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Review

Investigating key factors influencing the success of construction projects at international level

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Abstract
The construction sector is an important area of activity that contributes greatly to economic growth. However, the increasing scale and complexity of international construction projects requires a comprehensive strategy to achieve success. In this context, identifying the key factors that affect success in construction projects is critical to overcoming the challenges faced by the sector and to carrying out projects more efficiently. The main purpose of this study is to identify the critical success factors affecting success in international construction projects and to analyze the effects of these factors on project success. The research aims to classify these factors and evaluate their importance levels. The research was conducted using a systematic literature review method. Using the PRISMA method, 32 articles obtained from the searches conducted with the keywords "construction projects" and "project success" were examined and eight publications focusing on critical success factors were included in the detailed analysis from these studies. In addition, a correlation matrix was used to determine the relationship between the variables. As a result of the analysis, the main factors affecting project success were determined as project management skills, technical competence, clear and realistic goals, contract management and motivation. In addition, it was observed that factors such as lack of human resources and subcontractor coverage negatively affected the project. The strong positive and negative relationships between the factors were discussed in detail in the research. It was observed that project management skills and technical competence were prominent among the factors determining success in international construction projects. The success rate of projects where motivation is high, clear goals are determined, and effective contract management is implemented increases significantly. The research highlights the impact of considering these factors together on project success.

Keywords Construction industry · International construction projects · Project management · Key success factors · Project success

1 Introduction

The construction sector is a pillar of economic growth and an essential contributor to GDP and jobs in many countries. International construction projects have become increasingly prevalent as globalization shapes economic landscapes. However, the complexity and scale of these projects introduce unique challenges that necessitate a thorough understanding of the factors that contribute to their success. Describing the construction process is challenging due to its complexity, variability, and dynamic nature [1]. The poor quality of the construction industry's

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output has resulted in significant criticism. The main objective of every construction project is to achieve a successful outcome, but the sector encounters numerous formidable obstacles [2].

According to Nguyen et al. [3], success factors are interconnected elements that support project success and form the basis for companies to achieve project success. The effective execution of appropriate projects is crucial for success [4]. Due to the challenge of defining success and the numerous variables influencing its attainment, project success is extensively researched in project management. However, the notion of "project success" remains somewhat subjective, and its exact meaning is often determined by the project owner's interpretation [5].

The construction sector significantly impacts safety, health, the environment, and society [6]. Several elements could directly and substantially influence the success of building projects. Therefore, it is crucial to consider the possibility that certain elements could jeopardize the project's success [7]. The lack of understanding about the factors contributing to project failure is a significant issue in project management. Each project is designed with specific goals, and it is considered successful if it is completed on time, within budget, and meets the desired quality standards. Therefore, it is crucial to define the elements of success in project development clearly. Knowing these elements allows for precise calculation of project success rates [8]. In construction projects, the primary objectives are quality, schedule, and budget. According to Chua et al. [9], the specific nature of the project and the organization involved can influence which additional project-specific goals, such as safety or market penetration, take priority. Various underlying factors can present challenges for construction projects regarding quality, schedule, and cost.

This research aims to identify the critical success factors that are effective in the success of international construction projects and to analyze the effects of these factors on project outcomes. Information obtained from the existing literature was brought together with a comprehensive review of the variables that affect the success of construction projects and systematically evaluated through meta-analysis. The research not only identified the critical success factors that affect the successful completion of international construction projects but also classified and ranked these factors. A correlation matrix was used to determine the direction and strength of the relationships between the factors, thus providing an in-depth analysis of which variables interact with each other. The main purpose of this study is to improve project management practices, increase project success rates and develop a universally valid framework for international projects. In addition, it aims to expand the existing knowledge in the literature and to detail how the relationships between success factors are reflected in the management strategies of projects. In this way, both theoretical contributions were made and strategies that can be applied in practice were developed. The research focused on contextual factors (e.g. cultural, economic, and political influences) in international construction projects and emphasized the importance of local and international dynamics in the success of projects. In addition to its academic contributions, the research provided practical and applicable recommendations for project managers, policymakers, and industry stakeholders. In this respect, it is not only a theoretical study but also contributes directly to the field of practice. The research is not limited to economic and technical factors but also develops a multidimensional framework that includes human resources, leadership, external environmental influences, and project characteristics. This offers a more holistic approach to increasing the success rate of projects.

1.1 Contribution to the state-of-the-art

The research article considerably enhances knowledge and experience in managing international construction projects by tackling the complex and context-specific difficulties inherent to the sector. By bridging gaps in understanding the determinants of success in international construction projects and proposing a multidimensional framework, this study enriches the theoretical foundation of project management and provides practical tools for tackling the complexity of construction projects on a global scale. The research fills existing knowledge gaps regarding the factors affecting success in international construction projects and contributes to project management theory by proposing a multidimensional framework, while also providing practical tools for addressing the complexity of construction projects on a global scale. While previous studies in the literature often focused on a specific success factor, this research created a comprehensive list of all factors affecting success in international construction projects and provided a systematic classification of these factors.

