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Whole Life Critical Factors Influencing Construction Project Performance for Different Objectives: Evidence from Thailand

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Abstract: This study aimed to identify the critical factors (CFs) influencing project performance and analyze their relative importance across multidimensional criteria throughout the project life cycle. Based on a literature review, 179 individual factors were categorized into nine performance criteria. A questionnaire survey was conducted with client representatives, consultants, and contractors in Thailand. The statistical analysis of 93 subjects showed that the significance levels of the performance criteria and CFs changed depending on the considered phase in the project's life cycle. The analysis identified the three criteria (client satisfaction, quality, time) that were most frequently used to measure the success of a project. Furthermore, the findings revealed the top 10 CFs for each performance category throughout the life cycle. Notably, these findings provide compelling evidence of the following most important CFs across the performance measures: competence of project participants, adequate experience of project participants, the availability of competent staff, positive personal attitudes among project participants, participation in environmental initiatives by management, competent supervisors, effective project planning and control, the need for collaboration, and the professionalism of the project team's services. This research provides insights into the factors that influence project success and have managerial implications for project stakeholders, facilitating informed decision making throughout the life cycle. Through establishing novel perspectives, this study enhances the knowledge base in the construction management domain.

Keywords: critical factors; construction management; performance criteria; project life cycle; project performance; Thailand

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1. Introduction

One of the most significant discussions in the context of construction project management revolves around the critical factors (CFs) that contribute to the successful management of the project. Critical factors are important to the current operating activities and future achievements of organizations. They are also variables that predict project performance [1] and are considered a means to improve a project's effectiveness [2]. While there have been numerous studies examining the CFs that influence activity and project performance, there is limited consensus on this topic, prompting researchers to conduct further studies [3,4].

Moreover, over the decades, the criteria used to assess project success have gained considerable attention from various researchers, professionals, and construction practitioners. Successful project management is tied to the performance measures used by the company as instruments to assess management performance and monitor strategic plans [5]. The criteria for the measurement of project success can be described as a set of values through which favorable results can be achieved within a fixed specification. With the construction industry's growing complexity, having a restricted perspective on project performance that considers cost, time, and quality—referred to as the 'iron triangle'—as the only performance assessment criteria is insufficient. Furthermore, the focus on approaches for the

measurement of project success has shifted over the last few decades and expanded to encompass multidimensional criteria.

In addition, projects are typically divided into several distinct phases. A project's phases are mainly completed sequentially, but they can overlap in some situations. The more project phases there are, the more organizations are required to control the project's outcome. Collectively, the project phases are the components of a project's life cycle. However, although the generic project life cycle may be adapted to the specific needs of organizations, previous works have been limited in determining CFs for the entire project life cycle.

Over the last few decades, there have been numerous endeavors to explore the CFs for effective project execution. Previous studies have examined the key factors that impact project success, revealing their distinct advantages and disadvantages. However, most prior studies have focused on determining the perceptions of a certain subject at a specific point in time, overlooking the dynamic aspect of project performance criteria. As a result, there has been limited consensus on this topic, and efforts to establish a common ground throughout the project life cycle have been minimal. Therefore, it is necessary to ascertain the CFs that influence project performance in various dimensions and across the entire project life cycle. In an attempt to fill this knowledge gap, the present research aims to:

- Provide better insights into the CFs that influence project performance for various criteria in Thai construction projects and assess their relative importance;
- Determine the factors that contribute to improvements in project performance for effective management over the course of a project's life cycle.

To accomplish these objectives, the following research questions were considered:

1. Which factors influence project performance within the Thai construction industry?
2. Which factors contribute to the enhancement of construction project performance?
3. Which practices could aid in addressing the practical performance management approach to construction projects?

In order to address these questions, the findings obtained through a questionnaire survey administered to 93 respondents occupying senior executive positions within their respective organizations were employed. The most significant results emerging from the statistical analysis offer valuable insights into the dynamic nature of project performance criteria and the varied impacts of the critical factors across different project phases, thus enhancing our understanding of construction project management practices in Thailand.

This research paper is structured into seven sections. First, Section 1 outlines the introduction. Section 2 contains the literature review on the critical factors for project success, the project performance criteria, and the project life cycle. Next, in Section 3, the research design and the methods used to analyze the data are presented, and the hypotheses are articulated. Section 4 describes the results of this study. Following this, Section 5 discusses the CFs resulting from the analysis. In Section 6, the practical implications, particularly for project executives, project managers, and project teams, are presented. Finally, Section 7 states the conclusions and recommendations for future research.

2. Literature Review

The review of the literature focuses on the concept of project success factors, a subject that has been extensively studied and debated within the field of construction project management. This evaluation is based on the premise that project success relies on a wide range of CFs and distinct performance criteria that necessitate efficient management throughout the project life cycle.

2.1. Critical Success Factors

In the context of project management, the concept of project success factors was first introduced in 1967 and 1982, when the term 'critical success factors' (CSFs) was initially

used [4]. This has since become a widely researched topic among various researchers, professionals, and construction practitioners over the decades.

Rockart [6] introduced the concept of CSFs, defining them as 'those key areas of activity in which results are absolutely necessary for a particular manager to reach his or her goals' within the realm of information systems. While this study initially focused on the context of information systems, the concept of CSFs demonstrates broader applicability and offers valuable insights across a diverse range of domains.

Pinto and Slevin [3] conducted a survey to define CSFs across the project life cycle. The findings revealed that client consultation, client acceptance, technical tasks, the characteristics of the project team leader, and the project mission were the most significant factors impacting the success of a project's implementation. These factors were closely correlated with established concepts such as project leadership and project success criteria.

A survey aimed at identifying the significant factors in building projects was presented by Sanvido et al. [1], the findings of which identified four factors that are crucial to project success. Among these factors is a set of contracts that enables and encourages different experts to work together without conflicts of interest or competing goals. This underscores the importance of unambiguous and enforceable contracts in minimizing transaction costs and ensuring streamlined project execution. Furthermore, the study highlighted the significance of experience in managing, preparing, designing, constructing, and operating similar facilities, demonstrating the strategic advantage obtained when capitalizing on specialized knowledge and expertise.

Chua et al. [7] defined 67 success-related factors and categorized them into four key strategic goals. Using an analytic hierarchy process, the study's results disclosed a distinct set of key success factors for different types of project performance, depending on the life-cycle phase. Project characteristics and contractual arrangements could invariably be considered the critical variables in the success equation. In an empirical study, Cooke-Davies [8] identified 12 key factors that are crucial to successful project management, including the sophistication of a company's risk ownership allocation processes, an adequate and timely risk management strategy, and the sufficiency of documented information on the project's organizational roles and responsibilities.

There has been an increasing number of attempts to explore the factors that influence project performance. A study conducted by Iyer and Jha [9] found that there were six factors affecting schedule performance in construction projects as follows: the owner's competence; the project manager's competence; the commitment of all project participants; supportive owners and top management; favorable working conditions; and monitoring, feedback, and coordination. These characteristics align with numerous well-established concepts and frameworks in the field of construction project management. Through understanding these factors, project professionals can focus on key elements and employ targeted strategies to enhance the project's success. Park [10] conducted a survey to investigate the factors contributing to the effectiveness of a whole life performance assessment system, and revealed that the accuracy of project cost estimation, a fixed construction time, clarity in contracts, material quality, the management of work safety onsite, leadership/team management, and mutual/trusting relationships are paramount attributes. These elements play a pivotal role in the decision-making process when evaluating and selecting a construction project during the bidding stage.

Kog and Loh [11] attempted to distinguish among CSFs for different components of the construction project, consisting of the schedule, budget, and quality performance. The application of the analytical hierarchy approach indicated that the adequacy of plans and specifications, as well as the competency of the project manager, are two of the factors that significantly impact the overall performance criteria. Project teams can improve the project's outcomes, reduce delays, and maximize resource usage through actively addressing the identified aspects of each project component. In their study of the impact of contractors' attributes on project success, Alzahrani and Emsley [12] explored the factors that greatly affected the success of construction projects. Yun et al. [13] carried out a survey

to investigate the key organizational factors of success that influenced the effectiveness of public–private partnerships. Li et al. [14] examined the factors associated with green building (GB) projects. In their comprehensive review, the most commonly identified variables affecting GB projects were communication and cooperation between project participants, effective project planning and control, the owner's involvement and commitment, clear goals and objectives, and the project manager's performance.

Sobieraj and Metelski [15] examined crucial elements in the administration of investment–construction projects in Poland. The study identified the factors that significantly impacted the performance of construction projects. These factors included effective planning and reviews, a competent project manager, an experienced project team, client engagement, and established PM procedures. Jung et al. [16] prioritized factors for off-site construction (OSC) and established the relationships among the identified CFs for OSC. An analysis of the results indicated that, among the 20 factors identified, the most significant factors for OSC success were adequate relevant experience and knowledge among designers and engineers, persistent policies and incentives, and the adequate relevant experience and knowledge of the contractor.

The factors that lead to project success have remained a central topic of discussion in the field of construction management. Wuni and Shen [17] investigated the factors involved in executing circular modular construction projects in Hong Kong. The analyses suggested 21 significant factors, among which the three most important factors were early design completion and freezing, the early understanding and commitment of the client, and the effective leadership and support of a specialist contractor. Alawag et al. [18] conducted a study to ascertain the CSFs influencing the adoption of total quality management (TQM) in the Malaysian industrialized building system. Drawing upon established concepts such as quality management systems, the conceptual framework facilitated the identification and categorization of 35 factors into six primary groups. A subsequent analysis revealed leadership to be the most significant factor, followed by top management, continuous improvement, customer satisfaction, process management, and teamwork.

More recently, a study conducted by Ahmad [19] revealed factors with critical significance in green building projects, which included the proficiency of the project clients, project team collaboration, the early engagement of the project team, the client's motivation to achieve sustainable outcomes, and rigor in project design development. Naji et al. [20] examined the critical success factors of fast-track construction projects. Their statistical analysis revealed the most significant factors that impacted fast-track project performance, including poor communication among the design and construction teams, large amounts of rework, low-quality work performed by the contractor, design errors, insufficient payment according to the terms agreed with the client, and the unavailability of materials. As can be observed, CFs are essential to the success of any organization. On the other hand, although CFs have been widely addressed over the decades, they have not been sufficiently defined to date [4], and researchers continue to conduct investigations into them.

2.2. Project Performance Criteria

The term 'performance' has gained considerable attention in recent decades; nevertheless, its interpretation differs among professionals and construction practitioners [21]. The performance of an organization is multidimensional and depends on the performance of the group members [22]. The measurement of the performance of a project according to the 'iron triangle' is the conventional approach and is of interest among professionals, construction practitioners, and researchers. However, the criteria adopted to gauge project performance can be evaluated using several indicators [23] and vary according to the context of the organization.

Ashley et al. [24] defined six criteria for the measurement of project performance as follows: schedule performance, budget performance, functionality and quality, client satisfaction, project team satisfaction, and contractor satisfaction. These criteria align with the overarching theoretical framework of the stakeholder approach, which suggests that project success is contingent upon the satisfaction of the diverse range of stakeholders

involved in the project. In their study seeking to determine the criteria for project success, Lim and Mohamed [25] proposed the following two possible viewpoints: micro and macro. The micro perspective focuses on certain elements, such as cost, quality, time, safety, and performance, emphasizing the precise criteria employed to evaluate project success at the operational level. In contrast, macro perspectives take into account broader elements, such as time, utility, and operation, which incorporate the overall goals and objectives of the project, beyond individual performance measures. These models offer valuable insights for the pursuit of more effective strategies to enhance project management performance.

