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Multilevel Analysis of Project and Team competencies for Cost and Time Project Management Success in Construction Projects

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ABSTRACT

Purpose: Excessive costs and unexpected schedule setbacks are pervasive challenges encountered by countries globally. Insufficiently skilled teams elevate the risk of project delays. The behavioral dimensions of a project, encompassing intellectual, emotional, and contextual competencies at both individual and project levels, are often overlooked but play a vital role in the success of project management.

Design and Methodology: The study's sample data was gathered from project managers through a survey based on questionnaires. Only completed projects from the construction industry of Pakistan are selected for this study The responses collected serve as the foundation for conducting statistical analysis using multiple regression techniques.

Findings: The study reveals that the project manager's contextual and technical competency, coupled with the intellectual and emotional competence of the team, positively influences the CTPM success of construction projects. Conversely, knowledge and value diversity have been identified as factors with a negative impact on CTPMS. Additionally, Greater project size heightens the risk of delays and cost overruns, attributed to increased time spent on communication and collaboration within larger teams, posing challenges to budget adherence.

Implications: This research addresses the gap in existing literature by conducting a three-level analysis—project-level, project manager-level, and project team-level—to examine their collective impact on project management success, with a specific focus on cost and time considerations. The findings hold significant implications for project managers shedding light on the dynamics influencing the project management success. The manager can make better decisions to execute projects efficiently and cost effectively.

Keywords: Multi-level factors, Project cost and time management success, Construction industry, Project Manager, Project Team

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1. Introduction

A large number of studies in construction sectors have focused on the hard side of the project and rarely discussed the behavioral and soft side of the project (Phua 2013; Bolzan de Rezende et al., 2021). Despite the construction industry plays a pivotal role in the economic growth of the country, still it suffers from "Cost overrun" and "unscheduled delays" (Jin et al., 2012; Ghanbaripour et al., 2015; Yap and Shavarebi, 2022). Various small to large construction projects have been initiated through the "China Pakistan Economic Corridor (CPEC)" and the government of Pakistan's "Self Home Scheme". The last decade has witnessed that the human and behavioral dimension of project management, especially, competencies at the individual (project manager) and team levels is a key area of interest both for practitioners and scholars (Bolzan de Rezende et al., 2021). Given the constant shifts in daily circumstances, each project faces unique challenges that lead to deviations from planned timelines and budgets. Identifying the precise cause of failure becomes intricate due to these varied factors. Therefore, adopting a multi-level framework is essential to evaluate the success of project time and cost, ensuring the sustainability of the construction sector. Recognizing this necessity, professional associations in project management, like PMI and IPMA, have introduced competency models to enhance the effective management of projects (IPMA, 2015). Therefore, the objective of the study is to analyze cost and time management success through a multilevel competency framework.

The second largest growing sector of Pakistan's economy is the construction industry. Due to the distinctive characteristics of construction projects, it is essential to know the significant effect of team diversity to improve project performance (Jehn et al., 2013). Achieving success in construction projects necessitates a range of skills within project teams, encompassing tasks from project initiation and planning to execution, control, closure, and termination. (Ehsan et al., 2010). Team diversity are attribute of people that differentiates them from others and the way to get knowledge from people. According to the Planning Commission of Pakistan, 30,000 engineers and laborers get a chance to work together with national and multinational firms helping them to learn and experience new project management practices (Razzaq et al., 2018).

Construction-related projects become more complicated and need to address interrelated important factors at different levels for project management success concerning time and cost management (Ghanbaripour et al., 2015; Ribeiro et al., 2021; Sanchez et al., 2017). Construction projects have excellent value creation in terms of benefits and huge investment; however, most of the projects do not achieve their goals and are exposed to delays (Venkat Raman, 2019). Delays in construction projects lead to increased overall costs along with an extension in project completion time (Ismaila et al., 2022). The success of construction projects may be influenced by multilevel factors that lead projects to unscheduled delays and cost overruns. The majority of effort is employed to optimize the structure and shorten the time required to complete project activities while ignoring the multilevel behavioral approach for cost and time project success (Sarkar et al., 2021).

