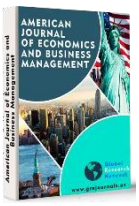

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Utilizing Project Management Techniques to Model Critical Success Factors in Large-Scale Construction Projects

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Abstract:
This study investigates the application of project management techniques to model critical success factors (CSFs) in large-scale construction projects, utilizing Confirmatory Factor Analysis (CFA) to validate the measurement model. Through factor level analysis, eight distinct categories of CSFs were identified, highlighting their significance in project management success. The structural model analysis revealed positive correlations between project management success and CSFs, impacting project-level outcomes such as customer satisfaction, team satisfaction, and project profitability. Strong predictive validity and appropriate model fit were demonstrated through R-squared and Q-squared values, as well as WarpPLS analysis. The study's theoretical implications include a clear differentiation between project management success and project success, while practical implications underscore the importance of leveraging success factors to enhance project outcomes. Overall, the research provides valuable insights for improving the management and performance of large-scale construction projects.

Keywords: Project Management Techniques, Critical Success Factors, Large-Scale Construction Projects, Confirmatory Factor Analysis (CFA), Project-Level Outcomes.

1. INTRODUCTION

Large-scale construction projects are complex endeavors that involve numerous stakeholders, intricate logistics, and significant investment of resources. Ensuring the success of such projects requires careful planning, coordination, and management of various factors. In recent years, project management techniques have emerged as essential tools for modeling and optimizing critical success factors in large-scale construction projects. The term "critical success factors" (CSFs) refers to the key elements or variables that are crucial for achieving project objectives and delivering desired outcomes. These factors can vary depending on the nature and scope of the project but often include aspects such as project scope, schedule, budget, quality, safety, and stakeholder satisfaction.

1.1. Construction Industry- An outline

Building or building framework is the course of development. Building is not quite the same as assembling since building is generally finished nearby for a trustworthy client, while assembling regularly includes large scale manufacturing of comparable things (Fuentes-Bargues, 2020). Funding, plan, and arranging all precede development. It stays set up until the task is done and totally utilitarian. As indicated by, there are three general classifications of development: modern, building, and foundation. Private and non-private development is regularly recognized from each other. Foundation is

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normally alluded to as "weighty common" or "weighty designing," and it incorporates huge public works, dams, spans, expressways, railways, water and utility circulation, and assembling plants, treatment facilities, and interaction substance offices.

The underpinning of the country's monetary improvement is the development area. Various investigations have exhibited how significant the development area is to the development of the public economy. Attest that the development area contributes essentially to the worldwide economy, representing 15% of the worldwide Gross domestic product (GDP). One of the primary enterprises in numerous countries that enormously adds to the extension and improvement of the nation is development.

The structure area is changing at present, wherever on the planet. The worldwide development industry's quick development has made a convincing case for the far and wide utilization of imaginative innovations and cycles (Chan, 2004). Driving organizations need to stay in front of patterns, for example, construction, creative advancements, current development techniques, present day development materials, higher limit programmed hardware, the shift from a labor driven industry to one that is semi-mechanized or completely computerized, green structures, and collusions to thrive. The development business will likewise have to acclimate to the public authority's advancing, maintainability centered standards and guidelines. The business is changing because of patterns, and organizations need to change with the times to be cutthroat. The worldwide development area is as of now being driven hard to increment efficiency and lessen costs for the individuals who are ready to keep awake to date with innovation headways.

1.2. Global Growth Statistics of Construction Industry

Over the course of the following couple of years, it is guessed that worldwide development would speed up, generally because of an improvement in the US economy (Development Market Study, 2017). Worldwide development spending is supposed to surpass USD 15 trillion of every 2025, up 70% from 2012, as per Oxford Financial matters (https://www.oxfordeconomics.com). China's financial improvement is dialing back in contrast with past periods as a result of the adverse consequence of the land issues. Moreover, the US of America's Gross domestic product development rate is steadily expanding because of endeavors to restore the economy. Accordingly, sooner rather than later, it is normal that the speculation income will move from creating to created nations. Long haul financial recuperation in China will, in any case, likely happen at a quicker rate than in India, given its critical advances. As per the Development Area Report (2015), the spending on development in agricultural countries might make up more than 60% of all spending around the world. 2018 is anticipated to see a +3.2% yearly ascent in the worldwide turnover of development organizations, up from a +2.4% yearly development in 2017 (Worldwide Development Report, 2017). Energized by the Worldwide Development Report, the accompanying graphical portrayal in the figure shows the worldwide development area's development rate, development spending, and design.

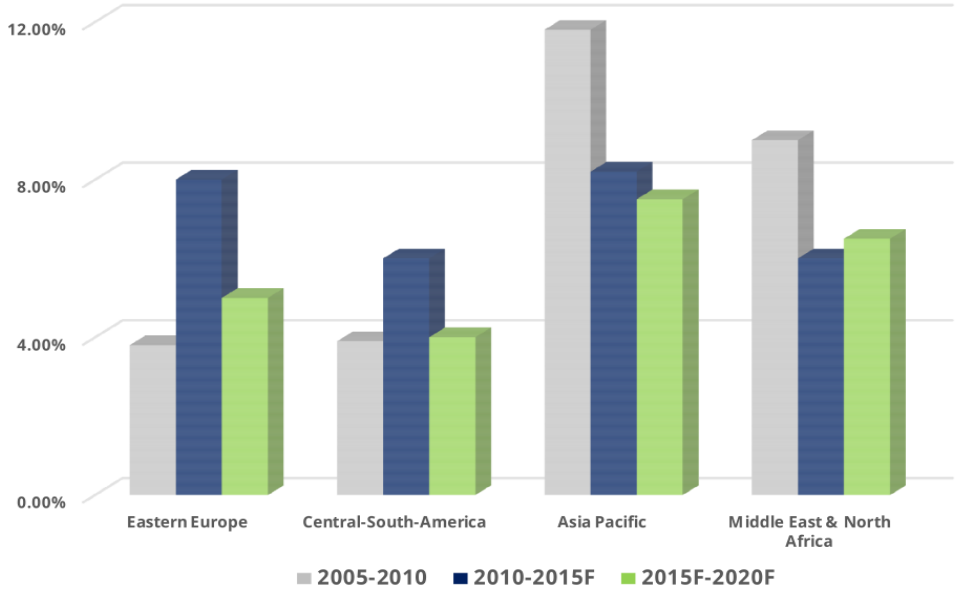

Figure 1: The World Construction Sector Growth Rate. (Source: Global Construction Report, 2017)

