Knowledge

Manage Human Resources: Can you effectively manage the human resources allocated to the project?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Time: Are you capable of managing project timelines and schedules?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Stakeholders: Can you identify and manage stakeholders' expectations throughout the project?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Risk: Are you skilled in identifying and mitigating project risks?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Quality: Do you prioritize project quality to meet or exceed stakeholder expectations?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Cost: Can you effectively manage project costs within budgetary constraints?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Procurement: Do you possess the procurement skills necessary for acquiring project resources?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Scope: Are you capable of defining and managing project scope effectively?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Resource: How effectively do you allocate and manage resources to support project objectives?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Communication: How proficient are you in communicating project-related information to stakeholders?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Requirements: Can you allocate project resources optimally to meet project requirements?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Integration: Are you proficient in communication methods relevant to project management?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Methods: Can you effectively integrate project components to achieve project objectives?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Client/Customer Management: Do you manage client or customer relationships effectively during project execution?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Health and Safety Management: Are you committed to ensuring health and safety standards are met within the project?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Knowledge Management: Can you effectively manage knowledge relevant to project activities?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Change Management: Are you skilled in managing change within the project environment?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Supply Chain Management: Can you manage the supply chain effectively to support project needs?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Knowledge and experience

Technical Expertise: Do you possess technical expertise relevant to the project domain?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Experience: Do you have sufficient experience to effectively manage project activities?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Business Expertise: Are you knowledgeable about the business aspects relevant to the project?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Administrative Expertise: Do you have the administrative skills necessary for project coordination and execution?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Contextual Skills

Administrative Expertise: Do you have the administrative skills necessary for project coordination and execution?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Contextual Skills

Adaptability: Can you adapt to changing project requirements and circumstances?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Contextual Awareness: Do you possess contextual awareness of project environments and constraints?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Strategic Alignment: Can you ensure strategic alignment of project activities with organizational goals?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Political Awareness: Are you politically aware of organizational dynamics that may impact the project?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Networking: Can you build and leverage networks to support project objectives?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Adaptability: Can you adapt to changing project requirements and circumstances?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Contextual Awareness: Do you possess contextual awareness of project environments and constraints?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Strategic Alignment: Can you ensure strategic alignment of project activities with organizational goals?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Political Awareness: Are you politically aware of organizational dynamics that may impact the project?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Networking: Can you build and leverage networks to support project objectives?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Management Skills

Monitor and Control: Do you effectively monitor and control project progress against established metrics?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Planning: Can you develop comprehensive project plans to guide project execution?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Directiveness: Are you directive in providing clear guidance and instructions to project team members?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Organization: Can you organize project activities and resources efficiently?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Coordination: Do you coordinate project activities across multiple stakeholders and teams?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Prioritization: Can you prioritize project tasks based on their importance and urgency?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Communication Skills

Verbal: Are you proficient in verbal communication to convey project-related information effectively?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Written: Can you communicate project-related information clearly, directly, and concisely in writing?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Listening: Do you actively listen to input and feedback from project team members and stakeholders?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Multi-level: Are you skilled in managing communication across multiple levels within the project hierarchy?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Open: Do you foster open communication channels within the project team?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Clear, **direct**, **and concise**: How often do you communicate project information clearly, directly, and concisely?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Engaging: Can you deliver engaging presentations to communicate project updates and findings?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Multi-cultural: Are you capable of communicating effectively in a multicultural project environment?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Contextual communication: Can you adapt communication strategies based on project-specific contextual factors?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Presentation skills: How skilled are you in delivering effective presentations to project stakeholders?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Team Working Skills

Collaboration: Are you proficient in collaborating with project team members to achieve project goals?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Support: Do you provide support and assistance to team members to help them achieve their objectives?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Developing Others: Are you effective in developing the skills and capabilities of project team members?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Team Building: Can you build cohesive and high-performing project teams?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Delegation: Are you proficient in delegating tasks and responsibilities to appropriate team members?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Escalation: Do you escalate project issues and concerns to higher authorities when necessary?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Trustworthiness: Do you demonstrate trustworthiness and reliability in your interactions with the project team?

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Section 3 of 4

3. Project Complexity

Project complexity refers to the level of intricacy, uncertainty, and interdependencies inherent in a project, including factors such as the number of stakeholders involved, technical challenges, organizational complexity, and environmental uncertainties.