The project manager of the construction industry is responsible for controlling costs, therefore, project manager competency directly relates to CTPMS (Arif et al., 2015). The most common issues that the construction industry faces are observed as delays, poor quality, over budget, and lack of human resource competency (Irfan et al., 2021). The study recognizes that the influence of team building on project success is significant, with highly committed and empowered project teams playing a key role. Additionally, the manager's leadership style enhances problem-solving skills and facilitates easier decision-making for the team (Yazdani & Bashir, 2018). Project managers are required to possess both technical expertise and innovation to efficiently oversee project activities and address conflicts. Consequently, a comprehensive set of behavioral, technical, and managerial competencies is essential for project managers to effectively navigate the complexities of project management, ultimately playing a pivotal role in achieving project-related outcomes (Fisher, 2011).

It is evident from the literature that project and team-level factors influence each other (Ozorhon et al., 2022). However, the literature has shown a narrow focus and ignores multilevel analysis in determining project cost and time management success. Empirical evidence regarding predictors of project cost and time management success is scattered and disconnected. Therefore, the cross-level investigation is important to examine how interaction among Project attributes, Project manager, and team-level factors impact time and cost project management success (Sanchez et al., 2017). The increasing interest in this subject has resulted in a literature gap concerning contextual, emotional, intellectual, and behavioral competencies. This study addresses this gap and enhances project management literature by employing a cross-level approach. It analyzes the combined influence of project attributes, individual-level project manager competency (encompassing technical and contextual competencies), and team-level factors such as value diversity, knowledge diversity, emotional competency, and intellectual competency. The goal is to provide a comprehensive perspective on the success of both project and team management.

2. Literature Review

2.1 Project Characteristics

Project management success is highly influenced by the characteristics of the project. Understanding Project characteristics such as the size of the project is essential as it directly influences project management success (Johnson et al., 2013; Songer et al., 1997). It has also been observed that cost overrun is greater in large projects as compared to small projects due to the complexity of such projects (Cantarelli et al., 2012; Lee et al., 2011). The expansion of project size poses challenges in adhering to budget constraints. Larger projects necessitate the allocation of additional staff and resources to meet deadlines, consequently raising the budget.

These larger projects often encounter increased risks and difficulties in coordination and communication. The heightened complexity diminishes the likelihood of achieving success in project management (Taylor et al., 2012). Increased project size requires coordination and it decreases team motivation thus having a negative impact on cost and time project management success. Thus, the following hypothesis is developed

H1a: *Project characteristics have a significant effect on Cost and Time Project Management Success (CTPMS)*

2.2 Project Manager Competencies

Competency is the ability of an individual to mobilize firm resources for expected outcomes (Khattak et al., 2016). Project Manager Competency is described as an ability to integrate technical proficiency and contextual skills such as collaboration with stakeholders, cognitive aptitude, and knowledge sharing (Alvarenga et al., 2019). Numerous authors recognized the importance of project manager competencies for improving project management success (Alvarenga et al., 2019). The project manager has a broader role than just executing project activities such as conflict negotiator, leader, and change agent. Irrespective of the type of project executed, project success is heavily dependent on project managers' competencies during the whole project life cycle (Al-Hajj, 2018; Angelides et al., 2009).

The utilization of competency-based measurement serves as a means to achieve excellence in managerial performance; therefore, it is crucial to prioritize the competency of project managers (Ahadzie et al., 2014). Competencies of project managers, including both technical and contextual skills, contribute to the success of project time and cost management. The selection process of project managers by project establishments is of interest to both construction managers and researchers (Sang et al., 2018). Therefore, technical and contextual competencies should be given prime importance in the selection of a project manager. The project manager needs to be technically competent to address all issues for smooth and successful delivery of the project (Hwang & Ng, 2013). The knowledge, skills, and abilities of project manager in projects regardless of size and complexity is technical competency, which involves project planning, quality assurance, documentation, resource management, and project monitoring. The project manager should combine technical knowledge and expertise to ensure project success (William D. Reisel, 2003). For a successful project manager, it is necessary to have technical knowledge of the project. The hard skills can be learned through training that will help the project manager to understand the technical aspect of the project (do Vale et al., 2018).