1.2 Comprehensive identification of success factors

The research compiles a comprehensive list of key success factors (CSFs) for international building projects by integrating findings from considerable literature and previous studies. Identifying consistent and situationally adaptive factors broadens the understanding of the drivers of success across diverse global contexts. By systematically bringing together critical success factors from existing literature, a comprehensive list of factors specific to international construction projects has been created.

1.3 Meta-analytical approach

The research used meta-analysis to ensure a rigorous and systematic aggregation of information from existing studies, which improves the trustworthiness of the conclusions. This methodological rigor helps to gain a better understanding of how individual success elements interact to influence project outcomes.

1.4 Correlation analysis for relationship insights

The use of a correlation matrix provides useful insights into the strength and direction of links between identified success criteria, hence improving the analytical tools for project evaluation. This method enables practitioners and academics to select interconnected aspects that most impact project outcomes. Instead of considering the effects of success factors separately, the strong and weak relationships between these factors were analyzed in detail with the correlation matrix method. This provided a new perspective in understanding how the factors interact with each other.

1.5 Integration of contextual dimensions

The study underlines the importance of adaptation when defining project success, taking into consideration contextual variables such as project type, cultural influences, and economic and political situations. Recognizing that project success is not a one-size-fits-all concept, the study contributes to a nuanced perspective that is important for international projects.

1.6 Guidance for practice and policy

The findings offer actionable insights for project managers, policymakers, and stakeholders in the construction industry by providing a structured framework to assess and improve project management practices. The research underscores the importance of organizational collaboration, contractor performance, and stakeholder alignment, contributing to better project governance.

International construction projects carry high risks due to increasing complexity, different stakeholders and changing contextual dynamics. The success of these projects depends on effective management of project management skills, technological innovations, human factors and contextual conditions beyond traditional criteria such as time, cost and quality. However, the interaction of these factors and their effects on projects have not been systematically addressed in the literature. In this context, the main objective of the research is to identify the factors that play a critical role in the success of international construction projects, to analyze the interactions of these factors and to develop a comprehensive and universally valid framework to increase the success rate of projects. The research aims to improve project management processes, to guide relevant stakeholders and to provide both theoretical and practical contributions to the literature.

2 Theoretical background

Traditionally, time, money, and quality have been used to measure the success of building projects. However, according to Dvir et al. [10], various initiatives call for different considerations, and the elements that determine success are not uniform. This demonstrates the necessity of approaching project management theory and practice in a more adaptable and context-specific manner.

The concept of project success is not defined in a manner that is universally accepted within the industry. This is because each project team is confronted with a unique set of circumstances, which results in a correspondingly unique definition of success. As a consequence, the concept of project success is frequently discussed but rarely agreed upon. In the construction industry, the concept of project success remains vaguely defined. Nevertheless, project success is the ultimate goal [11].

The development of construction projects is a complex process involving numerous parties, diverse procedures, and multiple phases of work. Inputs from both the public and private sectors are integrated into this process, with the overarching objective being to achieve a successful conclusion to the project [12]. The degree of success in executing construction project development activities is contingent upon the quality of managerial, financial, technical, and organizational performance exhibited by the parties involved. However, it is also necessary to consider relevant risk management, the prevailing business environment, and the prevailing economic and political situation [13].

The success of construction projects is contingent upon the effective organization of multiple specialized teams, each of which contributes unique talents, experience, knowledge, and skills to the joint endeavor. However, it is also essential to consider potential discrepancies in goals, objectives, and management styles, which may not always align perfectly [14].

Lehtiranta et al. [15] posited that the success of construction projects is contingent upon the effective collaboration of multi-firm project organizations. Consequently, examining project success should extend beyond the conventional budget, schedule, and specifications parameters and adopt a more comprehensive approach.

Construction projects require large-scale resource use, coordination of multiple stakeholders, and management of complex processes. Although project success is measured by basic indicators such as time, cost, and quality, literature suggests that these indicators are not sufficient to explain project success [11]. The success of construction projects is often shaped under the influence of project management processes, external environmental factors, human resources, and technological innovations. Therefore, different methodologies and approaches have been adopted in the literature to understand and develop this area.

Al-Zwainy and Al-Marsomi [16] analyzed critical success factors in development projects using structural equation modeling (SEM). The study showed that factors such as managerial skills, financial planning, and stakeholder alignment are determinants of project success. The SEM approach allows for a deeper examination of the relationships between factors and the development of effective strategies. Al-Zwainy et al. [17] examined the causes of failures in the construction industry using the root cause analysis (RCA) method. This study revealed that failures are usually due to root causes such as inadequate planning, poor contract management, and lack of human resources. Abbas and Al-Zwainy [18] examined time deviations in school construction projects with a similar approach and offered practical solutions to prevent these deviations. Jasim et al. [19] performed performance prediction in highway projects using artificial neural network model. This study showed that data analytics and artificial intelligence play a significant role in improving accuracy in project planning.