Atkinson [26] proposed a new framework for success criteria beyond the 'iron triangle' (time, cost, and quality), called the 'square route'. In addition to the iron triangle, this framework considers the information system, the benefits related to the organization, and the benefits for the stakeholder community. According to Iyer and Jha [9], the cost, schedule, quality, and absence of disputes are the critical performance criteria used to measure the success of a project. Within this framework, the cost, schedule, and quality are internal project variables, whereas the absence of disputes reflects the management of external environmental contingencies. Therefore, these criteria are crucial in ensuring project success through considering both internal and external variables that influence the project's outcomes.

Because construction projects are dynamic and are becoming increasingly complex, numerous factors need to be addressed across the lifespan of a built asset [10]. In a survey conducted by Kog and Loh [11], the examination of the factors associated with various components of construction projects was based on the conceptual framework of the project objectives, with a specific emphasis on the budget, schedule, and quality. The findings of the study reveal that different project criteria lead to markedly distinct sets of critical factors that influence project success.

Based on the literature review, researchers express differing opinions regarding the criteria used to measure project performance. Clearly, the above discussion implies that the focus of attention regarding the criteria used to gauge project success has changed. According to Chan and Chan [27], the conventional project performance definition, focusing on the 'iron triangle', is inadequate. A recent literature review on this subject showed that various emerging performance indicators have been put forward to measure project performance. These performance criteria can be applied to a variety of dimensions, including the environment, health and safety, productivity, human resources, risk, client satisfaction, profitability, and contracts and administration [10,23,28].

2.3. Project Life Cycle

The concept of the project life cycle has been of great interest in the field of project management for several decades. It is recognized that a project comprises several separate phases, with each phase representing one component of the life cycle.

Pinto and Slevin [3] conducted a field study using a questionnaire survey to investigate variations in the importance of critical factors over the course of four phases of the project life cycle; namely, conceptualization, planning, execution, and termination. Chan and Kumaraswamy [29] divided the construction process into the following three consecutive phases: project conception, project design, and project construction. In their study of the factors that affect process quality, Arditi and Gunaydin [30] divided a building project's life cycle into the following three phases: design, construction, and operation. In a study by Park [10], for a performance assessment spanning the entire life cycle, the project was divided into five distinct phases as follows: predesign, design, procurement, construction, and postconstruction. Moreover, in a guide to project management published by the Project Management Institute [31], a typical project life cycle is divided into four main phases as follows: initiation, planning, execution, and closeout.

As observed from the above discussion, many attempts have been made to describe the life cycle of a project. However, different authors define the project life cycle in terms of different phases, depending on the complexity and possible impacts of the project.

2.4. Gaps in Past Studies

Over the last several decades, numerous attempts have been made to explore the factors believed to significantly impact project performance. Each study or research work, as revealed in the literature review, possesses unique weaknesses and strengths. The majority of the previous studies have primarily focused on elucidating the importance of certain factors through capturing the perceptions of a certain subject at a single point in time. Furthermore, studies have neglected to consider the dynamic nature of project performance criteria and the evolving significance of the critical factors depending on the phase of the life cycle being considered. While these previous studies contribute to the collective comprehension of CFs, they do not sufficiently address the central research question:

- Which factors influence the performance of construction projects throughout the entire life cycle in the Thai construction industry?

Therefore, a knowledge gap exists in this particular construction management domain. This gap that requires investigation for a complete understanding of the extent to which contributing factors influence project success.

3. Materials and Methods

3.1. Research Framework

The methodological framework of this study includes formulating the problem statement and research objectives, reviewing the relevant literature, identifying research gaps, selecting the research design and instruments, gathering data through questionnaire surveys, analyzing the data using qualitative and quantitative methods, engaging in a detailed discussion, determining the practical implications, and drawing conclusions and recommendations for future research. Figure 1 depicts a flow diagram outlining the research approach.

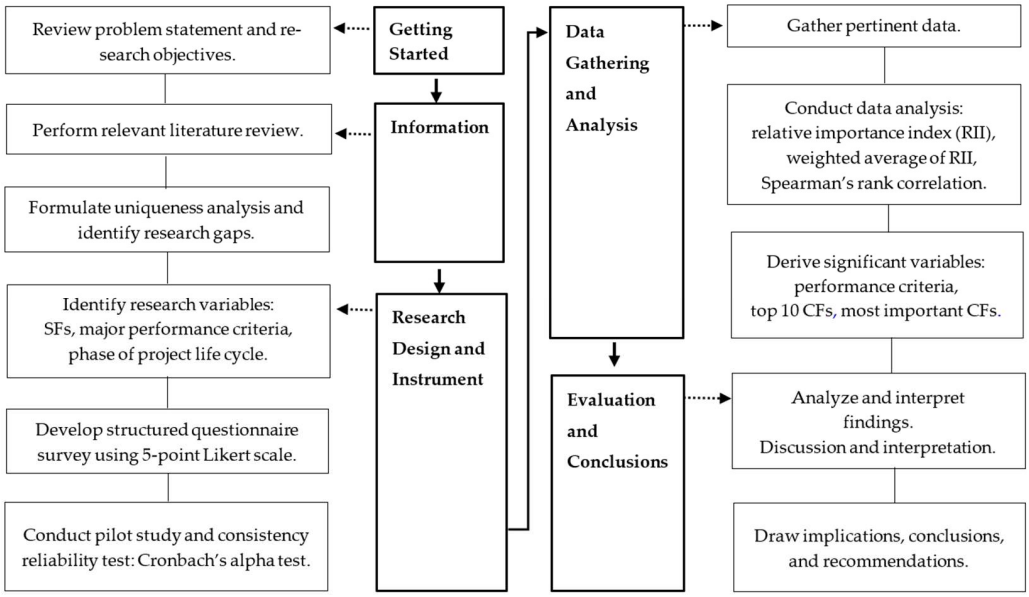

Figure 1. Flow diagram of research methodology.

3.2. Keyword Selection

Throughout the extensive literature search, care was taken to select relevant keywords and databases. The following outlines the methodology adopted for the keyword selection in the present research, which involved:

- Depicting the primary concepts, issues, and themes of the study;
- Outlining the study's objectives;
- Obtaining descriptors to identify the content and subject matter of the study.

Consequently, this study employed specific terms associated with construction management, including 'critical factors', 'project critical success factors', 'performance criteria', and 'project life cycle', as keywords to search for pertinent studies in databases such as Scopus and ScienceDirect. Scopus is a prominent database that is widely utilized by researchers, scholars, and academics. ScienceDirect is a reputable platform that hosts journals covering a wide range of disciplines. These platforms were selected as primary databases due to their extensive collection of relevant publications in the domain of construction management.

Employing the delineated approach, the database search undertaken in this study identified 90 accessible publications spanning the period between 1982 (when the concept of CSFs was initially introduced) and 2023. This underscores the relevance of the research data to both earlier investigations and recent scholarly contributions.

3.3. Identification of Research Variables

Corresponding with the research objectives, this study identified the following three main groups of variables: success-related factors as independent variables, performance criteria as dependent variables, and the phase of the life cycle as a moderating variable.

Success-related factors represent the essential aspects of project management that must be addressed to achieve the project objectives [16]. In this research, they were identified through a comprehensive literature review and expert consultation. Initially, a total of 225 individual factors reported in relevant previous studies were investigated. To correspond with the characteristics of the Thai construction industry, a total of 179 factors were explored [2–4,7–20,22,23,29,30,32–71]. Among these, 99 factors were selected, 47 modified, and 30 merged, with 3 new factors added. To illustrate this point, the phrase 'late delivery of materials and equipment' was modified to carry the reverse meaning; that is, the 'timely delivery of materials and equipment as planned'. Meanwhile, two components from different studies, 'risk identification' and 'risk response', were combined to convey the same meaning; that is, 'appropriate risk identification and response'. A list of the employed success-related factors is provided in Appendix A.

The criteria for project performance encompass a multitude of aspects related to the project outcomes. Following the identification of the success-related factors, the performance criteria were derived from a review of pertinent studies. Consequently, the following project performance criteria were identified as the nine most frequently used to assess the effectiveness and success of construction projects as follows: time, cost, quality, health and safety, environment, productivity, risk, human resources, and client satisfaction. In order to evaluate project performance across different objectives, all of these multidimensional performance criteria, including the 'iron triangle' as well as emerging performance measures such as human resources and risk management, were incorporated into the research design.

The phase of the project life cycle refers to the stage of project development, from initiation to completion and beyond. Following an exhaustive literature review, it was evident that previous researchers delineated the project life cycle into different phases, contingent upon the project's complexities and potential ramifications. Nonetheless, in the field of construction management, the project life cycle typically comprises the following five principal stages: conceptualization, planning and design, procurement, construction, and operation and maintenance. To adhere to the research objectives, all of these aspects were adopted as research variables.

Through identifying these variables, aiming to provide insights into the factors that contribute to project success and effectiveness at different stages of project development in the domain of construction management, this study could be considered reliable and valid.

3.4. Questionnaire Design

The questionnaire survey used in this study was based on 179 hypothesized individual factors, nine major performance categories, and five phases of the project life cycle. The nine performance criteria consisted of time (22), cost (23), quality (21), health and safety (23), environment (23), productivity (25), risk (25), human resources (24), and client

satisfaction (25). The numbers in parentheses indicate the factor count in each performance group. Additionally, the five distinct phases of the project life cycle were conceptualization, planning and design, procurement, construction, and operation and maintenance.

To ensure the completeness and accuracy of the questionnaire, a pilot survey involving 25 construction practitioners and professionals was undertaken. Based on the feedback from these subjects, necessary modifications were made to ensure the practicality of the questionnaire, such as omitting redundant variables, adding experts' comments and suggestions, and reorganizing the questions to improve its coherence.

Following the pilot test, the knowledge obtained was incorporated to form the final questionnaire. The internal consistency reliability of the questionnaire was assessed using the Cronbach's alpha test, as stated by Gliner and Morgan [72]. The value of Cronbach's alpha for the questionnaire, calculated using the software SPSS 26 for Windows, was 0.995, suggesting that the internal consistency reliability of the instrument was acceptable. Then, the questionnaire survey was conducted, focusing on three groups of respondents as follows:

- Group 1—Client Representatives (CR);
- Group 2—Construction Supervision Consultants/Design Consultants (CD);
- Group 3—Contractors (CS).

3.5. Data Collection

The primary data were collected through a questionnaire survey using snowball sampling, a nonprobability sampling method. According to Sekaran [73], this method can be considered very effective and is commonly used when obtaining responses from a sample population is challenging. In this study, 164 questionnaires were distributed to three groups of respondents. Of the total study population, 93 subjects completed and returned the questionnaire, yielding a response rate of 56.7%. A breakdown of the survey responses is provided in Table 1.

Table 1. Response rate of questionnaire survey.

Group of Respondents	Number of Questionnaires		Response Rate (%)	Proportion (%)
	Distributed	Returned		
Client representatives	51	26	51.0	28.0
Consultants	45	22	48.9	23.6
Contractors	68	45	66.2	48.4
Total	164	93	56.7	100.0

3.6. Statistical Analysis and Hypothesis Testing

Various statistical methods were used to analyze the data gathered through the questionnaire survey, including the relative importance index (RII), the 'weighted average' (Wa), and Spearman's rank correlation.

3.6.1. Relative Importance Index (RII)

The RII approach is commonly employed in construction research to gauge attitudes regarding the surveyed variables. This method serves as a trustworthy measure for the ranking of factors and is widely used for classification. Researchers contend that the common approach that utilizes the mean scores and standard deviations of individual attributes is not an appropriate statistical method for the evaluation of overall rankings because it does not consider the relationships between the variables [29]. Accordingly, this approach serves as a dependable indicator for the ranking of the factors under study. Additionally, this method can be used to transform the five-point Likert scale to evaluate the ranking of each factor.