1.3. Some Conceptual Models of Construction Supply Chain

The increasing competition is compelling construction industries to make premeditated decisions for a long run (Isik, 2009). An organisation can make an appropriate business strategy for a long run after reviewing their business status with a well-defined and effective process of performance management and can be applied over an empirically validated wide-ranging performance management system through its constituent Supply Chain Management. However, a wide-ranging performance management system is missing in the construction industry. Though several research studies are available on the performance management of supply chain, but limited studies are available on performance management of construction supply chain. Issues like risk management, measuring agility of construction supply chain are frequently considered in construction supply chain management, which gives a strong premise for this study.

- **EFQM Excellence Model:**

The EFQM Excellence Model consents public to understand the link of "cause and effect" among what their establishment performs and the outcomes it attains. It is beneficial to any establishment regardless of volume and segment which is an attractive feature of this model. EFQM Excellence model is non-prescriptive and it considers many changed conceptions. This framework inspires the support, teamwork and novelty that will needs to confirm the goal is achieved. It offers a mutual expression that permits the organisations to successfully disclose their knowledge and skill.

- **BSC Model:**

The primary aim of Balance Scorecard is to transform an organisations mission and vision in to real deed. It is a tactic performance management tool which can be used by the senior professionals to keep track of the implementation of actions by the staff and observe the outcomes rising from these activities.

- **KPIs Model:**

Key performance indicators (KPIs) are the measuring tools that organizations used to measure how successfully they are attaining the objectives. Generally, KPIs are called as a quantifiable instrument of the business improvement. Although various paper brings an inventive and beneficial method to describing the procedure of performance

management in construction supply chain, it has marked its limitation in not validating the conceptual model.

Although various paper brings an inventive and beneficial method to describing the procedure of performance management in construction supply chain, it has marked its limitation in not validating the conceptual model.

1.4. Performance Management in Construction Suppy Chain Management

It very well may be considered a framework in which providers, workers for hire, subcontractors, and clients team up with each other to accomplish shared goals inside the development business' production network (Oh, 2020). These common targets can be accomplished through the creation, conveyance, and establishment of interesting materials, plants, and apparatus for building projects.

By diminishing functional expenses, overseeing spending plan overwhelms, and helping industry efficiency — as found in a few assembling areas — development production network the board verifiably offers the opportunity to essentially build client and partner esteem through a strategic gander at benefit. This truly intends that, when energized by estimations and supported by business data, the presentation of development supply chains can be very significant. "PMS is the technique for evaluating helpfulness and capability of an activity. This sort of deed should be evaluated on the grounds that overseeing it without an unmistakable estimation would challenge. As per, supervisors can follow their progress in completing their essential obligation of further developing inspiration and correspondence to recognize issues right off the bat with the assistance of an exhibition evaluation framework. Expressed in an unexpected way, this sort of exhibition assessment offers fundamental help for planning improvements in store network organization. Earlier exploration on the central concerns and entanglements of production network the executives in building projects has been the focal point of various examinations previously. In any case, there is as yet an absence of information about production network the executives in the development business, hence many inquiries with deficient responses don't completely address the idea of development inventory network the board.

1.5. Process Phases of Project Management in the Performance

As "process groups," which are a coherent characterization of errands or exercises that are organized in the way that the tasks are being finished, the PMBOK Guide, Fifth Version, (p.61) supports understanding the "cycle phases." To complete a venture, for example, the undertaking must initially be begun, which involves making and endorsing the undertaking sanction. From that point onward, in the subsequent stage, an undertaking the executives plan is created to help with completing venture exercises (Milosevic, 2005). In the third stage, the task is completed and most of time and assets are dispensed to the genuine work. All through the entire venture life cycle, from the very start to the get done with, checking and controlling are continuous cycles. The last phase is project conclusion, which incorporates the arrival of the group and the finishing of all procurement contracts alongside updates on illustrations learned. Likewise, the cycle groups are set up with the goal that the venture exercises happen, often in the accompanying request: starting, arranging, executing, observing and controlling, and shutting. To complete the task, each of the five of these cycle groups or phases are vital. The means in the development supply chain are idea, procurement, assembling, establishment, and winding up, who are zeroing in on an eco-framework for warm coal-based power plants. The accompanying area talks about these phases of the development supply chain for the eco-arrangement of the warm coal-based power plant development project, as displayed in figure.

Concept Phase: The client's underlying offering cycle to pick the important project workers denotes the start of the administration movement. The employing of subcontractors and the obtaining of supplies are regularly taken care of by the main worker for hire.

Exact data on the expense and lead season of the materials required for the venture's sequencing and planning, notwithstanding other supply chain activities, is useful in this present circumstance. During this stage, nearby activities are focused on to reduce expenses and abbreviate the task's length. Guaranteeing that work and materials show up on time will forestall work process disruptions.

Procurement Phase: Buying is reliably viewed as a urgent move toward an association's supply chain the executives cycle. Buying the suitable supplies at the fitting time, cost, and source is one of the development supply chain director's key liabilities. This ensures that the development venture will be done on time and inside the assigned financial plan. This phase's goal is to cut costs related with stock, lead times, materials, and strategies.