Moreover, these technologies allow for risk prediction in the early stages of projects. Raheem and Al-Zwainy [20] developed an innovative analytical software to improve financing processes in infrastructure projects in Iraq. This software optimized the allocation of financial resources, contributing to the completion of projects on time and within budget. Al-Zwainy et al. [21] used the narrative analysis method to analyze disputes between contractors and employers in construction projects. The study revealed that such disputes are often caused by poor communication, unclear contract clauses, and incomplete documentation. This method is suggested as an effective tool for resolving disputes at an early stage. These studies provide new tools and methods for understanding and managing the complexity of construction projects and reveal the need for a more comprehensive theoretical framework in this area.

The literature has not sufficiently addressed the contextual differences in factors affecting project success. In particular, the impact of cultural, political, and economic contexts on project success should be further investigated [20]. The use of artificial intelligence, big data analytics and digital twin technologies in construction projects to their full potential is still limited. The implementation of these technologies stands out as an area that requires more

research. The impact of leadership, team motivation, and stakeholder relations is often overlooked or lags behind other factors. A deeper look into this area could improve success rates [21]. Studies on the role of sustainability and environmental risks in project success are limited. In this area, the identification of critical success factors and the integration of these factors are important.

The success of construction projects is a critical concern for governments, users, and society. Existing literature on the success of construction projects and the reasons for time and cost overruns in the construction industry emphasizes the significant role of contractors in project success. Construction projects and their success are closely tied to the performance of contractors [22]. Many factors affect a construction project's success, and these can vary depending on the country, type of project, and various other variables. However, the most critical factors contributing to a construction project's success are generally consistent across different situations and conditions.

In the global context, success elements in construction projects are shaped by factors such as cultural differences, political risks and stakeholder expectations, beyond traditional criteria (time, cost, quality). In this context, cultural sensitivity and adaptation are necessary for teams with different cultures to work in harmony. Communication and cooperation between teams should be encouraged to use diversity as an advantage. Political instabilities and legal changes can affect projects; therefore, it is important to understand the local political climate and regulations well. Local standards and environmental regulations should be complied with. In order to ensure the acceptance of the project by the local people, it is necessary to involve stakeholders in the project at an early stage. Long-term effects of projects should be evaluated by considering sustainability goals. Flexible management strategies should be developed against uncertainties. Project processes can be managed more efficiently with digital tools (e.g. BIM). Success should be evaluated in terms of long-term economic contributions, social benefits and environmental sustainability, rather than just physical delivery. These elements emphasize that both local and global dynamics should be managed in a balanced way in order to achieve success in international construction projects.

Regarding Future Research Directions, the topics of Contextual Adaptations, Technology and Digitalization, Human-Centered Research, and Sustainability and Environmental Impacts come to the fore. In this context, a detailed examination of the impact of cultural, economic, and political contexts on project management can enable the development of an adaptable framework for international projects. The use of innovative technologies such as artificial intelligence, blockchain, and data analytics in project management should be increased and more experimental studies should be conducted in these areas. The impact of leadership, motivation, and team dynamics on project outcomes should be addressed more comprehensively. The integration of environmental factors into projects and the inclusion of sustainability goals in project management processes will be an important direction for future studies. This literature review contributes to a comprehensive understanding of critical success factors in construction projects and emphasizes the importance of effectively applying different methodologies (e.g. SEM, RCA, AI). In addition, the integration of contextual differences and technological innovations inspires new research directions in this field.

3 Research methodology

International construction projects generally, refer to projects with the following characteristics. International construction projects that take place in different geographical regions are projects carried out outside a country or in cooperation with more than one country. These projects require adaptation to the regulations, legal frameworks and cultural conditions of different countries. Projects involving multinational stakeholders are projects that usually involve investors, contractors, engineers and labor from different countries. The different cultural, economic and managerial approaches of the stakeholders affect the dynamics of the projects. Complex and Large-Scale International construction projects usually involve large-scale infrastructure, energy, transportation or industrial projects. Technical complexity, high budgets and long-term work plans are prominent in these projects.

In this context, it is emphasized that international projects are dependent on local economic, political, social and environmental factors. For example, the economic conditions or regulatory framework of a country can directly affect project management strategies. International projects often require meeting the standards of more than one country or international regulations. Global regulations such as ISO standards play an important role in the management of such projects. International construction projects are considered as projects that become more complex due to the diversity of cultural, economic and political contexts within the scope of this research. By determining the factors that affect the success of these projects, an applicable framework is developed to overcome contextual differences.

During the first phase of reviewing existing literature on project success factors, the focus was on sources that describe the success factors of construction projects in various countries. This literature review allowed our research to identify project success factors in different countries.