In this study, a five-point Likert scale with a range of 'less important' (1) to 'extremely important' (5) was adopted for ranking purposes. The respondents' perceptions of the

relative rankings of the factors were determined using the relative importance index (RII), as detailed in the works of Enshassi et al. [23] and Chan and Kumaraswamy [29]. To calculate the RII for each factor, the weights assigned by respondents were aggregated using the following equation:

$$RII = \sum W/(A \times N), \quad 0 \leq RII \leq 1, \tag{1}$$

where W represents the weight given to each factor by the respondents (ranges from 1 to 5), A represents the highest weight (5), and N represents the total number of respondents for the factor.

The RII is a numerical value that ranges from 0 to 1 (0 not inclusive). When analyzing the RII derived from the analysis, RII values are utilized. The following scale categorizes the RII values into five levels of importance, ranging from extremely low to extremely high:

- 0.00–0.20: Extremely low importance;
- 0.21–0.40: Low importance;
- 0.41–0.60: Moderate importance;
- 0.61–0.80: High importance;
- 0.81–1.00: Extremely high importance.

3.6.2. Weighted Average (Wa) of the Rankings

This methodology finds widespread application across various industries, including construction management. In numerous scenarios, the data values do not uniformly hold the same significance. The 'weighted average' addresses these discrepancies through assigning weights to individual data values, thus accommodating the data variability and providing a more precise representation of the overall average. This method serves as one of the most straightforward approaches to elucidate principles and ascertain underlying data values.

Following the individual RII, the 'weighted average' (Wa) of the rankings was evaluated to determine the importance of each major performance criterion and success factor. The Wa was calculated using a combination of three RIIs derived from the results of the proportion of questionnaires obtained from each group corresponding to the total number of responses, as stated by Chan and Kumaraswamy [74]

$$Wa = \sum (n/N) \times RII, \quad 0 \leq Wa \leq 1, \tag{2}$$

where n represents the number of respondents in each group and N represents the total number of respondents.

After determining the Weighted Average of Relative Importance Index (Wa of RII), the ranking procedure is executed, with the factor demonstrating the highest Wa of RII value being deemed the most significant.

3.6.3. Spearman's Rank Correlation

Spearman's rank correlation, used to examine the relationship between two variables, is a highly beneficial statistical operation. There are several reasons for the selection of Spearman's rank correlation as an analytical instrument, including the following:

- It is highly suitable for the analysis of ordinal data, where the variables are ranked instead of being measured on a continuous scale;
- It is a nonparametric test that does not require normality;
- It is suitable for small sample sizes.

To assess the degree of concordance among the respondent groups in this study, Spearman's rank correlation was employed to determine the agreement in the rankings of the CFs and the project performance group between the two distinct respondent groups, as

in previous studies by Park [10] and Kog and Loh [11]. It is calculated using the following equation for any two sets of rankings:

$$rs = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)} \quad (3)$$

where *rs* represents the Spearman's rank correlation coefficient between two parties, di represents the difference in the ranks assigned to the variables for each cause, and n represents the number of pairs of ranks.

The correlation coefficient ranges from −1.0 to +1.0. A value of *rs* close to 1 represents a strong positive correlation between two variables, while a value close to −1 indicates a highly negative linear relationship between two variables. The strength of the Spearman's rank correlation coefficient depends on the magnitude of *rs* as follows:

- *rs* between 0.00 and 0.19: Very weak correlation;
- *rs* between 0.20 and 0.39: Weak correlation;
- *rs* between 0.40 and 0.59: Moderate correlation;
- *rs* between 0.60 and 0.79: Relatively strong correlation;
- *rs* between 0.80 and 1.00: Very strong correlation.

To ascertain the significance of the Spearman's rank correlation coefficient, a hypothesis test was employed. The following assumptions can be used to characterize significance testing:

- H_0: There is an insignificant degree of agreement among the participants;
- H_1: There is a statistically significant degree of agreement among the participants.

A *t*-test at a 95% confidence interval of the null hypothesis, H_0, was utilized to assess the significance of the correlation coefficient's rank. The *t*-test is defined by the following equation:

$$t = rs\sqrt{\frac{n-2}{1-rs^2}}, \quad (4)$$

4. Results

4.1. Background of Respondents and Characteristics of Projects

The demographic profile and project characteristics of the survey respondents are presented in Table 2. As indicated in the table, more than 60% of the questionnaire participants held key roles in senior executive positions within the organization, such as Managing Director, Project Director, and Project Manager. Therefore, it can be inferred that the respondents had sufficient experience to participate in this study.

Table 2. Respondent profiles and characteristics of projects.

General Information		Absolute Frequency	Relative Percent	Cumulative Percent
Job Title	Managing Director/Deputy Managing Director/Vice President	8	8.6	8.6
	Project Director	10	10.8	19.4
	Project Manager	38	40.9	60.3
	Production Manager	10	10.8	71.1
	Quality Control manager/Quantity Surveying Manager	5	5.4	76.5
	Design Manager/Technical Manager	8	8.6	85.1
	MEP Manager	3	3.2	88.3
	Others	11	11.7	100.0
Type of business	Public sector	5	5.4	5.4
	Private sector	88	94.6	100.0

Table 2. *Cont.*

General Information		Absolute Frequency	Relative Percent	Cumulative Percent
Field of specialisation	Building construction	15	16.1	16.1
	Residential construction	70	75.3	91.4
	Heavy engineering construction	1	1.1	92.5
	Industrial construction	7	7.5	100.0
Type of project delivery systems	Design–bid–build	36	38.7	38.7
	Design–build	30	32.3	71.0
	Construction management	26	27.9	98.9
	Public–private partnership	1	1.1	100.0

Regarding their fields of specialization, building construction and residential construction accounted for 91.4%. Most of these projects were high-rise buildings. Furthermore, the design–bid–build system was the favored project delivery system used by contracting agencies, with lump-sum contracts being the professionals' most preferred form. The survey respondents participated in construction projects of various sizes, ranging from USD 3 million to over USD 90 million.

4.2. Importance of Project Performance Criteria

The ranks and importance indices of nine major performance criteria across five phases of the project life cycle are presented in Table 3. Overall, the most striking finding was that client satisfaction was the most frequently used criterion to measure project success. This is because it can affect the project's performance, the company's reputation, and its profitability. Satisfied clients are more inclined to deal with a particular construction firm again in the future. Thus, construction firms must prioritize client satisfaction through ensuring high-quality work, effective communication, and excellent client services. Ultimately, repeat business is only possible with satisfied clients, allowing companies to build a strong client base and generate consistent revenues. The results demonstrated that the 'iron triangle' criteria, with respect to time, cost, and quality, may have been the most favorable benchmark used to evaluate project performance. While there were some instances in which the environmental and human resource criteria impacted project success, these were exceptions.

Table 3. Rank and relative importance index of nine major performance criteria categorized by project phase.

Project Performance Criteria	Weighted Average									
	CC		PD		PR		CN		OM	
	RII	R	RII	R	RII	R	RII	R	RII	R
Time	0.632	4	0.705	3	0.704	2	0.918	2	0.619	5
Cost	0.635	3	0.671	6	0.811	1	0.884	5	0.585	8
Quality	0.568	7	0.701	4	0.688	3	0.920	1	0.781	2
Health and safety	0.502	9	0.535	9	0.516	9	0.908	4	0.667	3
Environment	0.608	6	0.680	5	0.525	8	0.862	8	0.611	6
Productivity	0.524	8	0.634	8	0.623	6	0.912	3	0.630	4
Risk	0.695	2	0.729	2	0.660	5	0.852	9	0.570	9
Human resources	0.613	5	0.664	7	0.609	7	0.878	6	0.596	7
Client satisfaction	0.711	1	0.776	1	0.688	4	0.877	7	0.845	1

Note: CC = Conceptualization phase; PD = Planning and design phase; PR = Procurement phase; CN = Construction phase; OM = Operation and maintenance phase; RII = Relative importance index; R = Rank.

4.3. Deriving Critical Factors for Different Objectives across the Project Life Cycle

The weighted average RII and ranking of the top 10 CFs for the nine performance criteria across the life-cycle phases are presented in Tables 4–8.

Table 4. Top 10 critical individual factors categorized by performance criteria and project phases—Time.

Hypothesized Factors	Weighted Average									
	CC		PD		PR		CN		OM	
	RII	R	RII	R	RII	R	RII	R	RII	R
Time										
Adequacy of communication and coordination among parties	0.682	9	0.783	8	0.749	6	0.899	10	0.617	8
Adequacy of plans and specification	0.701	8	0.777	9	-	-	-	-	-	-
Adequate experience of project participants	0.776	4	0.853	2	0.748	7	0.903	5	0.671	2
Availability of resources as planned throughout the project duration	-	-	-	-	-	-	0.906	3	-	-
Commitment and involvement of all project participants	0.738	7	0.776	10	0.737	10	-	-	0.658	3
Completeness of design documents	-	-	0.910	1	0.746	9	-	-	-	-
Contractual motivation/incentives	-	-	-	-	-	-	-	-	0.624	7
Control of delays among agencies involved in the project	-	-	-	-	-	-	0.912	2	-	-
Effective change order management	-	-	-	-	-	-	-	-	0.618	9
Effective planning and scheduling	0.746	6	0.809	6	-	-	-	-	-	-
Effective site management and supervision	-	-	-	-	-	-	0.901	9	0.648	4
Favorable climatic condition	-	-	-	-	-	-	0.905	4	-	-
Frequent reviewing, monitoring, and updating of construction program	-	-	-	-	-	-	0.916	1	-	-
Mode of financing and payment for completed works	0.650	10	-	-	0.787	4	-	-	-	-
Competence of project participants	0.783	3	0.847	3	0.776	5	0.901	7	0.683	1
Proper construction methods/techniques implemented in the project	-	-	0.843	4	-	-	0.901	8	-	-
Proper procurement programing of materials and stacking	-	-	-	-	0.874	1	-	-	-	-
Rapid decision making									0.604	10
Realistic obligations/clear objectives	0.750	5	-	-	-	-	-	-	0.639	5
Realistic project time imposed in contract duration	0.783	2	0.799	7	0.746	8	-	-	-	-
Timely delivery of materials/equipment as planned	-	-	-	-	0.835	2	0.903	6	-	-
Top management support	0.790	1	0.817	5	0.796	3	-	-	0.630	6

Overall, the results show that the top 10 CFs in each performance criterion vary according to the phase of the project. For instance, in the client satisfaction category, 'adequate cost control measures' was ranked first and ninth in the procurement and construction phases, respectively, whereas it was not considered among the top 10 CFs in other phases of the life cycle. However, the findings offer compelling evidence for the 12 fundamental parameters that are essential to project performance across all phases of the project life cycle. These are 'adequacy of communication and coordination among parties', 'adequate experience of project participants', 'competence of project participants', 'availability of competent staff', 'effective coordination between parties taking part in the project', 'implementation of safety management system in accordance with legislation', 'utilization of up-to-date technology', 'clear and timely inspection', 'competent supervisors', 'need for collaboration', 'spirit of cooperation among project team', and 'professionalism of services provided by project team'.

Table 5. Top 10 critical individual factors categorized by performance criteria and project phases—Cost, Quality.