Structural Complexity

Structural complexity refers to the intricate and interconnected nature of project components, requiring detailed coordination and management for effective project execution.

Vision Clarity: The work's vision and benefits were clearly articulated.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Resource Availability: There were sufficient individuals with the necessary skills available.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Autonomy: The work was independent of other projects and business-as-usual operations.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Scope Clarity: The scope of the work was well defined.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Cross-Disciplinary Integration: Integration across multiple technical disciplines was not necessary.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Familiar Commercial Arrangements: The commercial arrangements were familiar to us.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Defined Quality and Regulatory Acceptance Criteria: Acceptance criteria for quality and regulatory requirements were clearly defined.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Attainable Pace: The pace of work was attainable.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Managerial Control Over Human Resources: Managers had adequate control over human resources (i.e., direct reporting).

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Full Dedication of Key Personnel: Key personnel were fully dedicated to the work.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Sufficient Budget Allocation: The budget allocated for the task was sufficient.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Well-Defined Schedule and Resource Plan: A schedule and resource plan were well-defined.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Accessibility of Resources: Resources (e.g., test facilities, equipment) were accessible when needed.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Client-Collaborated Success Measures: Success measures for the work were defined in collaboration with the client.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Established Supply Chain: The supply chain was established.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Supportive Management Tools: Existing management tools could support the work.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Flexibility of Budget Utilization: The budget could be utilized flexibly.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Familiarity with Technology: The technology involved was familiar to us.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Feasibility of Data Reporting: Accurate, timely, and comprehensive data reporting was feasible.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Defined Lines of Responsibility: Lines of responsibility for tasks and deliverables were clearly defined.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Single Country/Time Zone/Language/Currency Context: The work was carried out within a single country/time zone/language/currency.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Sociopolitical Complexity

Sociopolitical complexity: The complexity arising from social and political factors within a project environment.

Clear Sponsorship: The work had clear sponsorship consistent with its importance.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Transparent Business Case: The business case for the work was clear.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Alignment with Strategy: The goals for the work are aligned with the organization's strategy.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Senior Management Support: Your senior management supported the work.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Team Collaboration: Team members were motivated and functioned well as a team.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Managerial Experience: Managers were experienced in this kind of work.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Minimal Organizational Change: The work involved no significant organizational or cultural change.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Unaffected by Change: The work was unaffected by significant organizational or cultural change.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Aligned External Stakeholders: The external stakeholders (i.e., not immediate team members) were aligned, supportive, and committed to the project and had sufficient time for the work.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Committed External Stakeholders: The external stakeholders (i.e., not immediate team members) were aligned, supportive, and committed to the project and had sufficient time for the work.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Realistic Understanding among Stakeholders: The external stakeholders (i.e., not immediate team members) had a realistic, shared understanding of the implications of the work.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Core Team Decision Authority: The core team had the authority to make decisions.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

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4. Project Performance

Project Performance: The measure of how well a project meets its objectives and delivers its intended outcomes within specified constraints such as time, budget, and quality.

Schedule Objective (**Time Objective**): The project was completed within the specified timeline, and milestones were achieved according to the schedule.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Cost Objective: The project budget and financial resources were effectively managed.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Quality Objectives: The project met the specified quality standards and requirements.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Technical Specs: The project adhered to the technical specifications and requirements.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Business Goals: The project achieved the predefined business objectives and outcomes.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

Stakeholder Satisfaction: Stakeholders expressed satisfaction with the project outcomes and deliverables.

○ Strongly Disagree ○ Disagree ○ Neither Agree nor Disagree ○ Agree ○ Strongly Agree