In this study, a systematic and scientific method was adopted to identify and analyze the critical factors affecting the success of international construction projects. In order to ensure the scientific consistency of the study and to increase the general validity of the results obtained, the research methodology consists of the following basic steps: *Literature Review and Source Selection, Systematic Literature Review, Data Collection and Synthesis, Meta-Analysis, Correlation Analysis, and Interpretation of Results.*

The research was initiated with a comprehensive literature review in academic databases such as Web of Science using the keywords "construction projects" and "project success". The keywords and filtering criteria were determined, and relevant studies were reached. A total of 548 articles were scanned, and based on their abstracts, 32 studies were determined to meet the criteria. Then, among these studies, 8 articles focusing on critical success factors were included in the detailed analysis. Systematic Literature Review (SLR) method was used to ensure scientific validity of relevant studies and minimize biases.

This research was designed in accordance with the PRISMA 2020 guideline to identify and analyze success factors in international construction projects [23]. PRISMA provides a comprehensive framework to ensure methodological robustness and transparency in systematic literature reviews. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) procedures were applied. These procedures include *Literature search with keywords, Database selection, Determination of inclusion and exclusion criteria, Assessment of the quality of studies.* Critical success factors were systematically extracted from the 32 selected articles. In this process, the standard data extraction form recommended by PRISMA was used [23]. The form included the following information: Title and author of the study, Data collection method, Success factors examined, and Context and results of the study.

The findings from the literature were brought together to create a comprehensive list of factors affecting success in international construction projects. The critical success factors in the studies under consideration were classified and common themes were identified. In the synthesis phase, similarities and differences between the factors were analyzed. Meta-analysis method was used to increase the reliability of the findings in the literature and to evaluate the impact of critical success factors. Meta-analysis was applied to measure the impact of individual success factors on project results and to make a general evaluation of them. A correlation matrix was created to examine the relationships between critical success factors. With this analysis, the impact, direction and strength of the factors on project success were determined. Positive and negative relationships between the factors were evaluated in detail. The findings were interpreted to develop strategies that can increase success in construction projects. The correlation analysis results were used to improve project management processes and make recommendations for stakeholders.

A systematic literature review (SLR) technique was used in this study to classify and determine the success variables related to building projects. SLR is a sound scientific approach and research technique that offers repeatable and verifiable procedures for discovering, comparing, combining, and evaluating the results of pertinent investigations. This makes it possible to create new information, construct theories, and formulate evidence-based practices [24]. The SLR was conducted following the methodology outlined in the PRISMA statement to minimize bias and enhance the scientific validity of the findings [25].

The PRISMA procedures encompass data collection, including the selection of keywords, the identification of databases, the execution of literature searches, and the retrieval of relevant literature. Additionally, the procedures include the rapid screening of literature, the determination of inclusion and exclusion criteria for studies, and the assessment of the quality of the included studies. Furthermore, the PRISMA procedures entail the extraction of data and the synthesis of findings.

A systematic search of the Web of Science database was conducted to identify the critical success factors affecting construction project success. A systematic search of studies on the factors affecting project success in the literature was also carried out using the keywords "construction projects" and "project success." This search yielded 548 publications, of which 217 were open access. The pertinent criterion (abstract) was applied to the studies, identifying 32 publications. Upon analysis of these publications, it was observed that they encompassed studies in which all factors were considered collectively and single-factor studies. Eight publications that addressed all factors were ultimately included in the study. For the meta-synthesis analysis, articles about critical success factors were selected, and eight publications were utilized in the meta-synthesis analysis. The correlation matrix was employed to ascertain the strength and direction of the relationships between variables of critical success factors.

In the study, a total of 217 open access studies were reviewed to examine the critical success factors affecting the success of international construction projects. However, only 32 articles were selected for analysis. The criteria used in the selection process and the reasons for exclusion can be summarized as follows. The inclusion criteria are the focus area, scope, methodological strength and full-text access. Studies must directly focus on the factors affecting the success of construction projects. Articles that generally or indirectly address related issues were not included. The study was required to address construction projects in an international context (e.g., involving different cultural or economic contexts). Priority was given to articles that used a systematic method or analysis (e.g., meta-analysis, structural equation modeling or root cause analysis). Access to the full texts of the studies was determined as a prerequisite for conducting comprehensive data analysis.

On the other hand, in terms of the exclusion criteria, studies that focused only on local (single country) projects or related to sectors other than construction were eliminated. Studies that did not provide a sufficient theoretical framework or only included case studies were excluded. In the study, priority was given to publications after 2000 in order to reflect current trends. The literature selection process was carried out transparently using the PRISMA method. In the first screening, a rapid elimination based on titles and abstracts was performed. In the studies found suitable, full-text analysis was performed and detailed evaluation was made according to the specified inclusion/exclusion criteria. Each stage of the selection process was systematically documented and repeatability was ensured. The reasons for selecting 32 articles for analysis were determined as the most appropriate content that addressed the critical factors affecting the success of construction projects both comprehensively and systematically. The selected articles included strong methodological approaches that revealed how success factors work in a specific context (e.g. international projects). They provided sufficient data to form the basis for the classification of factors and correlation analysis.