A project manager with limited technical knowledge and expertise may struggle to provide effective solutions. Insufficient technical competency in project knowledge raises the project's risk levels, which correlates directly with variations in project costs (Martin et al., 2007). Therefore, this study evaluates the project manager's technical competency for improving project cost and time management success. Thus the following hypothesis is developed:

H2a: *Higher project manager technical competency is associated with high level of cost and time project management success (CTPMS).*

Project success is influenced by the environment in which it is being implemented. The project- driven changes occurring in the environment increase the need for organizations to rely on the contextual skills of project managers (Oh & Choi, 2020). Both technical expertise, authority, and experience remain crucial despite recognizing the significance of soft skills for optimal project manager performance. Success is not guaranteed by relying solely on either hard or soft skills; a combination of both, along with leadership qualities, is essential (Alvarenga et al., 2019). Contextual competency is referred to as key competency that enables project managers to effectively work in different cultural contexts (do Vale et al., 2018; Oh & Choi, 2020). It acts as an integrated system of knowledge and skills, associated with environmental metacognition, to make the right decision regarding contextual factors. Jałocha et al. (2014) emphasize the significance of project managers' contextual competence for the efficient management of projects. The absence of absorptive capacity in a project manager can result in the failure of a construction project. In such scenarios, it becomes imperative for the project manager to enhance their contextual competence to enhance project performance in a complex and uncertain environment (Maqbool et al., 2017). Contextual competence related to project, program, portfolio, and their association with strategic management of the project (Varajão & Cruz-Cunha, 2013). There is limited research on the contextual aspect of PM competence and its linkages with cost and time project management success of the construction project. Therefore, the following hypothesis was formulated

H2b: *Higher project manager contextual competency is associated with high level of cost and time project management success (CTPMS).*

2.3 Project Team Diversity

Success in projects is influenced by a multitude of factors, and employees, being a valuable resource, play a crucial role in ensuring the success of these projects (Rehmani & Hussain, 2018). The contemporary project management literature describes team diversity as a multidimensional phenomenon consisting of several heterogeneities between teams that act as one of the influencing factors for project management (Wu et al., 2019). Team diversity refers to individual attributes of people that differentiate them from others in terms of values, personality, demographic characteristics, and the way to get knowledge from people (Jehn et al., 2013). The diversity of the team can be classified as value and knowledge diversity (Yi et al., 2018). The heterogeneity among project teams in terms of cultural values, beliefs, and behavior is referred to as value diversity. Such type of diversity focuses on common shared goals and prioritization of project objectives (Wu et al., 2019).

It helps to enhance creativity, quality decision-making, and collaboration among team members that essential for project cost and time management success (Kirkman & Shapiro, 2005). Value diversity is employed for comprehension of the behavior of individual team members that influence project cost and time management success.

Therefore, the following hypothesis was formulated to examine the relationship between value diversity and project cost and time management success.

H3a: *Higher levels of project Team value Diversity is associated with Cost and Time Project Management Success (CTPMS).*

Knowledge diversity refers to the collective know-how, technical knowledge, and expertise of individual project team members, which contribute to the establishment of knowledge bases (Zhang & Li, 2016). Sharing of heterogeneous knowledge improves the overall capability of the project which is imperative for cost and time management success (Wu et al., 2019). In construction projects where teams are highly interdependent and share collective responsibility, face rapid changes in the scope of the project due to the client's requirements. Such teams require diversity in the knowledge that is essential for desired project outcomes. The success of a construction project highly depends upon the organization of a specialized and diverse team that can bring their management styles along with experience and skills to achieve joint project objectives (Chen et al., 2012). This study, based on the Knowledge Base View (KBV) theory at the team level, suggests that the influence of knowledge diversity is more pronounced in achieving success in project cost and time management.