Hypothesized Factors	Weighted Average									
	CC		PD		PR		CN		OM	
	RII	R	RII	R	RII	R	RII	R	RII	R
Cost										
Adequacy of communication and coordination among parties	0.660	10	0.755	10	-	-	0.897	10	0.615	4
Adequacy of raw materials and equipment	-	-	-	-	-	-	0.908	3	0.600	7
Adequacy of scopes and specifications	0.760	1	0.813	5	0.759	10	-	-	-	-
Adequate experience of project participants	0.739	2	0.828	4	0.770	7	0.903	4	0.660	2
Adequate tender sum	0.683	8	-	-	0.836	4	-	-	-	-
Availability of resources as planned throughout the project duration	-	-	-	-	-	-	0.903	5	0.603	6
Certainty of cash flow of the project	0.682	9	-	-	0.823	5	0.901	8	-	-
Competitive tendering process	-	-	-	-	0.845	3	-	-	-	-
Completeness of considerations in design	0.707	6	0.873	2	-	-	-	-	-	-
Completeness of design documents	0.704	7	0.899	1	0.766	8	-	-	-	-
Effective change in the scope of work management	-	-	0.768	7	-	-	-	-	-	-
Effective contract administration and management	-	-	-	-	0.761	9	-	-	0.598	9
Effective project cost control mechanisms	-	-	-	-	0.847	2	0.901	7	-	-
Effective site management and supervision	-	-	-	-	-	-	0.899	9	0.614	5
Eliminating waste	-	-	-	-	-	-	0.902	6	0.600	8
Frequent progress meeting	-	-	-	-	-	-	0.935	1	0.641	3
Mode of financing and payment for completed works	-	-	-	-	0.791	6	-	-	-	-
Proper project planning and scheduling	0.716	5	0.834	3	-	-	-	-	-	-
Rapid decision making	-	-	0.759	9	-	-	0.916	2	0.592	10
Realistic duration of contract period and requirement imposed	0.720	4	0.808	6	-	-	-	-	-	-
Relationship among project participants	0.723	3	0.760	8	-	-	-	-	0.669	1
Stability in the price of materials	-	-	-	-	0.860	1	-	-	-	-
Quality										
Adequacy of plans and specifications	-	-	0.780	9	-	-	-	-	-	-
Adequate communication among project teams	0.716	4	0.784	7	0.744	4	0.89	10	-	-
Availability of competent staff	0.755	1	0.808	4	0.735	8	0.919	3	0.689	4
Commitment and involvement of all project participants	0.702	6	0.789	6	0.738	7	-	-	-	-
Competency of project manager	0.748	2	-	-	0.751	3	0.935	1	0.673	6
Conformance to specification	-	-	0.824	2	0.761	2	-	-	-	-
Constructability	0.680	10	-	-	-	-	0.901	6	-	-
Determining quality in construction	-	-	0.824	3	0.767	1	0.907	5	-	-
Effective cooperation between parties taking part in the project	0.699	7	0.78	8	0.738	6	0.894	8	0.668	9
Effective design and construction quality plan	0.703	5	0.873	1	-	-	-	-	-	-
Effective monitoring and feedback	-	-	-	-	-	-	-	-	0.689	3
Effective quality assurance system in organization	-	-	-	-	-	-	-	-	0.800	1
Effective teamwork to promote quality issues in the project	-	-	-	-	0.725	9	0.901	7	-	-
Favorable working condition	-	-	-	-	-	-	-	-	0.671	7
Management commitment to continual quality improvement	0.680	9	-	-	0.723	10	0.894	9	0.668	10
Management leadership in promoting high process quality	0.689	8	-	-	-	-	-	-	0.697	2
Quality of equipment and raw materials	-	-	-	-	-	-	0.916	4	0.669	8
Top management support	0.725	3	0.796	5	0.744	5	-	-	0.684	5
Utilization of up-to-date technology	-	-	0.774	10	-	-	0.925	2	-	-

Table 6. Top 10 critical individual factors categorized by performance criteria and project phases—Health and safety, Environment.

Hypothesized Factors	Weighted Average									
	CC		PD		PR		CN		OM	
	RII	R	RII	R	RII	R	RII	R	RII	R
Health and safety										
Adequacy of budget allocated for safety	0.609	8	0.635	6	0.647	3	-	-	-	-
Adequate number of site safety representatives	-	-	-	-	-	-	-	-	0.662	6
Availability of adequate facilities for first aid treatment and medical advice	-	-	-	-	-	-	0.914	7	-	-
Clear organizational safety policy	0.658	2	0.660	4	-	-	-	-	-	-
Conducting regular safety meetings	-	-	-	-	-	-	0.925	4	0.658	10
Conducting safety hazard identification and review	-	-	-	-	-	-	0.914	8	0.66	7
Delegation of safety authority and responsibility to site personnel	0.589	9	0.617	9	-	-	-	-	-	-
Effective coordination, control, and management of subcontractors	-	-	-	-	0.608	6	0.925	3	0.666	2
Frequent conduct of appropriate site safety inspection and supervision	-	-	-	-	-	-	-	-	0.658	9
Historic, human, and psychological climate	-	-	-	-	0.593	10	-	-	-	-
Implementation of safety management system in accordance to legislation	0.632	4	0.661	3	0.603	9	0.933	1	0.665	4
Interrelation between employee and supervisor	0.622	5	0.633	8	0.606	8	-	-	0.671	1
Involvement of project participants in safety awareness	-	-	0.613	10	-	-	0.912	10	0.660	8
Issuing and implementation of in-house safety rules and procedures	0.620	6	0.634	7	-	-	0.914	9	-	-
Positive personal attitudes of project participants	0.641	3	0.690	1	0.645	4	-	-	0.666	3
Proper planning and organizing of safety working environment onsite	0.609	7	0.658	5	0.606	7	0.914	6	-	-
Provision and conduct of appropriate safety education and training	-	-	-	-	-	-	0.920	5	0.662	5
Safety equipment acquisition and maintenance	-	-	-	-	0.727	1	-	-	-	-
Sufficient safety resource allocation	0.581	10	-	-	0.626	5	0.929	2	-	-
Top management support	0.683	1	0.666	2	0.714	2	-	-	-	-
Environment										
Adequacy of cooperation among project participants	0.613	6	0.703	5	0.619	3	-	-	-	-
Budgeting allowed in implementing environmental management activities	0.656	4	0.682	6	0.669	1	-	-	-	-
Clear definitions on environmental management responsibilities among project parties	0.701	3	0.736	3	-	-	-	-	-	-
Effective air pollution control	-	-	-	-	-	-	0.888	4	-	-
Effective monitoring of energy consumption	-	-	-	-	-	-	0.861	9	0.682	4
Effective noise pollution control	-	-	-	-	-	-	0.896	1	-	-
Effective supervision among project parties	0.596	8	0.658	9	0.612	7	-	-	-	-
Effective waste pollution control	-	-	-	-	-	-	0.894	2	0.664	7
Effective water pollution control	-	-	-	-	-	-	0.890	3	0.661	10
Involvement by clients on environmental management plan	0.718	2	0.763	2	0.611	8	-	-	-	-
Participation in environmental initiatives by management	0.760	1	0.785	1	0.615	6	-	-	-	-
Project participants' awareness of waste reduction	0.589	9	-	-	-	-	0.881	5	-	-
Proper environmental site planning	0.654	5	0.733	4	-	-	-	-	0.664	8
Proper positioning and maintenance of site environment	-	-	-	-	-	-	0.874	7	0.662	9
Regular maintenance of equipment on the project	-	-	-	-	-	-	0.873	8	0.692	1
Sufficient auditing activities	-	-	-	-	0.618	4	0.875	6	0.684	2
Sufficient provision of environmental management training to all staff	-	-	-	-	0.600	10	-	-	0.682	3
Use of environmentally friendly equipment	-	-	0.647	10	0.615	5	-	-	0.664	6
Use of modular materials in the project	0.578	10	0.660	8	0.609	9	-	-	-	-
Utilization of up-to-date technology	0.604	7	0.677	7	0.633	2	0.860	10	0.666	5

Table 7. Top 10 critical individual factors categorized by performance criteria and project phases—Productivity, Risk.

Hypothesized Factors	Weighted Average									
	CC		PD		PR		CN		OM	
	RII	R	RII	R	RII	R	RII	R	RII	R
Productivity										
Adequacy of skill training and development to employees	-	-	-	-	-	-	-	-	0.635	7
Adequate communication among project teams	0.617	6	0.693	9	0.714	4	-	-	-	-
Appropriate construction method	-	-	0.740	3	-	-	0.924	1	-	-
Availability of construction materials	-	-	-	-	0.729	2	0.912	4	-	-
Availability of financial motivation system	0.613	8	-	-	-	-	-	-	0.630	10
Availability of skilled personnel	0.611	9	-	-	0.688	8	0.911	5	0.647	3
Availability of tools and equipment	-	-	-	-	-	-	0.914	3	-	-
Availability of utilities	0.604	10	-	-	-	-	-	-	-	-
Clear and timely inspection	0.631	4	0.695	8	0.712	5	0.910	6	0.643	4
Competent supervisors	0.645	2	0.732	4	0.717	3	0.916	2	0.675	1
Completeness of drawing documents	-	-	0.785	1	0.763	1	-	-	-	-
Constructability	-	-	0.680	10	-	-	-	-	-	-
Effective change order management	-	-	-	-	-	-	-	-	0.641	5
Effective control of working overtime	-	-	-	-	-	-	0.910	7	-	-
Effective planning and scheduling	0.643	3	0.767	2	0.710	6	0.908	9	-	-
Effective rework	-	-	-	-	-	-	-	-	0.639	6
Effective site management and supervision	0.620	5	-	-	0.684	9	-	-	-	-
Efficiency of tools and equipment	-	-	-	-	-	-	0.908	8	0.632	8
Management–labor relationship	0.645	1	0.714	5	0.679	10	-	-	0.651	2
Proper site layout arrangement and management	0.615	7	0.707	6	-	-	-	-	-	-
Specification and standardization	-	-	0.701	7	0.704	7	-	-	-	-
Utilization of up-to-date technology	-	-	-	-	-	-	0.906	10	0.632	9
Risk										
Absence of change in government codes and regulations	0.663	10	-	-	-	-	-	-	-	-
Absence of defective materials	-	-	-	-	0.791	6	-	-	0.643	6
Accurate anticipation of exchange rate fluctuation and inflation	0.669	9	-	-	0.766	8	-	-	-	-
Accurate measurement and pricing of bill of quantities	-	-	0.761	8	0.833	1	-	-	-	-
Adequacy of communication and coordination among parties	0.679	8	0.766	7	0.742	10	0.875	9	0.645	5
Availability of funds as planned throughout the project duration	0.733	3	-	-	0.793	5	-	-	0.637	7
Availability of resources as planned throughout the project duration	-	-	0.742	9	-	-	0.881	8	-	-
Certainty of cash flow of the project	-	-	-	-	0.800	2	0.870	10	0.632	9
Clear objectives and scope of work definition	0.767	1	0.805	4	-	-	-	-	-	-
Completeness of design documents	0.684	7	0.849	1	0.756	9	-	-	-	-
Effective change in the scope of work management	-	-	0.772	6	-	-	-	-	-	-
Effective control of third-party delays	-	-	-	-	0.770	7	0.882	7	0.649	4
Effective project planning and control	0.716	4	0.827	2	-	-	0.890	4	-	-
Feasibility of construction method	-	-	0.811	3	-	-	-	-	-	-
Financial stability of project participants	0.738	2	-	-	0.794	4	0.901	2	-	-
High construction productivity	-	-	-	-	-	-	0.894	3	-	-
Implementation of effective site safety management program	-	-	-	-	-	-	-	-	0.635	8
Implementation of proper site condition survey	0.714	5	0.740	10	-	-	-	-	-	-
Competence of project participants	0.703	6	0.790	5	-	-	0.886	5	0.669	3
Quality of work to match standards	-	-	-	-	-	-	0.884	6	0.695	1
Timely payment on contract and extra works	-	-	-	-	0.798	3	0.905	1	0.676	2

Table 8. Top 10 critical individual factors categorized by performance criteria and project phases—HR, Client satisfaction.