Production Phase: The actual execution of the development undertaking's creation could start at this phase. This covers component get together, assembling, designing, and material creation. It's conceivable that the accentuation will be on moving tasks from the site to prior supply chain phases. Decreasing the general expense and forestalling project delays are the goals.

Installation Phase: During this stage, the coordinated administration and supply chain movement upgrade that outcomes in conclusive development for establishment by viable on location association and tasks might be the primary concentration.

Winding up Phase: The task is gone over to the end client once the establishment is effectively gotten done, and they are liable for intermittent support. Notwithstanding the piece and trash created during development, store network the executives effectively partakes in this stage in the removal of any overabundance and outdated materials.

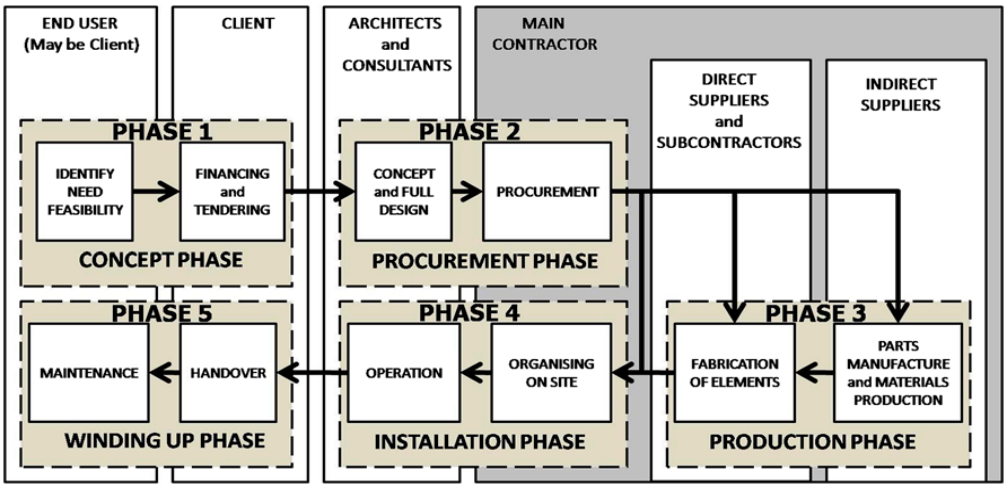

Figure 2: Flowchart of phase

1.6. Research Objective

To investigate and elucidate the causes and consequences of successful project management in building projects

The following are the study's precise goals:

1. To identify the project success factors in construction projects

2. To assess the influence of project success factors on Project Management Success

3. To ascertain the influence of Project Management Success on Customer Satisfaction, Team Satisfaction, and Project Profitability

4. To develop a model linking Project Success Factors, Project Management Success and outcomes in construction projects

2. LITERATURE REVIEW

Kumar, Singh, and Pandey (2024) by creating a scale to evaluate CSFs from the viewpoints of numerous stakeholders, add to this conversation and improve project success on big construction projects (Kumar, 2024). Their study emphasises how crucial stakeholder participation and goal alignment are to the success of a project.

Nguyen and Ogunlana (2004) A landmark study on project success variables in major Vietnamese building projects was carried out (Ogunlana, 2004). Their study emphasised the value of context-specific analysis by identifying critical components that are necessary for project success, including stakeholder involvement, effective communication, and project planning.

Wuni and Shen (2020) emphasised the significance of technical improvements and integration in improving project results as they focused on essential success elements for modular integrated construction projects (Shen, 2020). Their analysis emphasises how important innovation and teamwork are to contemporary building techniques.

Barakat (2009) A hybrid communication and information management strategy was developed specifically for large-scale construction projects in Dubai (Barakat, 2009). Barakat emphasises the significance of flexibility and proactive management techniques in dynamic project contexts by presenting a novel critical success factor method.

Li et al. (2018) A study on important success elements for project planning and control in the manufacturing of prefabrication homes was carried out in China (Li, 2018). In the context of prefabricated construction technologies, their research highlights the importance of effective planning, supply chain management, and quality control in ensuring project success.

Ahmadabadi and Heravi (2019) With an emphasis on Iranian highway projects, examined the influence of essential success elements on project success in Public-Private Partnership (PPP) projects (Heravi, 2019). Their case study emphasises how important stakeholder cooperation, risk management, and strong governance frameworks are to the completion of PPP projects.

Fortune and White (2006) A systems model for framing project essential success elements was presented (White, 2006). The approach highlights the dynamic and linked character of these components. Their methodology highlights the necessity of systemic approaches to management and decision-making and offers a comprehensive viewpoint on project success.

Akbari, Khanzadi, and Gholamian (2018) A rough sets-based prediction model was created to categorise large-scale construction projects according to the sustainable success index (Akbari, 2018). Their work emphasises the significance of sustainability factors in determining project success and advances predictive analytics in project management.

Chen et al. (2012) used a structural equation model to investigate the links between important success criteria for building projects (Chen, 2012). Their results highlight the intricate relationships between different elements including collaboration, project governance, and leadership, underscoring the necessity of integrated project management strategies.

Ghosh and Sar (2020) To determine crucial success variables, focused their analysis on railway construction projects in India (Sar, 2020). Their study demonstrated how crucial elements like risk management, stakeholder participation, and effective project management are to the success of a project.

Kumar, Pandey, and Singh (2023) examined, from the viewpoint of project practitioners, the important success criteria and success of projects (Kumar P. a., 2023). Their conclusions emphasised how important it is to have strong leadership, effective communication, and satisfied stakeholders in order to accomplish project goals.