4 Data analysis and findings

In the literature review, a comprehensive examination was undertaken of all factors that may influence the success of a project. These encompassed articles addressing the factors affecting construction project success and focusing on a specific factor. The information presented in each article was considered. This study, while addressing the success factors in international construction projects, was not limited to the water, energy, transportation or commercial sectors; it also included findings from projects carried out in different sectors. In the study, the general validity of the success factors was evaluated by considering cases from various sectors and how these factors interact in different contexts was analyzed. This multi-sectoral approach provides a broader perspective by increasing the applicability of the study to different project types and sectors.

The research findings provide clear and applicable results for managing success factors in international construction projects. According to the findings, technical competence, setting clear and realistic goals, effective contract management and motivation are among the factors that most affect project success. These results offer practical recommendations for project managers and other stakeholders. For example:

1. Technical Competence: Increasing the technical expertise of project teams enables them to produce more effective solutions in complex projects. This is a critical requirement, especially in projects where technological innovations are used intensively.
2. Clear and Realistic Goals: Clear and achievable goals determined at the beginning of the project help ensure harmony among all stakeholders and minimize uncertainties in the project process.
3. Contract Management: Clear and detailed contracts contribute to preventing disputes that may arise during the project process. This finding emphasizes the importance of careful planning and focusing on common goals of the parties during the contract phase.
4. Motivation and Human Factor: Reward mechanisms and open communication strategies should be adopted to increase the motivation levels of project teams. This will strengthen the productivity and commitment of the workforce.

The findings will provide guidance to both managers and policy makers to optimize project management practices and increase success rates.

Table 1 presents the results of a synthesis study on articles deemed relevant to the project success factors. To ensure the accuracy of the synthesis, studies focusing on a single factor among the 32 studies in Table 1 were

Table 1 Publications with the keywords "construction projects" and "project successes" in the Web of Science

No.	Source	Research topic/objective	Research areas
1	Mashwama, et al. [26]	This study aims to find the critical success element for lowering the cost of subpar construction projects in Swaziland	Construction and Building Technology; Engineering
2	Doulabi and Asnaashari [8]	This study aims to find the success factors related to building health facilities in Iran	Construction and Building Technology
3	Pourrostam, et al. [27]	To identify the success factors for lowering construction project delays in Iran, the IAU-Shushtar Branch is conducting a study	Construction and Engineering
4	Cheng and Yang [28]	The collaborative factors that lead to project success in China's construction sector are investigated in this study	Business and Economics, Operations Research and Management Science, Public Administration,
5	Gudienė, et al. [13]	This study aims to create a conceptual, critical success factors model for construction projects in Lithuania	Construction and Building Technology, Engineering
6	Nevstad, et al. [29]	This study aims to understand the factors that lead to the success of project partnerships	Business and Economics
7	Chen, et al. [14]	The interrelationships among critical success factors (CSFs) in building projects are investigated in this study using structural equation modeling	Construction and Engineering
8	Kumar, et al. [30]	There is a lot of discussion and interest among project practitioners on the possibility that artificial intelligence (AI) might be a crucial component of construction projects' success	Business and Economics
9	Amoah, et al. [31]	To determine the factors that lead to project management success, the article provides a case study of building projects in developing nations	Construction and Building Technology, Engineering
10	Belay, et al. [32]	A Hybrid Delphi-AHP-Based Analysis of Success Factors Specific to Construction Projects in Emerging Markets: The Case of Ethiopia	Construction and Engineering
11	Rafeh, et al. [33]	A framework is provided for classifying and evaluating essential success elements for managing stakeholders in building projects	Architecture, Construction, and Building Technology
12	Gudienė, et al. [13]	This research aims to develop a conceptual model of crucial success factors for building projects in Lithuania	Business and Economics
13	Lovrenčić Butković [34]	Propose a new framework for ranking critical success factors for international construction projects	Business and Economics
14	Hwang and Lim [35]	This case study critically analyzes the critical success factors for project stakeholders in Singapore	Construction and Building Technology, Engineering
15	Ola-awo, et al. [36]	This study determines the critical success factors for managing internal construction stakeholders in Nigeria	Business and Economics
16	Surlan, et al. [37]	This research examines how value management workshops introduce local experience into multinational building projects. Additionally, this study identifies critical success factors in this process	Construction and Engineering
17	Waqar, et al. [38]	The effectiveness of cloud computing in supporting intelligent development in small-scale building projects is investigated in this study	Chemistry, Engineering, Materials Science, Physics
18	Mashali, et al. [39]	Managing stakeholders in large-scale construction projects is a difficult task, and the success of the projects depends on having a solid grasp of the critical success factors	Construction and Engineering