Hypothesized Factors	Weighted Average									
	CC		PD		PR		CN		OM	
	RII	R	RII	R	RII	R	RII	R	RII	R
Human resources										
Adequacy of compensation level	-	-	-	-	0.705	3	-	-	-	-
Adequacy of skill training and development to employees	-	-	-	-	-	-	-	-	0.699	3
Adequate communication among project team members	0.669	8	0.733	6	0.715	1	-	-	-	-
Adequate employee support from senior management	0.682	6	-	-	-	-	-	-	0.692	9
Attractiveness of compensation level	-	-	-	-	-	-	0.880	9	-	-
Availability of employee motivation system	0.663	10	-	-	0.695	5	-	-	-	-
Availability of internal promotion	-	-	-	-	-	-	-	-	0.692	8
Availability of participation programs	-	-	-	-	-	-	0.890	4	-	-
Availability of skilled personnel	-	-	0.746	1	0.686	9	0.899	2	0.710	2
Clearly written line of responsibility	0.686	5	0.725	8	-	-	-	-	-	-
Commitment of the project team	0.688	3	0.733	5	0.692	6	-	-	-	-
Comprehension of organization's mission/vision	0.712	2	0.727	7	-	-	-	-	-	-
Effective human resource planning	-	-	0.742	3	-	-	0.884	6	-	-
Effective monitoring and feedback	-	-	-	-	-	-	-	-	0.699	5
High effectiveness of training program	-	-	-	-	-	-	-	-	0.682	10
High efficiency of project organization	-	-	0.724	9	0.688	8	0.875	10	-	-
High labor productivity	-	-	-	-	-	-	0.905	1	-	-
Legal requirement/compliance	-	-	-	-	0.699	4	-	-	0.695	6
Need for collaboration	0.688	4	0.744	2	0.707	2	0.895	3	0.699	4
Positive attitude of employees	0.678	7	-	-	-	-	-	-	0.720	1
Proper administration and disciplinary procedures to all employees	-	-	-	-	0.677	10	-	-	-	-
Spirit of cooperation among project team members	0.666	9	0.723	10	0.692	7	0.884	7	0.695	7
Sufficiency of managerial and technical manpower	-	-	-	-	-	-	0.888	5	-	-
Timely decision making in human resource	-	-	-	-	-	-	0.880	8	-	-
Top-down decision making	0.718	1	0.740	4	-	-	-	-	-	-
Client satisfaction										
Accurate project cost estimates in accordance with plans and specifications	0.729	10	0.795	4	0.796	2	-	-	-	-
Adequate cost control measures	-	-	-	-	0.804	1	0.890	9	-	-
Aesthetics of completed work	-	-	-	-	-	-	0.914	3	0.832	2
Appropriate provision of skilled and trained workforce	-	-	-	-	-	-	0.909	4	-	-
Client orientation	0.748	4	-	-	0.736	10	-	-	-	-
Commitment and involvement of top management	0.779	1	0.791	5	-	-	-	-	-	-
Completeness of considerations in design	0.759	3	0.811	2	-	-	-	-	-	-
Completeness of product/service	-	-	-	-	0.748	6	-	-	0.764	7
Durability of completed work	-	-	-	-	-	-	0.918	1	0.849	1
Effective change order management	-	-	-	-	-	-	0.899	7	-	-
Effective coordination between client and project parties	0.734	7	0.774	6	0.750	5	-	-	0.748	10
Effective management and organization of work	0.734	6	0.763	9	-	-	-	-	-	-
Effective planning and scheduling	0.747	5	0.848	1	0.740	7	-	-	-	-
Efficient functionality of product/service	-	-	-	-	-	-	-	-	0.772	6
Good communication at all levels	0.733	8	0.763	10	0.738	9	-	-	-	-
High quality of workmanship	-	-	-	-	-	-	0.918	2	0.752	9
Participation and commitment of project teams	-	-	0.764	8	0.738	8	0.883	10	-	-
Professionalism of services provided by project team	0.776	2	0.798	3	0.761	3	0.903	6	0.758	8
Quality of product/service to match standards	-	-	-	-	-	-	-	-	0.779	5
Rapid response to legitimate complaints	-	-	-	-	-	-	-	-	0.794	3
Recognition of risks and uncertainties associated with the project	0.733	9	-	-	-	-	-	-	-	-
Safe work environment	-	-	-	-	-	-	0.896	8	-	-
Timeliness of service	-	-	0.770	7	0.755	4	0.905	5	0.786	4

4.4. Degree of Agreement among the Respondent Groups

4.4.1. Major Performance Categories

The correlation between two sets of rankings for the nine major performance categories across the entire project life cycle, as identified by different groups of respondents, is presented in Table 9. As the table shows, in the CC and PD phases, there is a substantial positive degree of agreement between client representatives and contractors, with coefficients of 0.967 ($p \leq 0.001$) and 0.667 ($p \leq 0.001$), respectively, whereas there are differing perceptions of the degree of agreement between client representatives and consultants, as well as between consultants and contractors. In the PR phase, it can be concluded that all groups of participants exhibit strong positive significance between any different pairs of respondents. This emphasizes the concordance between the client representatives and contractors in the nine major performance groups. However, the results in Table 9 indicate that the Spearman's correlation coefficients between the client representative and consultant groups is −0.100 during the CN phase. This implies that there is a substantial negative degree of agreement between the two groups. In addition, it is observed that the level of agreement is insignificant between the client representative and consultant groups in the OM phase.

Table 9. Spearman's rank correlation between participants for nine major performance groups by project phase.

Participants	CC		PD		PR		CN		OM	
	rs	**Sig**	***rs***	**Sig**	***rs***	**Sig**	***rs***	**Sig**	***rs***	**Sig**
Client representatives and consultants	0.600	0.088	0.617	0.077	0.700	0.036 *	−0.100	0.798	0.500	0.170
Consultants and contractors	0.500	0.170	0.450	0.224	0.750	0.020 *	0.667	0.050 *	0.717	0.030 *
Client representatives and contractors	0.967	0.000 **	0.667	0.000 **	0.950	0.000 **	0.483	0.187	0.683	0.042 *

Note: * Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

4.4.2. Top 90 Critical Factors

The correlation between two sets of rankings for the top 90 CFs across the entire project life cycle, according to different groups of respondents, is presented in Table 10. The Spearman's rank correlation analysis demonstrates that there is a significant degree of agreement between any two groups of project participants during the CC, PD, and PR phases (Table 10). This emphasizes the concordance among all survey respondents regarding the top 90 CFs. However, the results in Table 10 indicate that there are differing perceptions of the degree of agreement in the CN and OM phases. In addition, it is observed that the level of agreement is significant only between the client representative and consultant groups in the OM phase.

Table 10. Spearman's rank correlation between participants for the top 90 CFs by project phase.

Participants	CC		PD		PR		CN		OM	
	rs	**Sig**	***rs***	**Sig**	***rs***	**Sig**	***rs***	**Sig**	***rs***	**Sig**
Client representatives and consultants	0.495	0.000 **	0.382	0.000 **	0.326	0.006 **	0.515	0.069	0.313	0.003 *
Consultants and contractors	0.327	0.002 **	0.578	0.000 **	0.231	0.029 *	−0.162	0.128	0.112	0.294
Client representatives and contractors	0.372	0.000 **	0.482	0.000 **	0.326	0.002 **	−0.074	0.486	0.057	0.596

Note: * Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

4.5. Analysis of Most Critical Factors

The ranking and relative importance indices discussed in the previous section provide insights into the CFs adopted in each category. However, the results fail to identify the underlying factors influencing project performance and success. Consequently, the following analysis aims to investigate the CFs that significantly impact project performance over the life cycle. Table 11 shows the project performance criteria matrix of CFs, obtained and developed by combining the weighted averages of the RII of the nine performance criteria by phase (Table 3) with the weighted averages of the RII for the top 10 CFs in each category (Tables 4–8).

Table 11. Project performance criteria matrix of CFs across the whole project phases.

Performance Criteria/Critical Factors	Wa of RII					Combined Wa of the RII	R
	CC	PD	PR	CN	OM		
Time							
Competence of project participants	0.783	0.847	0.776	0.901	0.683	0.807	1
Adequate experience of project participants	0.776	0.853	0.749	0.903	0.671	0.800	2
Top management support	0.790	0.817	0.796	0.875	0.630	0.791	3
Commitment and involvement of all project participants	0.738	0.776	0.737	0.897	0.658	0.772	4
Adequacy of communication and coordination among parties	0.682	0.783	0.748	0.899	0.617	0.759	5
Effective planning and scheduling	0.746	0.809	0.707	0.860	0.590	0.753	6
Realistic project time imposed in contract duration	0.783	0.799	0.746	0.836	0.552	0.753	7
Realistic obligations/clear objectives	0.750	0.773	0.727	0.835	0.639	0.753	8
Completeness of design documents	0.641	0.910	0.746	0.822	0.568	0.748	9
Rapid decision making	0.645	0.733	0.723	0.886	0.604	0.732	10
Cost							
Adequate experience of project participants	0.739	0.828	0.770	0.903	0.660	0.790	1
Relationship among project participants	0.723	0.760	0.732	0.895	0.669	0.765	2
Completeness of design documents	0.704	0.899	0.766	0.812	0.542	0.755	3
Adequacy of communication and coordination among parties	0.660	0.755	0.758	0.897	0.615	0.751	4
Rapid decision making	0.658	0.759	0.751	0.916	0.592	0.751	5
Certainty of cash flow of the project	0.682	0.690	0.823	0.901	0.560	0.750	6
Frequent progress meeting	0.656	0.731	0.703	0.935	0.641	0.747	7
Effective project cost control mechanisms	0.604	0.695	0.847	0.901	0.565	0.743	8
Adequacy of scopes and specifications	0.760	0.813	0.759	0.776	0.546	0.739	9
Proper project planning and scheduling	0.716	0.834	0.709	0.836	0.522	0.735	10
Quality							
Availability of competent staff	0.755	0.808	0.735	0.919	0.689	0.788	1
Competency of project manager	0.748	0.770	0.751	0.935	0.673	0.784	2
Determining quality in construction	0.669	0.824	0.767	0.907	0.665	0.776	3
Top management support	0.725	0.796	0.744	0.882	0.684	0.773	4
Adequate communication among project teams	0.716	0.784	0.744	0.890	0.665	0.767	5
Effective cooperation between parties taking part in the project	0.699	0.780	0.738	0.894	0.668	0.764	6
Management leadership in promoting high process quality	0.689	0.749	0.714	0.891	0.697	0.758	7
Effective design and construction quality plan	0.703	0.873	0.696	0.866	0.615	0.756	8
Management commitment to continual quality improvement	0.680	0.760	0.723	0.894	0.669	0.755	9
Effective quality assurance system in organisation	0.627	0.704	0.716	0.860	0.800	0.754	10