Altarawneh, Thiruchelvam, and Samadi (2018) The impact of important success determinants on crucial delays in water infrastructure development projects in Abu Dhabi was examined (Altarawneh, 2018). Using the partial least squares structural equation modelling (PLS-SEM) method, their research determined the critical success components of a project, including resource management, contractor performance, and project planning.

Tonne et al. (2024) Critical success variables for project management in social housing projects were studied (Tonne, 2024). Their study highlighted how crucial it is to fulfil project objectives by taking into account elements like quality control, stakeholder participation, and budget management.

Jung, Lee, and Yu (2021) Critical success criteria for off-site building were identified and prioritised by using interpretive structural modelling (ISM) and MICMAC (Matrice d'Impacts Croisés Multiplication Appliquée à un Classement) analysis (Jung, 2021). Their analysis identified supply chain management, technological adoption, and regulatory compliance as critical success factors for off-site building projects.

Al-Hajj and Zraunig (2018) looked into how project management implementation affected construction projects' ability to be completed successfully (Zraunig, 2018). In order to ensure project success, their research focused on the importance of efficient project planning, resource allocation, and monitoring.

Hasler (2016) In order to determine the crucial success elements influencing the successful completion of institutional projects, used a case study technique (Hasler, 2016). According to his studies, risk management, project leadership, and stakeholder involvement are all essential for project success.

Alshami (2018) looked at important variables that affect construction project success while taking project size into account (Alshami, 2018). His research focused on the importance of project planning, communication, and resource allocation, while taking project scale into account, in order to achieve success.

Yamany et al. (2024) In their investigation of the crucial success elements of infrastructure construction projects, placed particular emphasis on risk management, stakeholder involvement, and project planning as vital components of project success (Yamany, 2024).

Coleman (2019) looked into the essential elements of linear transportation project success (Coleman, 2019). In order to ensure the success of linear transportation projects, his doctoral dissertation examined elements including stakeholder satisfaction, schedule adherence, and project scope management.

Kineber group (2023) the relationship between crucial success elements, value management implementation phases, and total project success in construction is the main emphasis of this study (group, 2023). It probably looks at how various value management implementation stages affect project success, taking into account elements that help or hurt the project's chances of success.

Chan and associates (2019) the key success elements for implementing Building Information Modelling (BIM) in Hong Kong are covered in this article (associates, 2019). It might look at things like stakeholder cooperation, technological infrastructure, organizational preparedness, and regulatory assistance that affect how well BIM is used in the construction sector.

Khosravi & Rezvani (2019) most likely, this chapter gives a summary of the important success and failure criteria in complicated, large-scale initiatives (Rezvan, 2019). It could cover a wide range of variables that affect project performance, including communication tactics, risk management, stakeholder engagement, and project management techniques.

Sinaga & Husin (2021) this study probably looks into important success criteria for using 4D BIM and Critical Chain Project Management (CCPM) in the context of basement work on Indonesian high-rise residential complexes (Husin, 2021). It might look at how CCPM and 4D BIM integration might boost productivity and timeliness in building projects.

Kineber group (2021) it is likely that the important success elements for value management implementation in sustainable residential building projects are examined in this article. In order to identify and evaluate the elements that lead to project performance in sustainable building, such as cost control, sustainability practices, stakeholder engagement, and project planning, structural equation modelling may be used (group, 2021).

3. DATA DESCRIPTION AND COLLECTION

The details of the participating firm's age/years of operations are given below in the Table. The basic criterion for selecting each sample project is that the project was completed and handed over to the customers. The industry average for completing a project is 3 years. Hence all the firms which took part in the survey had to be more than 3 years since their operation in the Construction Industry.

The age range of 11 to 20 years comprised 55 firms, or 51.41% of the sample. Additionally, 29 businesses (27.10% of the sample) belonged to the age range of 21 to 30 years. Additionally, 11 businesses fell into the category of those with up to ten years of industry experience. Eight businesses (7.47%) belonged to the 30- to 40-year-old age group, while eight businesses (3.74%) had been in business for longer than 30 to 40 years.

Table 1: Construct Characteristics in Large-Scale Construction Projects

No.	Construct	Number	Type of Scale	Cronbach Alpha
1	Project Specific Success	14	Likert Type Scale (5-point Scale)	0.720
2	Owner Specific Success	11		0.774
3	Contractor Specific Success	9		0.957
4	Architect & Consultant	8		0.816
5	Project Manager Specific	10		0.932
6	Resource Specific Success	11		0.867
7	External Environment	7		0.873
8	Finance Specific Success	8		0.764
9	Project Management	3	Likert Type Scale (5-point Scale)	0.790
10	Customer Satisfaction	5		0.914
11	Team Satisfaction	6		0.95
12	Project Profitability	6		0.742
13	Market Perception	1	Rating	
14	New Projects	1	Ratio Scale	

3.1. Editing and Coding

The data collected was entered into a Microsoft excel sheet. Each question from the questionnaire was given a code. A total of 77 questions was used to answer success factors. They were coded as PSF1 to PSF14, OSF1 to OSF11, CSF1 to CSF9, ACSF1 to ACSF8, PMSF1 to PMSF10, RSF1 to RSF11, EESF1 to EESF7 and FSF1 to FSF8. Similarly, PMS1 to PMS3, CS1 to CS5, TS1 to TS6, and ProjProf1 to ProjProf6 were used for other constructs.

3.2. Profile of the Respondents

The section describes the designation of the primary respondents. The data was collected from qualified respondents who could answer the details with respect to the projects. Data was given by the Project Managers in most of the cases, closely followed by Senior Project Manager.