H3b: *Higher levels of project Team knowledge Diversity is associated with Cost and Time Project Management Success (CTPMS).*

2.4 Project team competency

The Project team learning process is impacted by their Emotional competence. Project team member who understand other's emotion as well as regulate their own emotion is more likely to adjust to the project environment for expected outcomes. Such competencies provide the foundation for improving project cost and time success (Obradovic et al., 2013; Rezvani et al., 2019). The construction industry is affected due to a lack of behavioral and managerial competencies (Irfan et al., 2021). Leaders displaying aversive behaviors through threats and intimidation create workplace stress, adversely impacting organizational outcomes (Ali et al., 2023). Project managers must consider the importance of intellectual competency rather than just focusing on managerial skills, leadership capability, knowledge, and experience of project team members (Hanna et al., 2016).

The ability of a team member to make decisions depends on their intellectual competency. The intellectual competence of a project team enhances their effectiveness in handling complex situations, thereby reducing uncertainty and the likelihood of project failure. The team's problem-solving ability fosters flexibility in adapting to changes and adjusting accordingly based on the situation (Li et al., 2011). The following hypothesis is developed as

H4a: *Higher levels of project Team emotional competency is linked with higher the levels of the Cost and Time Project Management Success (CTPMS).*

H4b: *Higher levels of project Team intellectual competency, higher the levels of the Cost and Time Project Management Success (CTPMS).*

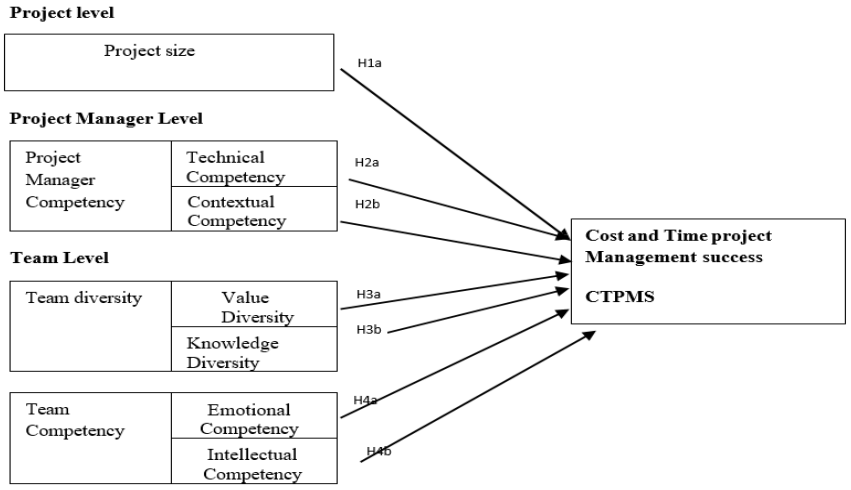

Figure 2.1. Research Model

3. Methodology

3.1 Measures

3.1.1 Dependent Variable

Cost and time Project Management success (CTPMS): In contrary to traditional perceptual measures of Project management success, this study used an incremental marginal perspective for PMS suggested by Sanchez et al. (2017). In this approach, small increments in value are mutually dependent relative to baseline cost and time. The study operationalized CTPMS as the relationship between baseline cost and actual cost that the project incurs multiplied by baseline time and the actual time that the project incurs. It helps us to measure variations in project management success due to antecedents included in this study.

$$Cost\ and\ time\ PMS = \left(\frac{Baseline\ cost}{Actual\ cost}\right).\left(\frac{Baseline\ time}{Actual\ time}\right)$$

3.1.2 Independent variable Project Size:

Numerous measures were used for the operationalization of project characteristics in construction management literature. Project size was used as a proxy for Project characteristics. Project size was measured in terms of project cost and number of people involved in the project team. Each dimension of the project size was collected as a metric variable on the Likert scale. The Cronbach alpha of 0.715 indicates that the construct is internally consistent and reliable.

Project Manager Competency

Project Manager Competency was measured by the level of knowledge about technical and contextual competency at the time of project execution. To evaluate project manager competence for construction projects, this study used the Varajão and Cruz-Cunha (2013) scale to measure technical and contextual competency on 5-point Likert scale.