Table 11. *Cont.*

Performance Criteria/Critical Factors	Wa of RII					Combined Wa of the RII	R
	CC	PD	PR	CN	OM		
Health and safety							
Positive personal attitudes of project participants	0.641	0.690	0.645	0.912	0.666	0.734	1
Top management support	0.683	0.666	0.714	0.879	0.637	0.732	2
Implementation of safety management system in accordance to legislation	0.632	0.661	0.603	0.933	0.665	0.726	3
Clear organisational safety policy	0.658	0.660	0.583	0.912	0.654	0.719	4
Proper planning and organising of safety working environment onsite	0.609	0.658	0.606	0.914	0.647	0.714	5
Safety equipment acquisition and maintenance	0.576	0.581	0.727	0.897	0.643	0.709	6
Interrelation between employee and supervisor	0.622	0.633	0.606	0.884	0.671	0.708	7
Issuing and implementation of in-house safety rules and procedures	0.620	0.634	0.577	0.914	0.648	0.706	8
Sufficient safety resource allocation	0.581	0.604	0.626	0.929	0.641	0.706	9
Adequacy of budget allocated for safety	0.609	0.635	0.647	0.873	0.645	0.704	10
Environment							
Participation in environmental initiatives by management	0.760	0.785	0.615	0.818	0.609	0.728	1
Involvement by clients on environmental management plan	0.718	0.763	0.611	0.800	0.600	0.709	2
Clear definitions on environmental management responsibilities among project parties	0.701	0.736	0.587	0.830	0.622	0.708	3
Proper environmental site planning	0.654	0.733	0.560	0.849	0.665	0.708	4
Utilisation of up-to-date technology	0.604	0.677	0.633	0.860	0.666	0.703	5
Budgeting allowed in implementing environmental management activities	0.656	0.682	0.669	0.832	0.581	0.696	6
Adequacy of cooperation among project participants	0.613	0.703	0.619	0.834	0.633	0.694	7
Sufficient auditing activities	0.573	0.629	0.618	0.875	0.684	0.693	8
Effective supervision among project parties	0.596	0.658	0.612	0.854	0.653	0.690	9
Project participants' awareness of waste reduction	0.589	0.636	0.583	0.881	0.660	0.689	10
Productivity							
Competent supervisors	0.645	0.732	0.717	0.916	0.675	0.755	1
Completeness of drawing documents	0.579	0.785	0.763	0.905	0.621	0.750	2
Effective planning and scheduling	0.643	0.767	0.710	0.908	0.619	0.748	3
Clear and timely inspection	0.631	0.695	0.712	0.910	0.643	0.737	4
Appropriate construction method	0.588	0.740	0.666	0.924	0.628	0.731	5
Management–labor relationship	0.645	0.714	0.679	0.873	0.651	0.728	6
Adequate communication among project teams	0.693	0.714	0.888	0.630	0.708	0.726	7
Availability of skilled personnel	0.656	0.688	0.911	0.647	0.703	0.723	8
Effective site management and supervision	0.678	0.684	0.881	0.630	0.698	0.716	9
Utilisation of up-to-date technology	0.678	0.668	0.906	0.632	0.692	0.714	10
Risk							
Effective project planning and control	0.716	0.824	0.732	0.890	0.611	0.767	1
Competence of project participants	0.703	0.790	0.731	0.886	0.669	0.765	2
Financial stability of project participants	0.738	0.731	0.793	0.901	0.606	0.765	3
Clear objectives and scope of work definition	0.767	0.805	0.714	0.856	0.620	0.763	4
Availability of funds as planned throughout the project duration	0.733	0.710	0.794	0.862	0.637	0.755	5
Completeness of design documents	0.684	0.849	0.756	0.835	0.581	0.752	6
Adequacy of communication and coordination among parties	0.679	0.766	0.742	0.875	0.645	0.751	7
Accurate measurement and pricing of bill of quantities	0.636	0.761	0.833	0.858	0.597	0.747	8
Availability of resources as planned throughout the project duration	0.655	0.742	0.738	0.881	0.618	0.738	9
Timely payment on contract and extra works	0.600	0.650	0.798	0.905	0.676	0.734	10

Table 11. *Cont.*

Performance Criteria/Critical Factors	Wa of RII					Combined Wa of the RII	R
	CC	PD	PR	CN	OM		
Human resources							
Need for collaboration	0.688	0.744	0.707	0.895	0.699	0.759	1
Availability of skilled personnel	0.660	0.746	0.686	0.899	0.710	0.753	2
Spirit of cooperation among project team members	0.666	0.723	0.692	0.884	0.695	0.744	3
Top-down decision making	0.718	0.740	0.677	0.869	0.638	0.740	4
Effective human resource planning	0.660	0.742	0.677	0.884	0.658	0.737	5
Clearly written line of responsibility	0.686	0.725	0.673	0.867	0.678	0.737	6
Adequate communication among project team members	0.669	0.733	0.715	0.859	0.652	0.737	7
Commitment of the project team	0.688	0.733	0.692	0.856	0.658	0.736	8
Positive attitude of employees	0.678	0.716	0.673	0.846	0.720	0.736	9
Availability of employee motivation system	0.663	0.694	0.695	0.867	0.677	0.731	10
Client satisfaction							
Professionalism of services provided by project team	0.776	0.798	0.761	0.903	0.758	0.802	1
Timeliness of service	0.708	0.770	0.755	0.905	0.786	0.790	2
Effective planning and scheduling	0.747	0.848	0.740	0.880	0.714	0.789	3
Commitment and involvement of top management	0.779	0.791	0.733	0.867	0.726	0.781	4
Effective coordination between client and project parties	0.734	0.774	0.750	0.882	0.748	0.781	5
Accurate project cost estimates in accordance with plans and specifications	0.729	0.795	0.796	0.869	0.678	0.774	6
Client orientation	0.748	0.761	0.736	0.866	0.731	0.772	7
Adequate cost control measures	0.689	0.742	0.804	0.889	0.718	0.771	8
Participation and commitment of project teams	0.703	0.764	0.738	0.885	0.739	0.770	9
Effective management and organisation of work	0.734	0.763	0.722	0.884	0.725	0.770	10

Note: Wa = Weighted averages; CC = Conceptualization phase; PD = Planning and design phase; PR = Procurement phase; CN = Construction phase; OM = Operation and maintenance phase; RII = Relative importance index; R = Rank.

From the data presented in Table 11, the performance criteria matrix of CFs indicates the most significant factor for each performance criterion across all stages of the project life cycle. Accordingly, the most important CFs pertaining to each criterion among the 90 CFs can be summarized as follows:

- Competence of project participants;
- Adequate experience of project participants;
- Availability of competent staff;
- Positive personal attitudes of project participants;
- Participation in environmental initiatives by management;
- Competent supervisors;
- Effective project planning and control;
- Need for collaboration;
- Professionalism of services provided by project team.

5. Discussion

5.1. The Most Critical Factors

The following paragraphs further explain the nine most significant factors resulting from the analysis.

5.1.1. Competence of Project Participants

The respondents ranked this factor as the most crucial determinant of time performance, with a relative importance index (RII) of 0.807 (Table 11). The term 'competence' pertains to the combined knowledge, skills, experience, and qualifications of the individuals or groups engaged in a project, aimed at achieving optimal performance. Typically,

the project participants can encompass clients, consultants, contractors, subcontractors, vendors, and any other individuals or groups involved in the project's activities [7]. This factor is of paramount importance as experienced team members have distinct levels of skills and abilities to cope with the threats and uncertain environments in project strategy execution [4]. This result proves to be similar to that of Iyer and Jha [9], who observed that the client's competence has a considerable impact on the schedule outcomes, especially when the main objective is to achieve a deadline. Due to the diverse and complex nature of construction projects, the project manager's competence (i.e., technical, monitoring, and leadership capabilities) is also crucial for efficient task execution and resource identification. Additionally, the capabilities of team members, and not only the project manager, to manage resources, engage in communication, achieve goals, develop their capabilities through education, and utilize their knowledge for best practices is crucial for a successful project [75]. As stated, the competence of project teams plays a vital role in determining the success of overall project management. This has been widely discussed in previous studies, notably by Belout and Gauvreau [76] and Sommerville and Dalziel [77].

5.1.2. Adequate Experience of Project Participants

With a relative importance index of 0.660–0.903, the adequate experience of project participants is a critical factor for project performance across the five phases of the project life cycle (Table 5). This factor was determined to be the most significant in terms of cost performance, because it obtained a relative importance index of 0.790 (Table 11). This factor is essential because a successful project usually requires experienced project teams to carry out the tasks and activities. Moreover, a high level of proficiency among project stakeholders helps to maximize the performance of the project. Similar findings can be found in the study of Sobieraj and Metelski [15], suggesting that the absence of sufficiently experienced project teams makes project success unattainable; thus, the company's senior executives must be vigilant regarding this aspect. In contrast, inadequate experience among team members can lead to a large number of inaccuracies or mistakes, ultimately resulting in cost overruns [78]. Chan and Kumaraswamy [74] stated that a lack of expertise among project participants, especially contractors and designers, appears to be the primary cause of construction time overruns. As is evident, adequate experience means that the individuals or groups involved in the project possess the required knowledge and background to effectively contribute to the successful planning, design, execution, and completion of a construction project.

5.1.3. Availability of Competent Staff

In the quality criterion, the availability of competent staff was identified as a common critical factor influencing project performance across the five phases of the life cycle, with an RII of 0.689–0.919 (Table 5). According to the respondents, this attribute was also regarded as the most important factor in determining quality performance, with an RII of 0.788 (Table 11). This crucial factor can be considered as the provision of staff with the appropriate competences at the required time point. The availability of productive employees is a critical variable that enables the accomplishment of a project's specific objectives and is central to achieving the desired quality. This finding is consistent with those of Enshassi et al. [23], who found that the availability of personnel with vast experience and qualifications enables all interested parties to perform a project with positive outcomes. Additionally, the proficiency of both the project manager and the owner plays a crucial role in maintaining the appropriate level of quality in construction projects [9]. In turn, clients benefit from the expertise of competent staff through the delivery of projects that meet or exceed their expectations. Therefore, the project leaders should ensure that the project is executed by appropriately competent individuals or groups throughout its life cycle [31]. As indicated, the availability of competent staff is integral to achieving project success and contributes to the overall effectiveness of construction projects, positively impacting the reputation of the company.

5.1.4. Positive Personal Attitudes of Project Participants

This pertains to an individual's overall predisposition toward either supporting or opposing a particular stimulus object. Attitude demonstrates a tendency to persist consistently throughout time and poses difficulties in the face of change [79]. A positive personal attitude was identified as the most critical factor in the health and safety criterion, with an RII of 0.734 (Table 11). Construction projects require a favorable mindset to cultivate cooperation among the numerous interested parties and a proactive approach, in order for these parties to efficiently work together and tackle obstacles. For health and safety, a safety-oriented working mindset appears to suggest a more favorable perception of the work environment and atmosphere, resulting in improved health and safety performance. This finding aligns well with those of Aksorn and Hadikusomo [80], who concluded that enhancing employees' favorable attitudes to safety can lead to the effective application of safety programs. However, a study conducted by Liu et al. [81] revealed a surprising finding, that the attitudes of owners toward safety was found to have the least impact on the safety performance of contractors. Considering client satisfaction, most satisfied clients appreciate a project team that is committed, responsive, and solution-oriented. Without embracing a proactive approach toward achieving professionalism in services, it may not be feasible to effectively meet the needs of clients [82]. As found in the present research, the significance of maintaining a positive personal attitude cannot be overstated. It enhances the ability to achieve multidimensional objectives and overall project success. Therefore, construction projects require the coordinated efforts of various project participants, and a favorable mindset contributes to a robust and efficient project environment.

5.1.5. Participation in Environmental Initiatives by Management

This refers to the commitment and proactive approach of senior management in incorporating environmental sustainability policy into the fundamental aspects of the organization's activities. Through the extensive analysis, this factor was determined to be the most significant in environmental performance, with an RII of 0.728 (Table 11). Reduce, reuse, and recycle (also known as the '3Rs') are fundamental to waste minimization. Some crucial aspects, such as life-cycle assessment, carbon reduction targets, green building certification, the circular economy, and energy efficiency, help to significantly improve the environmental consequences associated with the built facilities and contribute to the enhancement of their environmental performance [17,19]. The findings of this research are aligned with the conclusions of Lopez-Gamero et al. [83], who indicated that proactive environmental management is directly affected by the timing and intensity of early investments in environmental endeavors, which, in turn, leads to improvements in both environmental performance and company efficiency. Clearly, the participation and encouragement of top executives in environmental initiatives are observed as key drivers of the success of environmental management strategies.

5.1.6. Competent Supervisors

In regard to productivity, clear and timely inspection and competent supervisors are regarded as the CFs most affecting the performance of the project throughout all phases (Table 7). Of these, the respondents ranked competent supervisors as the most important factor in the productivity category, with an RII of 0.755 (Table 11). Supervisors play a critical role in monitoring and controlling the activities of the project to ensure that the quality of the products and services is in accordance with the work standards and specifications. Moreover, the supervisors' proficiency in overseeing multiple aspects, such as planning and scheduling, resource allocation, effective communication and coordination, and problem solving, significantly impacts the overall productivity and performance of the project. In sum, these research findings are aligned with several studies, suggesting that talented supervisors have a substantial and favorable influence on the productivity and success of construction projects [84–86].