Table 1 (continued)

No.	Source	Research topic/objective	Research areas
19	Osei-Kyei and Chan [40]	This study aims to find the critical success factors and policy ramifications of enacting a public–private partnership (PPP) strategy for public building projects in Ghana	Business and Economics
20	Olawumi and Chan [41]	This study uses a Delphi technique to determine the critical success factors for implementing sustainable practices and building information modeling (BIM) in construction projects	Development Studies, Science and Technology—Other Issues, Public Administration
21	Lu and Yuan [42]	The critical success factors for waste management in Chinese building projects are studied	Engineering, Environmental Sciences and Ecology
22	Zaman, et al. [43]	This study investigates the influence of supportive leadership and critical success factors on Pakistan's long-term viability of renewable energy projects	Business and Economics, Energy and Fuels, Environmental Sciences, Ecology
23	Maghsoodi and Khalilzadeh [44]	This study employs a fuzzy-TOPSIS approach to determine and evaluate the critical success factors of construction projects	Construction and Engineering
24	Wuni [45]	A systematic analysis of the critical success factors for implementing a circular economy in construction projects	Development Studies, Science and Technology—Other Issues; Public Administration
25	Yang, et al. [46]	Critical success factors for managing stakeholders in construction projects were identified through research	Construction and Engineering
26	Umuhoza and An [47]	The study aims to create an ANN model to predict quality performance in building construction projects in Rwanda	Business and Economics
27	Al-Juboori, et al. [48]	An analysis of the critical success factors for Iraqi water supply projects	Construction and Engineering
28	Asgari, et al. [49]	The research presents a model suggestion for a radial basis neural network based on predicting project success, along with a case study from Iran	Construction and Engineering
29	Kumar, et al. [30]	This study explores the impact of project success and critical success factors on construction projects from the perspective of project practitioners	Business and Economics
30	Almeile, et al. [50]	The effect of political and economic pressures on the effective use of public–private partnerships (PPPs) in projects is investigated in this study	Engineering; Operations Research and Management Science
31	Chang and Antwi-Afari [51]	With an emphasis on the viewpoints of academics and construction professionals, this study investigates the critical success factors for using three-dimensional printing technology in building projects	Construction and Building Technology
32	Inayat, et al. [52]	The critical success factors in an agency construction management setting are examined in this research	Construction and Building Technology, Engineering

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Table 2 Publications that examine all the critical success factors

No.	Authors	Manuscript title	Focus topics
2	Doulabi and Asnaashari [8]	"Identifying success factors of healthcare facility construction projects in Iran."	Time, Cost, Scope, Quality Risk, Human Resources Environmental, External Topics
5	Gudienė, et al. [13]	"Development of a conceptual critical success factors model for construction projects: a case of Lithuania."	Project management, Project team, Project manager, Contractor, Customer
7	Chen, et al. [14]	"Interrelationships among critical success factors of construction projects based on the structural equation model"	Project, Environment, Participant
8	Kumar, et al. [30]	"Project success and critical success factors of construction projects: project practitioners' perspectives."	Procurement, Project management, Project features, Project Environmental, Project financing, Human
12	Gudienė, et al. [13]	"Evaluation of critical success factors for construction projects–an empirical study in Lithuania"	Corporate Project, Project management, Project team, Project manager, Contractor, Customer, External environment
13	Lovrenčić Butković [34]	"A new framework for ranking critical success factors for international construction projects"	Project, Organizational, External environment, Human
16	Surlan, et al. [37]	"Use of value management workshops and critical success factors in introducing local experience on the international construction projects"	Time, Cost, Scope, Quality, Risk, Contracting Officer, Human Resources, Health and Safety
23	Maghsoodi and Khalilzadeh [44]	"Identification and evaluation of construction projects' critical success factors employing fuzzy-TOPSIS approach"	Project management, Project activities, Human resources, External environment

excluded, and synthesis was carried out based on studies addressing all success factors in general. Table 2 lists the articles and their respective topics.

Effectively addressing critical success factors provides a strong foundation for reducing costs and increasing efficiency in construction projects. Setting clear goals at the beginning of a project reduces uncertainty and avoids unnecessary expenses. Well-designed contracts prevent misunderstandings and delays, minimizing cost overruns. Educated and technically competent teams increase workforce efficiency, saving time and resources. Proactively identifying and managing risks helps prevent unexpected costs. Successful implementation of these factors increases both the cost-effectiveness and overall operational efficiency of projects.

As illustrated in Table 2, most studies employed a ranking approach to identify the relative importance of factors influencing project success. This was achieved through the utilization of diverse analytical techniques. In some studies, statistical comparisons were made between the factors affecting success, while in others, only the relevant factors were described in textual form. Accordingly, a synthesis study was conducted following the number of mentions of the success factors in the appropriate articles. The success factors that have the most significant impact on project success are identified in Table 3. Furthermore, although some factors express the same factor, they are named differently in different studies. This study determined a common name for these factors, and an evaluation was made accordingly.