Team Diversity

Team diversity is classified as value diversity and knowledge diversity. Knowledge team diversity (KTD) is operationalized as differences among team members based on experience, education, and expertise brought to the team. Items for KTD were taken from Wu et al. (2019) scale that was developed to measure KTD in construction projects. The respondents were asked to record their responses on a 5 point Likert scales ranging from strongly disagree to strongly agree. Value team diversity (VTD) was measured through a four-item scale by (Wu et al., 2019).

Team Competency

Team competency was measured through emotional competency and intellectual competency. Nine items were borrowed from Oh and Choi (2020) scale to measure emotional and intellectual project team competency. The Cronbach alpha value indicates that the emotional and intellectual competence of the Project team competence is a reliable construct.

3.1.3 Analytical Procedure

Data was analyzed in three different stages. In the data screening stage, the assumption for multivariate data was evaluated to check the fitness of the data for the proposed hypothesized relationship. In the second step, the reliability of the instrument was evaluated. The correlation analysis was performed to check the relationship between different factors and CTPM. To test for simultaneous effects of multilevel predictors on CTPMS, multiple regression analysis was performed.

3.1.4 Results

Before testing the model and hypothesis, a reliability test was performed for each construct to evaluate the reliability of the instrument. Table 1 exhibits that the instrument is internally consistent and reliable as Cronbach alpha for all constructs is greater than the suggested threshold value of 0.70.

Table 1: Reliability Analysis

S.No	Variables	Questions/Items	Cronbach's Alpha
1	Project size	4	.715
2	Technical Competency	17	.953
3	Contextual competency	11	.938
4	Knowledge Diversity	5	.806
5	Value Diversity	4	.778
6	Emotional Competency	7	.906
7	Intellectual competency	3	.879
	Overall reliability of questionnaire		.804

Table 2 exhibits Pearson correlation to identify relations between variables as a precondition for causal research. The dependent variable CTPMS shows a positive relationship ($p<0.01$) with project size, technical competency, Contextual competency, Emotional competency, and Intellectual competency. The correlational matrix shows a negative but significant association ($p<0.05$) with knowledge diversity, project size, and value diversity.

Table 2: Correlation

	CTPMS	P.S	T.C	C.C	K.D	V.D	E.C	I.C
CTPMS	1							
P.S	.054	1						
T.C	.310**	.578**	1					
C.C	.191**	.579**	.183**	1				
K.D	-.175*	.257*	.175*	.134	1			
V.D	-.059	.554**	.422**	.236**	.095	1		
E.C	.210**	.075	.001	.191**	-.042	-.009	1	
I.C	.305**	.590**	.669**	.230**	.082	.343**	.102	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 3 illustrates the results for testing the proposed hypothesized relationship. Project Size (β= -.101, t=-3.61, p<0.01) shows a negative association with cost and time management success thus supporting H1a. Project manager competency (technical β=.212, t=4.75, p < 0.01; contextual β=-.221, t= 4.10, p<0.01) shows a positive association with cost and time project management success, supporting H2a and H2b. Project Team diversity (Knowledge β=-.047, t=-3.03, p < 0.01; Value β=-.054, t=-2.01, p<0.01) shows a negative significant effect on cost and time project management success and hence partially supported H3a and H4a. Project team Competency (Emotional β=.065, t=-2.34, p <0.01) (Intellectual β=-.074, t= 2.63,p < 0.01) show a positive and significant relationship with cost and time management success, supported H4a and H4b.

Table 3: Multiple Regression

Variables	Unstandardized Co-efficient		t-value	Sig.
	B	Std. Error		
(Constant)	1.953	.153	12.75	.000
Project Size	-.101	.028	-3.61	.000
Technical Competency	.212	.045	4.75	.000
Contextual Competency	.221	.054	4.10	.000
Knowledge Diversity	-.047	.016	-3.03	.003
Value Diversity	-.054	.027	-2.01	.045
Emotional Competency	.065	.028	2.34	.020
Intellectual Competency	.074	.028	2.63	.009
	Test Statistics			
R2		.310		
Adjusted R2		.285		
F		12.3		
Sig.		.000		