5.1.7. Effective Project Planning and Control

The results of the analysis revealed that effective planning and control was the most significant factor in the risk category, with an RII of 0.767 (Table 11). Project planning is essential in ensuring timely completion, cost control, and high-quality outcomes and minimizing conflicts. A thorough comprehension of the project, efficient resource acquisition, and effective scheduling are required [87]. The process of planning allows for the identification and assessment of potential risks, enabling project participants to develop strategies to mitigate these risks and reduce the likelihood of unexpected setbacks. Project control covers multiple aspects, such as quality assurance, budget control, adherence to schedules, and performance monitoring. Effective planning and control appear to generate a proactive and adaptable risk management strategy. In contrast, Abednego and Ogunlana [88] pointed out that the inability to effectively manage a risk becomes apparent when there is inadequate project planning and control. In essence, a project is a complex and unpredictable endeavor, involving intricate and long-lasting risks that must be carefully managed to ensure its success [89]. Thus, project participants are obligated to establish a proper planning and control system through appropriate tools and project management practices. Consequently, this results in optimal risk mitigation and management.

5.1.8. Need for Collaboration

Of the 25 individual factors examined, the need for collaboration was identified as the critical factor influencing human resources throughout all phases of the project life cycle (Table 8). This factor was ranked as the most significant, with an RII of 0.759 (Table 11). The need for collaboration is observed as an essential element because the project team comprises large numbers of participants with a diverse range of knowledge and skills. A successful project requires strong collaboration and commitment from interested parties. Thus, the project team needs to work together in partnership to ensure that the project objectives are achieved. Surprisingly, the findings of this research did not corroborate the previous conclusions made in prior studies. A study conducted in the Gaza Strip, Palestine, by Enshassi et al. [23] revealed that 'belonging to work' was the most important factor in the studied groups. Moreover, a previous study conducted in South Korea by Park [10] postulated that 'leadership and team management' were of the utmost significance within the human resources domain. Given these results, it would appear that different economic organizations have differing points of view.

5.1.9. Professionalism of Services Provided by Project Team

This can be defined as services provided to clients, which include the quality and reliability of the advice, the communication skills, and the courtesy or manners of personnel. The survey respondents regarded the professionalism of the project team as a common critical factor across all five phases (Table 8). This factor was determined to be the most important in the client satisfaction criterion, with an RII of 0.802 (Table 11). Professionalism in services is crucial, as proactive attitudes toward achieving professionalism and providing trustworthy services are more appreciated by clients or end users than active measures that seek to rectify problems after an outbreak [82]. Through adhering to these practices, the project team, including the consultants, contractors, and other parties involved, can enhance the project's credibility and success, while also building trust with the clients and stakeholders. Crucially, construction firms should prioritize client satisfaction by ensuring high-quality work, effective communication, and excellent client services. Repeat business is only possible with satisfied clients, which allows the company to build a strong client base and generate consistent revenues.

5.2. Comparison of This Research's Findings with Previous Studies

The exploration of success criteria and CFs is not new. However, the identification of project performance criteria and the factors that are crucial to a project's success throughout its life cycle is somewhat limited. Therefore, there is little information regarding a similar

survey for comparison. Park [10] conducted a questionnaire survey in South Korea to examine how the performance of a project throughout the whole life cycle was influenced by several factors, including scope, cost, time, quality, health and safety, human resources, risk, and contract/administration. Enshassi et al. [23] identified the factors that affected construction project performance in the Gaza Strip, Palestine. In their study, project performance was measured using a wide variety of criteria that could be correlated with numerous dimensions.

The following is a comparative summary of the key results of this study with regard to those of Park [10] and Enshassi et al. [23]:

- A comparison of the importance of the project performance criteria reveals that this study and that of Park [10] provide similar findings; namely, that cost performance and quality performance are essential criteria (particularly in the PD and CN phases, respectively). Moreover, the results of this study correlate favorably with those of Park [10] and Enshassi et al. [23], who found that health and safety, human resources, and the environment are less likely to influence project performance. However, when compared to these previous studies, client satisfaction—which was not considered previously—was found to be of importance. It is the most frequently used criterion in evaluating a project's success. This difference between these findings is probably due to the different contexts of the organizations considered in each study.
- Examining the importance of the CFs, as anticipated, it was observed that the sets of CFs in each performance category differed from those in previous works. Nevertheless, the top 10 CFs identified in the present study share a number of similarities with Park's [10] findings. Both studies conclude that the CFs influencing project performance in each category are rapid decision making (time); the certainty of the cash flow for the project (cost); quality in construction (quality); the proper planning and organization of a safe working environment on-site (health and safety); the financial stability of the project participants (risk); and the need for collaboration (human resources). The comparison suggests that these critical factors are reliable, in the sense that they are consistent with the findings of the previous study.
- With the careful consideration of the most important factors considered in the present research and Park's study, it is apparent that there are some discrepancies in the conclusions of the two studies. There are several possible explanations for this result, one of which is the variation in the set of individual factors employed in the two studies. As a result, this led to a discrepancy in the research outcomes.

Taken together, these results suggest that each study introduces unique conclusions. The results may be either consistent with or significantly different from those of other studies. Notably, identical findings are attainable even when only a limited portion of the elements is present [7,80].

6. Practical Implications

This research has managerial implications for project stakeholders, because it reveals the CFs that have a favorable influence on project performance, from inception to completion and beyond. In summary, the findings of this study carry significant implications, particularly for project leaders, project managers, and project teams within construction organizations. These implications can be briefly elaborated through the following three dimensions:

- Enhanced decision making: The findings of this study offer project executives invaluable insights to refine their decision-making processes. Through discerning the most significant factors across various project phases, project leaders can make informed decisions to mitigate risks, optimize resources, and ultimately enhance the likelihood of project success. This may involve prioritizing specific aspects of project management based on the identified critical factors.
- Improved project management practices: The identification of the CFs throughout the phases of the project life cycle provides practical insights for project management teams. Through acknowledging these factors, project managers can customize their

management strategies to tackle specific challenges and enhance the overall project performance, thereby fostering improved project outcomes.

- Proactive performance improvement: Understanding the dynamic nature of the project performance criteria and the shifting significance of the CFs across various project phases facilitates proactive performance enhancement measures. Project teams can foresee challenges, closely monitor key factors, and promptly implement corrective actions to steer the project toward success. This proactive approach can engender better control over project outcomes and mitigate deviations from the objectives.

Through considering these practical implications, stakeholders—particularly those in the Thai construction industry—can leverage the insights gained from this study to enhance their project management strategies, streamline their resource allocation, and ultimately improve the outcomes of their projects.

7. Conclusions and Recommendations for Future Research

This study explored the CFs influencing project performance and examined the agreement regarding the importance of these factors across various objectives throughout the project life cycle in Thailand. The results obtained from a questionnaire-based survey revealed the following findings:

1. The importance of individual critical factors and project performance criteria varies depending on the phase of the project life cycle.
2. Notably, client satisfaction emerged as a key criterion contributing to project success, suggesting a shift toward broader measures of success beyond traditional metrics. The statistical analysis demonstrated that the top 10 CFs vary, according to the project objectives and the phase of the project.
3. This study revealed the following most important CFs influencing project performance in construction projects within the Thai construction industry: the competence of project participants, adequate experience of project participants, the availability of competent staff, positive personal attitudes of project participants, participation in environmental initiatives by management, competent supervisors, effective project planning and control, need for collaboration, and the professionalism of the services provided by the project team. These factors were found to vary across different phases of the project life cycle, emphasizing the dynamic nature of project performance criteria.
4. This study identified factors that enhance construction project performance, emphasizing the key success criteria and highlighting their role in overall project improvement. The results of this study suggest that decision makers, professionals, and practitioners in Thailand's construction sector should prioritize client satisfaction, quality performance, and time performance as the key components to achieve project success.
5. The practical implications suggest potential practices that could aid in improving the performance management approaches in construction projects. These offer insights for project stakeholders—particularly project leaders, project managers, and project teams—to enhance their decision making, improve their project management practices, and implement proactive performance improvement measures, ultimately improving the outcomes of construction projects.
6. The findings of this study were compared to those of earlier studies. The comparison indicated that the importance of the performance criteria and the top 10 CFs identified were consistent with those determined previously, while the most important CFs significantly differed from those in previous studies.

A limitation of the present study is its exclusive focus on the perceptions of practitioners and professionals regarding the CFs in the Thai construction industry. Therefore, it may not be possible to generalize these findings to other geographical locations. Nevertheless, this study could be used to identify CFs in the framework of construction project management.

The findings of this study indicated prospective strategies for ongoing or future implementation in the Thai construction industry. However, further research should be conducted, incorporating the following considerations:

1. Further works should be undertaken that adopt an identical approach to determine and compare the perceived CFs across diverse regions. More information in this field will not only enable a high degree of consensus on the CFs associated with project performance, but will also serve as a guideline to develop good practices for effective project management in the construction industry.
2. Given the rapid evolution of technology, future research could explore emerging trends and their implications for project management practices. For example, sustainability, digitalization, and innovation could be investigated as emerging criteria to assess their influence on project performance and success.

Evidently, placing focus on the Thai construction industry provides a unique perspective on CFs and project performance. Consequently, this study establishes new insights into the contextual nature of construction management. Overall, through the establishment of these novel perspectives, this study significantly contributes to the expansion of the body of knowledge in the domain of construction management, providing valuable insights for researchers, professionals, and practitioners in the field.

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Appendix A. The List of Success-Related Factors Employed for the Research

Table A1. List of identified success-related factors from the literature review—Time.

No.	Success-Related Factors	Comment	Reference(s)
1	Adequacy of communication and coordination among parties	Merged	[29,32–34]
2	Adequacy of plans and specifications	Selected	[11,32]
3	Adequate experience of project participants	Modified	[29,32–34]
4	Availability of resources as planned throughout the project duration	Modified	[23,29,32,33]
5	Commitment and involvement of all project participants	Selected	[9,11]
6	Competency of project participants	Selected	[9,11]
7	Completeness of design documents	Modified	[32]
8	Contractual motivation/incentives	Selected	[11,32]
9	Control of delays among agencies involved in the project	Modified	[29,32,34]
10	Effective change order management	Selected	[10,29,32–34]
11	Effective planning and scheduling	Modified	[29,32,34]
12	Effective site management and supervision	Modified	[29,32–34]
13	Favorable climatic condition	Selected	[9,32]
14	Frequent reviewing, monitoring, and updating of construction program	Selected	[11,33]
15	Mode of financing and payment for completed works	Selected	[23,32–34]
16	Proper construction methods/techniques implemented in the project	Modified	[32,33]
17	Proper procurement programming of materials and stacking	Selected	[29,32]
18	Rapid decision making	Selected	[9,10]
19	Realistic obligations/clear objectives	Selected	[9,11]
20	Realistic project time imposed in contract duration	Modified	[10,29,32,33]
21	Timely delivery of materials/equipment as planned	Modified	[10,32]
22	Top management support	Selected	[11,32]

Table A2. List of identified success-related factors from the literature review—Cost.