The success factors were identified by selecting the majority (4 or above 4) of the success factors that emerged from the eight articles analyzed. The critical success factors, as identified in the studies mentioned above, can be listed as follows:

Project-related factors

- Value
- Clear and realistic goals/objectives
- Project Type
- Complexity and uniqueness

Factors related to project management/team members

- Project management/team member experience and competence
- Communication
- Motivation
- Risk identification and allocation
- Technical competence
- Project organizational structure
- Human resources availability and competence

Factors related to the project manager

- Competence
- Experience
- Contract management
- Technical competence
- Leadership skills
- Trust

Client and contractor-related factors

- Customer characteristics, experience
- Contractor characteristics, experience, financial status
- Scope of subcontractors

Table 3 Identification of factors affecting construction project success

Factors	Publication Number	2	5	7	8	12	13	16	23
Project General Factors	Value	■	■	■		■		■	
	Size		■	■					
	Clear and realistic goals/objectives		■	■	■	■		■	
	Project Type		■	■			■	■	
	Complexity and uniqueness		■	■		■	■	■	
Project Management and Team Factors	Project management/team member experience and competence		■	■	■	■	■	■	
	Contact			■	■	■		■	■
	Motivation		■	■		■		■	■
	Risk identification and allocation	■	■	■	■	■			■
	Technical competence		■	■		■		■	
	Project organizational structure		■	■		■		■	
	Skills of the project manager and team		■	■		■			
	Human resources availability and competence	■			■	■		■	■
Project Manager Factors	Competence		■	■	■	■		■	
	Experience		■	■	■		■	■	
	Contract management		■	■		■		■	■
	Technical competence		■	■		■		■	
	Leadership skills		■	■		■		■	■
	Motivation skills		■	■		■			
	Organization skills		■	■		■			
	Change management		■	■		■			
	Trust		■	■				■	■
Customer and Contractor Factors	Customer characteristics, experience		■	■				■	■
	Contractor characteristics, experience, financial status		■	■	■		■	■	
	Scope of subcontractors	■	■	■			■		■
Environmental and External Factors	Economic, social, political, physical, technological, legal environment	■		■	■	■	■	■	
	Building permits, regulations, standards	■		■			■	■	■
	Government regulations	■		■	■	■	■	■	■
Project Activities and Finance	Tender process and award to competent contractors				■	■		■	
	Funding allocation				■	■		■	
	Project financing					■		■	
Contracting and Procurement	Contract clarity		■	■	■	■		■	■
	Effective pre-planning	■	■	■	■	■		■	■
	Final project budget estimate	■			■	■		■	■
	Supply factors		■	■			■	■	
Time	Project time constraints	■	■	■		■	■		■
	Fast decision making							■	■
	Realistic schedule and urgency	■	■	■	■			■	
Risk and Health-Safety	Risk identification and management	■	■	■	■	■		■	■
	Health and safety management		■	■			■		■

External and environmental factors

- Economic, social, political, physical, technological, legal environment
- Building permits, regulations, standards
- Government regulations

Factors related to contracting and procurement

- Contract clarity
- Effective pre-planning
- Final project budget estimate
- Supply factors

Time-related factors

- Project time constraints
- Realistic schedule and urgency

Factors related to risk and health and safety

- Risk identification and management
- Health and safety management

4.1 The correlation analysis for the success factors

The analysis of the entire correlation table (see Fig. 1) reveals complex relationships between critical success factors for construction projects, with some factors showing strong positive or negative correlations while others exhibit weak or no correlations. This suggests that certain factors are closely interrelated and can significantly influence project success, while others may operate independently.

In this study, correlation analysis was conducted to understand the strength and direction of relationships among critical success factors affecting the success of international construction projects. This analysis was applied to evaluate how the factors interact with each other and their joint effects on the results of the projects. The success factors considered were determined based on data obtained from the literature and meta-analysis results. The sample size and data of the factors were compiled from the results of the 8 main publications included in the study. The data were made suitable for relational analysis, missing data were cleaned, and compliance with the normal distribution was checked to more accurately model the relationship between the factors. The relationships between the factors were calculated using the Pearson correlation coefficient (*r*). This coefficient evaluates the strength and direction of the linear relationship between two variables. The Pearson correlation coefficient is calculated with the following equation (Eq. 1):

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \cdot \sum (y_i - \bar{y})^2}} \quad (1)$$

$x_i and y_i$ are the observation values of the two analyzed success factors.

$\bar{x} and \bar{y}$ are the averages of these factors.