Table 2: Participation of Firm Members in the Study

Firm	Total Members	Participating Members
Darin Group	32	17
Akg Group	62	42
Shamara Holding Group	17	11
Ta'az Group	27	19
Galiawa Group	35	18
TOTAL	173	107

3.3. Profile of the Respondents

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Table 3: Profile of the Respondents

Designation	# Respondents
Project Manager	80
Senior Project Manager	78
General Manager (Projects)	51
Managing Director	20
	229

4. ASSESSMENT OF MEASUREMENT MODEL

The assessment of the measurement model involves a rigorous evaluation of its validity and reliability, ensuring that it accurately captures the constructs and their interrelationships in the context of the study. One crucial method employed in this assessment is Confirmatory Factor Analysis (CFA), which scrutinizes the relationships between the observed indicators and the latent constructs they represent. By examining cross-loadings and indicator loadings, CFA validates the factor structure and ensures that each indicator predominantly loads onto its intended construct rather than onto others. Validity and precision are paramount in this assessment, where validity pertains to the extent to which the measuring instrument accurately measures what it is intended to measure, while reliability focuses on the consistency and stability of the results obtained. Factor level analysis is conducted to delve into the specific elements falling under each success factor category, employing a comprehensive approach to analyze their coefficients' strengths.

- **Confirmatory Factor Analysis**

At the point when the scientist has an assumption about the factor structure, they utilize confirmatory factor analysis. Confirmatory Factor Analysis (CFA) is in some cases alluded to as the estimation model or the compelled factor analysis. According to, CFA is in this way worried about the connections between developing measures, markers, and the builds they were expected to gauge. Cross-loadings and pointer loadings are given in Addendum II. The pointer idle variable association is referred to by every cell in the table. After a construction framework is changed through diagonal revolution, these marker loadings are gotten. The Pearson relationships between's the dormant factors and the pointers are contained in the design framework. It is important that there be high loadings and minimal cross-loadings. Each stacking's standard blunders and P values are inspected. The approval boundary of a confirmatory factor analysis is generally indicated by the provided P values.

The Confirmatory Factor Analysis demonstrates that the loadings of every pointer are more noteworthy than the cross-loadings. Moreover, every marker's P esteem (Supplement II) is under 0.05. In this manner, the factor structure was approved by the CFA on the information, one might say.

- **Validity and Precision**

An estimating scale's legitimacy and dependability are its essential determinants of value, legitimacy is how much an estimating gadget estimates what it should gauge, while unwavering quality is the consistency, security, and redundancy of the outcomes.

4.1. Factor Level Analysis

The factor level analysis in this section was performed using the data from 229 projects. Here, we've tried to enumerate the key elements that fell into each of the success factor categories. Below are the eight success factor categories that were employed in the study.

1. Project Specific Factors (PSF)
2. Owner Specific Factors (OSF)
3. Contractor Specific Factors (CSF)
4. Architect & Consultant Specific Factors (ACSF)
5. Project Manager Specific Factors (PMSF)
6. Resource Specific Factors (RSF)
7. External Environment Specific Factors (EESF)
8. Finance Specific Factors (FSF)

All the items belonging to the eight categories of project success factors were analyzed based on the strength of their coefficients.

4.2. Outcomes project management success: project-level and firm- level analysis

- **Structural Model I: Structural Model for Project Management Success and Project-Level Outcomes**

The assessment of the Structural Model for Project Management Success and Project-Level Outcomes is given in this section. For analyzing the model, the data collected from 229 projects were used. The Project-Level Outcomes of Project Management Success are Customer Satisfaction, Team Satisfaction and Project Profitability. The significance of the correlations was assessed using the path coefficients and the p values. The eleven potential routes that were examined and determined to be relevant are.

It was discovered that PMS and the eight Success Factor categories—PSF, OSF, CSF, ACSF, PMSF, RSF, EESF, and FSF—were favourably correlated. Likewise, it was discovered that the PMS significantly and favourably impacted the Project-Level Outcome, specifically CS, TS, and ProjProf.

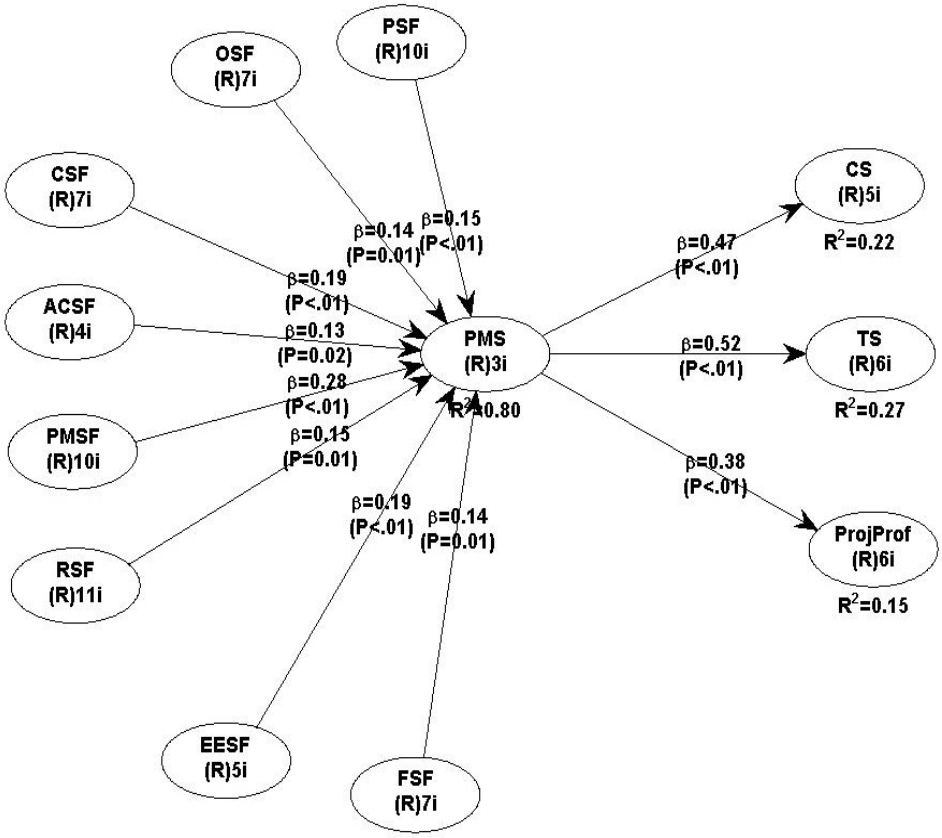

Figure 3: Structural Model I: Structural Model for Project Management Success and Project-Level Outcomes