Dependent Variable: COST AND TIME PMS

4. Conclusion

Expanding on prior research that concentrated on individual-level effects, this study contributes to the existing literature by creating and validating a multilevel behavioral framework for achieving success in cost and time management within the field of project management. By drawing a competency and knowledge view of the project perspective, this study examined how project characteristics, project manager competencies (such as technical and contextual competency), and team competencies (such as emotional and technical competency) along with team diversity (such as value and knowledge diversity) influence project time and cost management success at project, individual and at team level respectively. This study found that project size has a significant relationship with project cost and time management success. This result of the study is consistent with a previous study (Martin et al., 2007) that recognized that a larger project size decreases the chances of the project being completed on time and within the predetermined cost.

Large team spend significant time on communication, conflict resolution and collaboration among team members (Zhou et al., 2013) resulting in delays and cost overruns. Larger projects have more difficulty in meeting project budgets due to risks in staff allocation, project complexity, coordination, and control (Sanchez et al., 2017). Results of the study have showed that individual-level competencies such as project manager's technical and contextual competency have a positive effect on project management success. These findings are supported by existing literature (such as Bauer et al. (2014) and Dziekoński (2017) that acknowledged the positive relationship between project manager competencies and project success. Team level effect was evaluated through team diversity and team competency.

5. Theoretical Contribution

Although technical rationality may contribute to achieving project goals, however, it is criticized due to its focus on linear thinking to problem-solving highlighting the importance of contextual and multi-level approaches for project management success. This study contributes to the academic literature by analyzing multi-level factors for improving project cost and time management success. Project management (PM) scholars have acknowledged that PM approaches are context-specific and different approaches are desirable in different situations according to national, industry, firm, and project characteristics. To augment this research area, it is vital to accumulate empirical research around the globe. Existing construction literature largely focused on the hard side of the construction projects and ignored the soft or behavioral dimension of project management success, especially, in the context of developing countries such as Pakistan. By employing a competency framework, this study examines behavioral predictors of project management success at different levels to provide a holistic overview of PM success. Previously literature only focused on single level analysis to assess project management success and the literature that focuses on multi-level factors, especially from a behavioral perspective is limited.

This study found that behavioral predictors such as emotional and intellectual competency play key roles in project cost and time success at the team level. The results of the study identified that, at the individual level, a project manager's technical and contextual competencies are key factors for CTPMS for construction industry projects. Difference in values and knowledge increases the chances of disagreements and conflict among team members (Liang et al., 2012; Phillips-Alonge, 2019) and as a result, negatively influences project time and cost of project management success. The results of the study demonstrate that, by improving intellectual and emotional competencies, the CTPMS of large construction projects can be enhanced.

6. Implications

Although numerous studies and Project management professional bodies such as PMI recognized the importance of different PM practices, however, individual practices are essential but not sufficient for PM success in construction projects. Integration of these practices is essential to enhance project management success. The research provides valuable insights for project managers and team members seeking to improve the success of construction projects. Given the inherent complexity of construction projects due to cost and time constraints, individuals with diverse

backgrounds, expertise, experiences, and behaviors are brought together with the expectation of collaboratively working towards shared objectives. In such a situation, analysis of multilevel factors is essential for addressing construction industry specific challenges. Cost overrun and unscheduled delays are universal problems that may be minimized by improving the array of competency of the project manager and other team members. In construction projects in developing countries like Pakistan, the technical competence of the project manager alone is not enough to ensure PM success. Each construction project is executed in a different context. Through integration of contextual and technical competencies of a project manager is crucial for avoiding unscheduled delays and cost overruns which is imperative for achieving the objective of construction projects. This study highlights the importance of the soft competencies of the project team to improve PM success.

7. Limitations and Avenue for future Research

This study is limited to only project characteristics and individual and team-level predictors of project management success. Portfolio and program-level factors need to be explored to assess project management success. Despite of extensive review of literature regarding team and individual competencies that influence CTPMS, not all competencies are included in the conceptual framework of the study. Although the study analyzed the attributes of construction projects, however, organizational culture may influence the findings of the study. In the future, organizational-level factors may be considered to improve the generalizability of the study.

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