No.	Success-Related Factors	Comment	Reference(s)
1	Adequacy of communication and coordination among parties	Merged	[35,37,38]
2	Adequacy of raw materials and equipment	Modified	[32,35,36,38]
3	Adequacy of scopes and specifications	Modified	[38]
4	Adequate experience of project participants	Added	-
5	Adequate tender sum	Selected	[35,39]
6	Availability of resources as planned throughout the project duration	Modified	[35,36]
7	Certainty of cash flow of the project	Selected	[32,39]
8	Competitive tendering process	Selected	[35,39]
9	Completeness of considerations in design	Selected	[36]
10	Completeness of design documents	Modified	[36,38]
11	Effective change in the scope of work management	Selected	[32]
12	Effective contract administration and management	Modified	[35,36,38]
13	Effective project cost control mechanisms	Selected	[7,32,36]
14	Effective site management and supervision	Added	-
15	Eliminating waste	Selected	[32,39]
16	Favorable climatic condition	Selected	[35–37]
17	Frequent progress meeting	Modified	[32,37,39]
18	Mode of financing and payment for completed works	Selected	[35,36]
19	Proper project planning and scheduling	Modified	[35]
20	Rapid decision making	Selected	[39]
21	Realistic duration of contract period and requirement imposed	Modified	[35,36]
22	Relationship among project participants	Modified	[35,36]
23	Stability in the price of materials	Modified	[7,32,35,36]

Table A3. List of identified success-related factors from the literature review—Quality.

No.	Success-Related Factors	Comment	Reference(s)
1	Adequacy of plans and specifications	Selected	[42]
2	Adequate communication among project teams	Selected	[4,42]
3	Availability of competent staff	Selected	[9,11,23]
4	Availability of trained resources	Selected	[9,10,23,30,42]
5	Commitment and involvement of all project participants	Merged	[9,11,42]
6	Competency of project manager	Selected	[9,11,41]
7	Conformance to specification	Selected	[10,23]
8	Constructability	Modified	[10,11]
9	Contractual motivation/incentives	Selected	[11]
10	Determining quality in construction	Selected	[10]
11	Effective cooperation between parties taking part in the project	Selected	[9,30]
12	Effective design and construction quality plan	Selected	[10]
13	Effective monitoring and feedback	Selected	[9,43]
14	Effective quality assurance system in organization	Selected	[10,23,42]
15	Effective teamwork to promote quality issues in the project	Selected	[2,30,40]
16	Favorable working condition	Selected	[9]
17	Management commitment to continual quality improvement	Selected	[30,41]
18	Management leadership in promoting high process quality	Selected	[18,30,40,42]
19	Quality of equipment and raw materials	Selected	[10,23]
20	Top management support	Selected	[9,18,41]
21	Utilization of up-to-date technology	Merged	[2,10,41]

Table A4. List of identified success-related factors from the literature review—Health and safety.

No.	Success-Related Factors	Comment	Reference(s)
1	Adequacy of budget allocated for safety	Selected	[43,44]
2	Adequate number of site safety representatives	Selected	[43–45]
3	Availability of adequate facilities for first aid treatment and medical advice	Selected	[10,43]
4	Clear organizational safety policy	Selected	[42,43,45,46]
5	Conducting incident investigation	Selected	[43,44,46]
6	Conducting regular safety meetings	Selected	[10,23,42–44]
7	Conducting safety hazard identification and review	Selected	[10,42]
8	Delegation of safety authority and responsibility to site personnel	Selected	[10,42,43,80]
9	Development of safety committee in the project	Selected	[42,45]
10	Effective coordination, control, and management of subcontractors	Selected	[43,45]
11	Frequent conduct of appropriate site safety inspection and supervision	Merged	[42,43,80]
12	Historic, human, and psychological climate	Merged	[43–45]
13	Implementation of safety incentives and penalties	Merged	[43,44,46]
14	Implementation of safety management system in accordance to legislation	Selected	[10,42]
15	Interrelation between employee and supervisor	Merged	[43–45]
16	Involvement of project participants in safety awareness	Merged	[43–45,80]
17	Issuing and implementation of in-house safety rules and procedures	Selected	[42,43]
18	Positive personal attitudes of project participants toward safety management	Merged	[43,46,80]
19	Proper planning and organizing of safety working environment onsite	Merged	[10,42,43]
20	Provision and conduct of appropriate safety education and training	Merged	[42,43,45,80]
21	Safety equipment acquisition and maintenance	Merged	[42,80]
22	Sufficient safety resource allocation	Selected	[10,43,44,46,80]
23	Top management support	Selected	[43,44,80]

Table A5. List of identified success-related factors from the literature review—Environment.

No.	Success-Related Factors	Comment	Reference(s)
1	Adequacy of cooperation among project participants	Merged	[48–50]
2	Budgeting allowed in implementing environmental management activities	Selected	[49]
3	Clear definitions on environmental management responsibilities among project parties	Selected	[48,49]
4	Effective air pollution control	Selected	[23,47]
5	Effective ecological control	Selected	[47]
6	Effective indoor air quality control	Added	-
7	Effective land contamination control	Added	-
8	Effective monitoring of energy consumption	Selected	[47]
9	Effective noise pollution control	Selected	[23,47]
10	Effective supervision among project parties	Merged	[48,49]
11	Effective waste pollution control	Selected	[23,47]
12	Effective water pollution control	Selected	[47,48]
13	Involvement by clients on environmental management plan	Selected	[49]
14	Participation in environmental initiatives by management	Selected	[83]
15	Project participants' awareness of waste reduction	Modified	[47,48]
16	Proper environmental site planning	Selected	[49]
17	Proper positioning and maintenance of site environment	Merged	[47,51]
18	Regular maintenance of equipment on the project	Merged	[47,51]
19	Sufficient auditing activities	Merged	[47,49]
20	Sufficient provision of environmental management training to all staff	Selected	[48,49,51]
21	Use of environmentally friendly equipment	Selected	[51]
22	Use of modular materials in the project	Merged	[50,51]
23	Utilization of up-to-date technology	Added	-

Table A6. List of identified success-related factors from the literature review—Productivity.

No.	Success-Related Factors	Comment	Reference(s)
1	Adequacy of skill training and development to employees	Modified	[86]
2	Adequate communication among project teams	Modified	[52,57,84,85]
3	Adequate control of absenteeism rate through the project	Selected	[23,52,53,84,86]
4	Appropriate construction method	Modified	[55,85,86]
5	Availability of construction materials	Modified	[20,52,53,57,84,86]
6	Availability of financial motivation system	Modified	[57,86]
7	Availability of skilled personnel	Modified	[52,55,85,86]
8	Availability of tools and equipment	Modified	[45,53,84,85]
9	Availability of utilities	Modified	[52,85]
10	Clear and timely inspection	Modified	[57,84–86]
11	Competent supervisors	Modified	[52,53,84,85]
12	Completeness of drawing documents	Modified	[57,84–86]
13	Constructability	Added	-
14	Effective change order management	Selected	[55,57,84,85]
15	Effective control of working overtime	Selected	[53,57,84–86]
16	Effective planning and scheduling	Added	-
17	Effective rework	Selected	[53,57,84–86]
18	Effective site management and supervision	Modified	[54]
19	Efficiency of tools and equipment	Modified	[53,55,84–86]
20	Favorable climatic condition	Modified	[52,54,57,84–86]
21	Management–labor relationship	Selected	[23]
22	Proper site layout arrangement and management	Selected	[84]
23	Specification and standardization	Selected	[84]
24	Systematic control of workers turnover and changing crew members	Merged	[52,53,56,84,85]
25	Utilization of up-to-date technology	Selected	[54]

Table A7. List of identified success-related factors from the literature review—Risk.

No.	Success-Related Factors	Comment	References
1	Absence of change in government codes and regulations	Merged	[59–61]
2	Absence of defective materials	Selected	[10,59,61]
3	Accurate anticipation of exchange rate fluctuation and inflation	Selected	[58–61]
4	Accurate measurement and pricing of bill of quantities	Modified	[58,60–62]
5	Adequacy of communication and coordination among parties	Merged	[10,58,59]
6	Adequacy of risk management techniques	Selected	[10]
7	Appropriate risk identification and risk response	Modified	[10,60]
8	Availability of funds as planned throughout the project duration	Modified	[58]
9	Availability of resources as planned throughout the project duration	Selected	[4,58,60,61]
10	Certainty of cash flow of the project	Modified	[10,62]
11	Clear objectives and scope of work definition	Merged	[10,41,58–60]
12	Competence of project participants	Modified	[10,58–61]
13	Completeness of design documents	Modified	[10,58–62]
14	Dispute resolution clauses incorporated in the contract	Selected	[4,58,59,61]
15	Effective change in the scope of work management	Selected	[4,10,58,59,61]
16	Effective control of third-party delays	Modified	[58–61]
17	Effective project planning and control	Selected	[4,10,58–60,62]
18	Feasibility of construction method	Selected	[58,60]
19	Financial stability of project participants	Modified	[10,58,59,61]
20	High construction productivity	Modified	[58,59,61,62]
21	Implementation of effective site safety management program	Modified	[58–62]
22	Implementation of proper site condition survey	Modified	[10,58,60]
23	Provision of force majeure plan	Modified	[58–61]
24	Quality of work to match standards	Selected	[58–61]
25	Timely payment on contract and extra works	Modified	[20,58,59,61,62]

Table A8. List of identified success-related factors from the literature review—Human resources.

No.	Success-Related Factors	Comment	Reference(s)
1	Adequacy of compensation level	Selected	[63,64]
2	Adequacy of skill training and development to employees	Merged	[3,10,63,65,66]
3	Adequate communication among project teams	Modified	[10]
4	Adequate employee support from senior management	Modified	[63,66]
5	Availability of employee motivation system	Merged	[10,23,66]
6	Availability of internal promotion	Selected	[64]
7	Availability of participation programs	Selected	[64]
8	Availability of skilled personnel	Selected	[10]
9	Clearly written line of responsibility	Selected	[63]
10	Commitment of the project team	Selected	[63]
11	Comprehension of organization's mission/vision	Selected	[10]
12	Effective human resource planning	Merged	[3,23,63–65]
13	Effective monitoring and feedback	Selected	[10]
14	High effectiveness of training programs	Modified	[64]
15	High efficiency of project organization	Modified	[10]
16	High labor productivity	Modified	[10,65]
17	Legal requirement/compliance	Selected	[63]
18	Need for collaboration	Selected	[10]
19	Positive attitude of employees	Modified	[23]
20	Proper administration and disciplinary procedures to all employees	Modified	[63]
21	Spirit of cooperation among project team members	Merged	[10,66]
22	Sufficiency of managerial and technical manpower	Selected	[10,65]
23	Timely decision making in human resource	Selected	[10,65]
24	Top-down decision making	Selected	[10]

Table A9. List of identified success-related factors from the literature review—Client satisfaction.

No.	Success-Related Factors	Comment	Reference(s)
1	Accurate project cost estimates in accordance with plans and specifications	Selected	[22]
2	Adequate cost control measures	Selected	[22,70]
3	Aesthetics of completed work	Selected	[68–70,82]
4	Appropriate provision of skilled and trained workforce	Selected	[22,68]
5	Client orientation	Selected	[22,70,82]
6	Commitment and involvement of top management	Modified	[71]
7	Completeness of considerations in design	Selected	[82]
8	Completeness of product/service	Merged	[69,71,82]
9	Durability of completed work	Merged	[69,70]
10	Effective change order management	Modified	[22]
11	Effective coordination between client and project parties	Merged	[23,68]
12	Effective management and organization of work	Selected	[68]
13	Effective planning and scheduling	Merged	[22,69,70]
14	Effective supervision and control on-site project activities	Selected	[22,83]
15	Efficient functionality of product/service	Merged	[69,71]
16	Good communication at all levels	Selected	[22,67,69,82]
17	High quality of workmanship	Selected	[69]
18	Participation and commitment of project teams	Modified	[67]
19	Professionalism of services provided by project team	Selected	[23,82]
20	Proper dispute resolution	Modified	[23,69,71]
21	Quality of product/service to match standards	Selected	[22,69]
22	Rapid response to legitimate complaints	Selected	[70]
23	Recognition of risks and uncertainties associated with the project	Selected	[69]
24	Safe work environment	Modified	[22]
25	Timeliness of service	Selected	[69,70,82]

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