All eleven of the study's hypotheses are found to be supported, based on the path coefficients and significance of the Structural Model I: Structural Model for Project Management Success and Project-Level Outcomes. The table that follows provides an overview of the findings from the testing of the theories.

Table 4: Relationship between Success Factors and Project Management Success, and their Impact on Project-Level Outcomes

Relationship	Path Coefficient	p-Value
PSF--> PMS	0.155	0.008
OSF--> PMS	0.145	0.013
CSF--> PMS	0.189	0.002
ACSF--> PMS	0.128	0.025
PMSF--> PMS	0.28	<0.001
RSF--> PMS	0.145	0.013
EESF--> PMS	0.194	0.001
FSF--> PMS	0.143	0.014
PMS--> CS	0.474	<0.001
PMS--> TS	0.521	<0.001
PMS--> ProjProf	0.381	<0.001

4.3. R-Squared and Q-Squared Values

The factual proportion of the information's vicinity to the fitted relapse line is called R-squared. It is in some cases alluded to as the numerous relapse coefficient or the coefficient of assurance. It is considered satisfactory when the R-squared values for PMS, CS, TS, and ProjProf are 0.80, 0.22, 0.27, and 0.15, individually. Geisser Stone A proportion of the model's prescient legitimacy is its Q-Squared esteem. For prescient legitimacy to be laid out, the expected result should be more noteworthy than nothing. Better prescient legitimacy is shown by a bigger worth. The Q-Squared upsides of 0.685, 0.241, 0.265, and 0.162 show the model's solid prescient legitimacy.

Table 5: R-Squared and Q-Squared Values

	PMS	CS	TS	ProjProf
R-Squared	0.801	0.225	0.271	0.145
Adjusted R-Squared	0.794	0.221	0.268	0.141
Q-Squared	0.685	0.241	0.265	0.162

4.4. Model Elements and Model Fit, Quality Indices from WarpPLS

General SEM analysis results using WarpPLS involve two parts: General Model Components and Model Fit& Quality Records. These two sorts are depicted in the table beneath.

- **General Model Elements**

In this work, Number juggling Mean Ascription — one of the five strategies for attribution of missing information — is utilized. (The other attribution methods are the accompanying: stochastic different relapse, stochastic various leveled relapse, numerous relapse, and stochastic ascription). Since the product's creation, PLS Relapse has been the external model calculation naturally. The external model loads are iterated until they balance out utilizing this methodology. The inward model in the PLS Relapse method doesn't matter to the external model.

The product's default procedure, called Warp3, searches for associations between inactive factors that are described by capabilities whose underlying subordinates are U-bends. The example that these sorts of communications stick to is more similar to a S-bend. The product's default semi parametric method, Stable3, comes energetically suggested. From the outlook of registering load, this approach creates more steady coefficients and is compelling. Furthermore, they offer very exact standard blunder gauges, which are expected to work out P values.

4.5. Model fit and quality indices

Model fit and quality indices are essential metrics used to evaluate the effectiveness and robustness of structural equation models (SEM) or path models. These indices provide valuable insights into how well the proposed model fits the observed data and the overall quality of the model's estimation.One commonly used metric is the Average R-squared (ARS), which measures the proportion of variance in the endogenous variables explained by the model. A higher ARS value indicates a better fit between the model and the data. Similarly, the Average Adjusted R-Squared (AARS) adjusts the ARS for the number of predictors in the model, providing a more conservative estimate of model fit.

- **Model Fit and Quality Indices**

To assess the model's quality, a number of metrics are utilized, including Average R-Squared (ARS), Average Variance Inflation Factor (AVIF), and Average Path Coefficient (APC) values. At $p<0.001$, the Average Adjusted R-Squared (AARS) esteem is 0.356, showing significant results. ARS esteem is 0.360, significant at $p<0.001$, according to the

study. APC is 0.250, which is significant at p<0.001, in a similar manner. Furthermore, the AVIF esteem is less than 5, at 2.951. Put otherwise, every one of these metrics indicates that the model's goodness-of-fit is appropriate.

The Tenenhaus GoF (GoF) record is the most regularly used metric to assess how well a model explains information. The square root of the product between the ARS and what they refer to as the average collection file is the GoF. For PLS-based path demonstrating, the Tenenhaus GoF list is the usually used model fit record. At 0.496, the record esteem was higher than the predetermined thresholds of 0.1 for minor impact size, 0.25 for medium impact size, and 0.36 for large impact size.

A peculiarities that results from multivariate statistical studies is known as Simpson's paradox. Other names for it incorporate the reversal paradox and the Yule-Simpson impact. An indicator of how free a model is from Simpson's paradox cases is the Simpson's Paradox Ratio (SPR) list. Assuming the model's Simpson's difficulty Ratio is 1, it indicates that no examples of the predicament exist. A model is considered to be free of Simpson's paradox in no less than 70% of its routes in the event that its SPR esteem is equivalent to or higher than 0.7.

A model's degree of freedom from negative R-squared contributions is expressed as the R-Squared Contribution Ratio (RSCR). A model with a R-squared contribution ratio of 1 indicates that there are no bad R-squared contributions. At the point when a model's complete sum of positive R-squared contributions equals or exceeds 90 percent of its all out sum of absolute R-squared contributions, it is considered to have a satisfactory RSCR worth of 0.9.