8.6 Appendix 6: Practical Implications of the Model

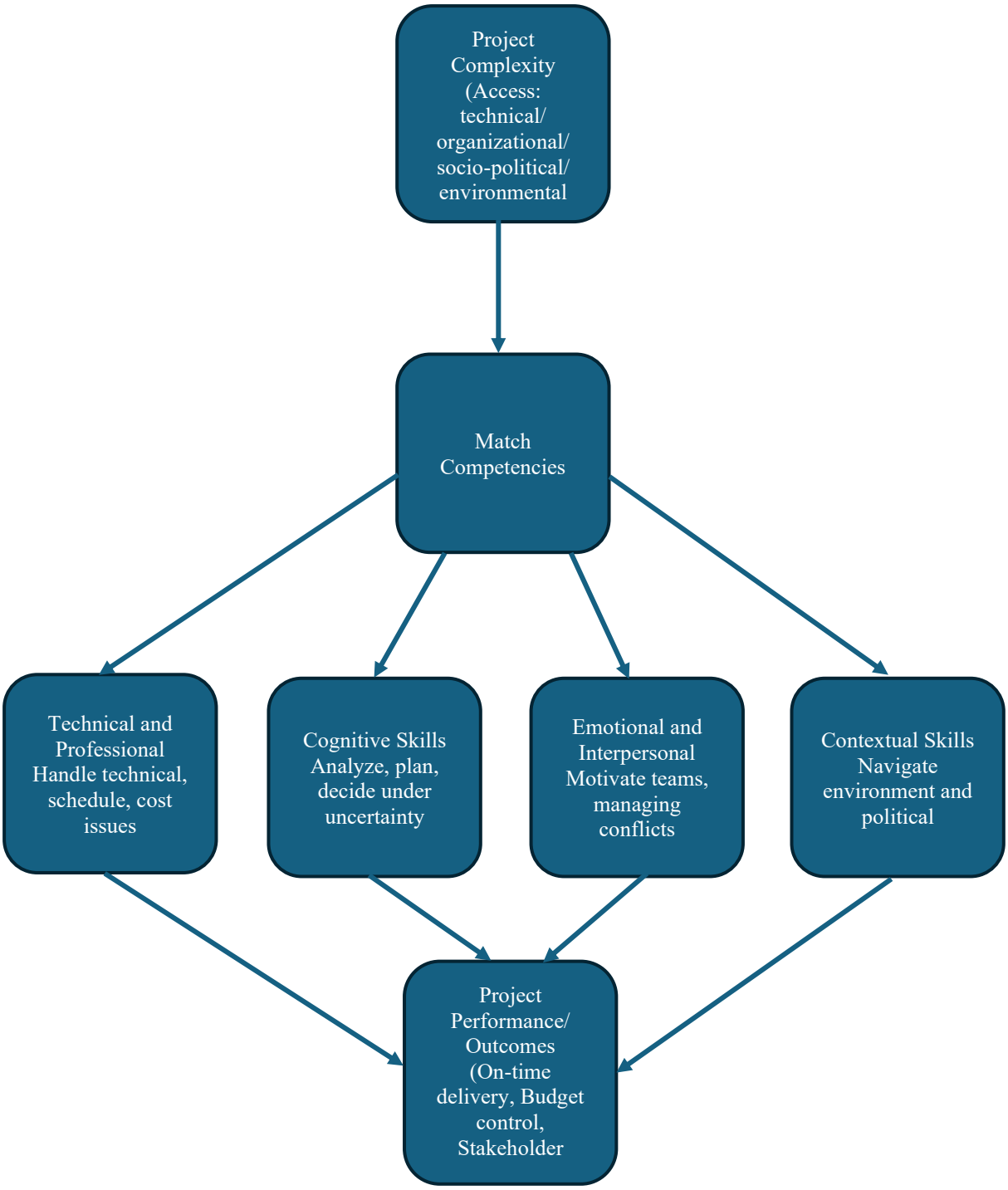

Figure 17: Practitioner-friendly version of the proposed competency–complexity–performance model.

Source: own research

Statement of Original Work

I hereby declare that this dissertation represents my original work and has been conducted by me under the supervision of Dr. Anna Dunay. To the best of my knowledge, this research does not contain any material previously published or written by another person, except where due acknowledgment has been made in the text.

All contributions from other sources, including published works and unpublished collaborations, have been properly cited and credited. Any findings, interpretations, or conclusions presented in this dissertation are my own, unless explicitly stated otherwise.

Acknowledgments

I extend my gratitude to two exceptional mentors who have provided invaluable support throughout this journey. Firstly, I am deeply grateful to Dr. Anna Dunay for her unwavering encouragement and guidance. Dr. Anna, your mentorship has been indispensable, and I am sincerely thankful for your patience and dedication.

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Dedication

This dissertation is dedicated to Muhammad Sharif, my father and an individual I deeply admire. His unwavering patience, steadfast support, and continual encouragement have been instrumental in making this accomplishment possible.