The statistical suppression ratio (SSR) quantifies the degree to which a model is without statistical suppression occurrences. At the point when the SSR esteem is equivalent to or higher than 0.7, it indicates that no less than 70% of the model's routes are free from statistical suppression.

A metric used to evaluate how much support bivariate nonlinear coefficients of association offer for the proposed directions of the causal links in a model is the Nonlinear Bivariate Causality Direction Ratio ("NLBCDR"). In something like 70% of path-related examples in the model, the support for the reversed hypothesized direction of causality is frail or less, according to adequate values of NLBCDR equivalent to or greater than 0.7.

Table 6: Model Fit and Quality Indice

Statistic	Value	Interpretation
Average Path Coefficient (APC)	0.250	Significant (p<0.001)
Average R-squared (ARS)	0.360	Significant (p<0.001)
Average Adjusted R-Squared (AARS)	0.356	Significant (p<0.001)
Average block VIF (AVIF)	2.951	Acceptable (< 5), Ideally (< 3.3)
Average full collinearity VIF (AFVIF)	4.079	Acceptable (< 5), Ideally (< 3.3)
Tenenhaus GOF (GOF)	0.496	Small (>= 0.1), Medium (>= 0.25), Large (>= 0.36)
Sympson's Paradox Ratio (SPR)	1.000	Acceptable (>= 0.7), Ideally (1.000)
R-Squared Contribution Ratio (RSCR)	1.000	Acceptable (>= 0.9), Ideally (1.000)
Statistical Suppression Ratio (SSR)	1.000	Acceptable (>= 0.7)
Nonlinear Bivariate Causality Direction Ratio (NLBCDR)	0.909	Acceptable (>= 0.7)

5. SUMMARY OF FINDINGS

The summary would detail the relationships between project management success dimensions (e.g., time, cost, specification) and project-level outcomes (e.g., customer satisfaction, team satisfaction, project profitability). It would highlight the extent to which each dimension of project management success contributed to achieving desirable project outcomes.

5.1. Relationship among Success Factors and Time, Cost and Specification

The structural relationship between antecedents and Time, Cost and Specification were evaluated. The findings are as follows:

The analysis reveals that Time dimension of Project Management Success is influenced by the factors-PSF, PMSF, RSF, EESF, and FSF. Among these factors PMSF is having the strongest effect on Time dimension, followed by EESF.

The result of the study indicates that Cost dimension of Project Management Success is influenced by OSF, PMSF, RSF, and, EESF. Out of these four factors, RSF is found to have the strongest effect on PMS, followed by EESF.

Similarly, in the case of the Specification dimension -OSF, PMSF, RSF, EESF, and FSF were found to be have a significant influence. Among them, PMSF was found to have the strongest effect, followed by RSF.

5.2. Relationship among Time, Cost, Specification and the Project-Level Outcomes

Here, the effect of Time, Cost and Specification on Customer Satisfaction (CS), Team Satisfaction (TS) and Project Profitability (ProjProf) was evaluated. The summary findings of the relationship among Time, Cost, Specification and the Project-Level Outcomes are as follows:

All three dimensions of PMS -Time, Cost, and Specification, were found to have a significant positive relationship with the outcome variables- CS, TS, and ProjProf.

Time was found to have the strongest influence on CS and TS. The path coefficient of Time-ProjProf was also found to be significant.

Cost was found to have positive relationship with CS, TS, and ProjProf. All the relationship were also found to be significant.

Specification was found to have the strongest effect on ProjProf. The relationship between Specification-CS and Specification-TS were also found to be significant.

5.3. Theoretical Implication

The study contributes to knowledge in construction project management by developing and testing the theoretical model emphasizing the antecedents and outcomes of Project Management Success. A clear differentiation between Project Management Success and Project Success is provided by this study.

Multiple stakeholder perception studies are rare in the Construction Industry context. Normally, studies are conducted using single respondents. Here, perceptions of Customers, Project Managers and Independent Project Reviewers were used. This study have evaluated the actual Customer Satisfaction. Also, this study evaluated the impact of success factors on Project Management Success. All those factors which are vital to a construction project, the presence of which can enhance the likelihood of Project Management Success were analyzed. This list of success factors can serve as a Checklist which the management can make use in a project and thereby increase the likelihood of project success.

5.4. Practical Implications

The findings of this study imply that it is important for the firms to have a clear idea about the success categories/factors, which is consistent with the previous studies. The previous studies in this context majorly focused on ranking the success factors. Here the impact of each success factors are considered, hence providing a better understanding of success factors. It suggests that all owners, project managers, team members and other critical participants, each of them bring in some competencies or attributes which can be fundamental to the success of the projects. It's the responsibility of the management to bring out a proper mix of team and resource at the right environment to confirm real success.

The study found that Project Specific Factors itself contribute to project success. It follows that the firms should take up those projects based on their experience and knowledge. The firm should ensure that they have the right team to carry out the projects undertaken. Too huge a project, which is unmanageable for the team, should not be committed, unless proper resources are raised. It is mandatory to procure regulatory approvals from the concerned authorities. No delay or unethical ways should be adopted to procure the same. The proper tender should be invited and a proper methodology is mandatory to choose from the tender. Each milestone should be clearly defined and also properly communicated to the concerned parties of the project.

REFERENCES

1. *Fuentes-Bargues, J.L., Bastante-Ceca, M.J., Ferrer-Gisbert, P.S., & González-Cruz, M.C. (2020). Study of Major-Accident Risk Assessment Techniques in the Environmental Impact Assessment Process. Sustainability, 12, 5770.*
2. *Chan, A.P.C., Scott, D., & Chan, A.P.L. (2004). Factors Affecting the Success of a Construction Project. Journal of Construction Engineering and Management, 130, 153–155.*
3. *Isik, Z., Arditi, D., Dikmen, I., & Birgonul, M.T. (2009). Impact of Corporate Strengths/Weaknesses on Project Management Competencies. International Journal of Project Management, 27, 629–637.*
4. *Oh, M., & Choi, S. (2020). The Competence of Project Team Members and Success Factors with Open Innovation. Journal of Open Innovation: Technology, Market, and Complexity, 6, 51.*
5. *Milosevic, D., & Patanakul, P. (2005). Standardized Project Management May Increase Development Projects Success. International Journal of Project Management, 23, 181–192.*
6. *Kumar, V., Singh, R., & Pandey, A. (2024). Multiple stakeholders' critical success factors scale for success on large construction projects. Asian Journal of Civil Engineering, 25(2), 1691-1705.*
7. *Nguyen, L. D., & Ogunlana, S. O. (2004). A study on project success factors in large construction projects in Vietnam. Engineering, construction and architectural management, 11(6), 404-413.*
8. *Duy Nguyen, L., Ogunlana, S. O., & Thi Xuan Lan, D. (2004). A study on project success factors in large construction projects in Vietnam. Engineering, Construction and Architectural Management, 11(6), 404-413.*
9. *Wuni, I. Y., & Shen, G. Q. (2020). Critical success factors for modular integrated construction projects: A review. Building research & information, 48(7), 763-784.*
10. *Barakat, T. A. H. (2009). A hybrid model of communication and information management in mega construction projects in Dubai using a new critical success factor approach (Doctoral dissertation, © Tarek Abdullah Hussein Barakat).*
11. *Li, L., Li, Z., Wu, G., & Li, X. (2018). Critical success factors for project planning and control in prefabrication housing production: A China study. Sustainability, 10(3), 836.*
12. *Ahmadabadi, A. A., & Heravi, G. (2019). The effect of critical success factors on project success in Public-Private Partnership projects: A case study of highway projects in Iran. Transport policy, 73, 152-161.*
13. *Fortune, J., & White, D. (2006). Framing of project critical success factors by a systems model. International journal of project management, 24(1), 53-65.*

14. Akbari, S., Khanzadi, M., & Gholamian, M. R. (2018). Building a rough sets-based prediction model for classifying large-scale construction projects based on sustainable success index. Engineering, Construction and Architectural Management, 25(4), 534-558.
15. Chen, Y. Q., Zhang, Y. B., Liu, J. Y., & Mo, P. (2012). Interrelationships among critical success factors of construction projects based on the structural equation model. Journal of management in engineering, 28(3), 243-251.
16. Ghosh, S. K., & Sar, A. K. (2020). Critical Success Factors for Construction Projects: a Study of Railway Construction Projects in India. International Journal of Management (IJM), 11(8).
17. Kumar, V., Pandey, A., & Singh, R. (2023). Project success and critical success factors of construction projects: project practitioners' perspectives. Organization, technology & management in construction: an international journal, 15(1), 1-22.
18. Altarawneh, J. Y., Thiruchelvam, V., & Samadi, B. (2018). Analysis of critical success factors influence on critical delays for water infrastructure construction projects in the Abu Dhabi emirate using PLS-SEM method. International Business Research, 11(2), 16.
19. Ton, H. N. N., Huynh, T. C. T., Tran, T. T., & Nguyen, T. T. D. (2024). Identifying Critical Success Factors Related to Project Management to Achieve Critical Success Criteria in Social Housing. Review of Integrative Business and Economics Research, 13(2), 87-106.
20. Jung, S., Lee, S., & Yu, J. (2021). Identification and prioritization of critical success factors for off-site construction using ISM and MICMAC analysis. Sustainability, 13(16), 8911.
21. Al-Hajj, A., & Zraunig, M. (2018). The impact of project management implementation on the successful completion of projects in construction. International Journal of Innovation, Management and Technology, 9(1), 21-27.
22. Hasler, M. D. (2016). Critical Success Factors Affecting Successful Completion of "Institutional" Projects: A Case Study Approach (Doctoral dissertation).
23. Alshami, W. (2018). Critical factors contribute to construction project success: Study of success factors in relation to the project size.
24. Yamany, M. S., Abdelhameed, A., Elbeltagi, E., & Mohamed, H. A. E. (2024). Critical success factors of infrastructure construction projects. Innovative Infrastructure Solutions, 9(4), 1-20.
25. Coleman, N. (2019). Project critical success factors: A study of linear transportation projects (Doctoral dissertation, Northcentral University).
26. Kineber, A. F., Othman, I., Oke, A. E., Chileshe, N., & Zayed, T. (2023). Modeling the relationship between value management implementation phases, critical success factors and overall project success. Construction Innovation.
27. Chan, D. W., Olawumi, T. O., & Ho, A. M. (2019). Critical success factors for building information modelling (BIM) implementation in Hong Kong. Engineering, Construction and Architectural Management, 26(9), 1838-1854.
28. Rezvani, A., & Khosravi, P. (2019). Critical success and failure factors in large-scale complex projects. In The Practitioner's Handbook of Project Performance (pp. 243-254). Routledge.
29. Sinaga, T., & Husin, A. E. (2021). Key Success Factors for Critical Chain Project Management (CCPM) and 4D Building Information Modeling (BIM) for Improving Time Performance in Basement Work on 5 Layers of High-rise Residential Buildings in Indonesia.
30. Kineber, A. F., Othman, I., Oke, A. E., Chileshe, N., & Zayed, T. (2021). Exploring the value management critical success factors for sustainable residential building–A structural equation modelling approach. Journal of Cleaner Production, 293, 126115.