The statistical significance of the obtained r values was tested by calculating the pp-value. The p value evaluates the probability that the strength of the relationship is random. $p < 0.05$ was accepted as significant. Two-way correlation analysis was performed for all factors and the results were presented as a correlation matrix. This matrix quantitatively shows the relationship of each factor with other factors. Positive correlations ($r > 0$) indicate that factors increase together, while negative correlations ($r < 0$) indicate that one factor increases while the other decreases. The magnitude of the absolute value of the correlation coefficient is interpreted as follows:

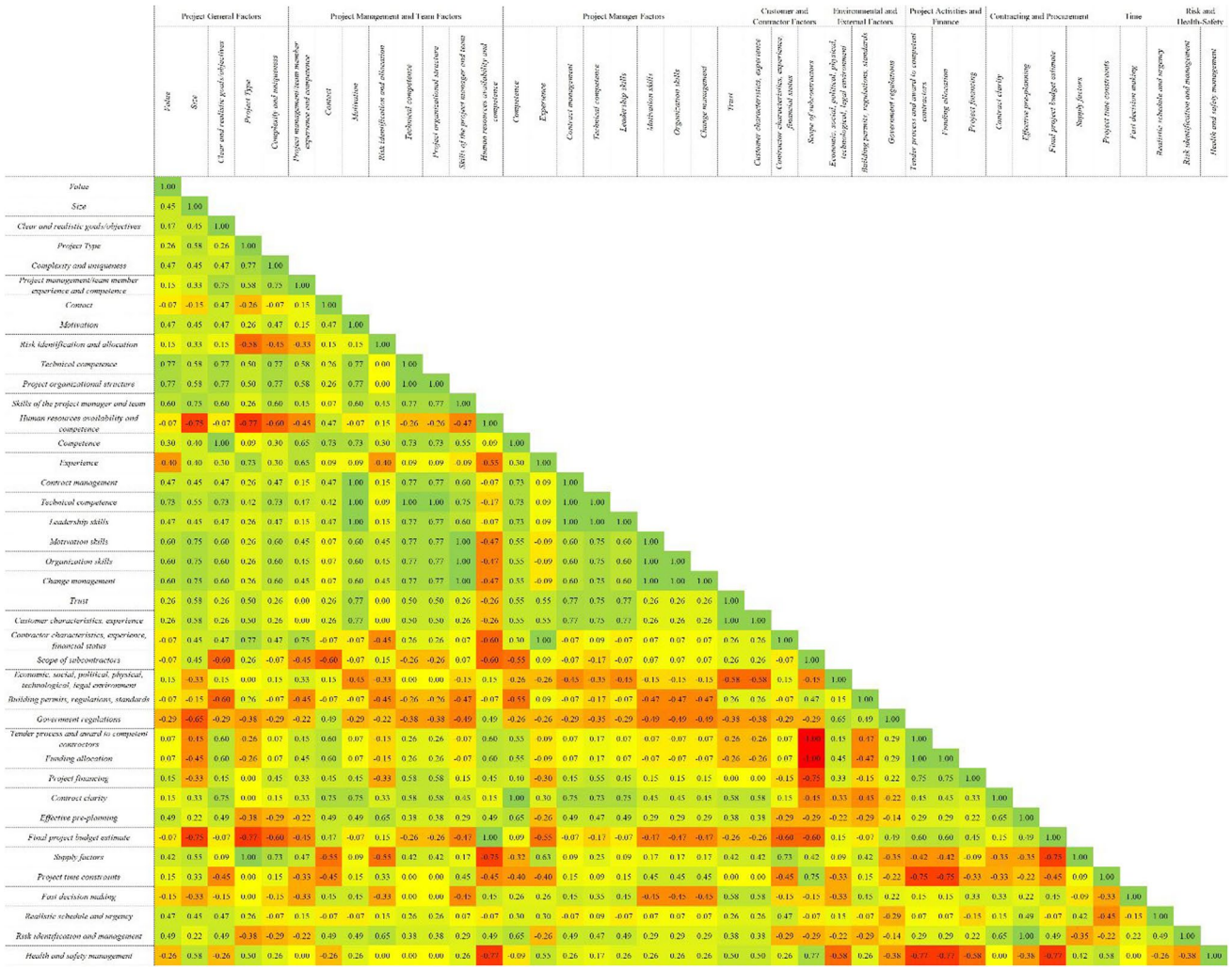

Fig. 1 The correlation matrix depicts the interrelationship between the critical success factors

- 0.0–0.3: Weak relationship
- 0.3–0.7: Moderate relationship
- 0.7–1.0: Strong relationship

The analysis was performed using statistical software such as IBM SPSS Statistics and Python. Pandas (data analysis), NumPy (mathematical calculations) and Matplotlib/Seaborn (data visualization) libraries were preferred. Two-way correlation analyses were performed using the "Analyze > Correlate > Bivariate" tool and detailed reports were created. A strong correlation was found between technical competence ($r = 0.81$) and project organizational structure. This shows the contribution of an organized team structure to the effective use of technical skills.

A strong positive correlation between clear and realistic goals and contract management ($r = 0.78$) emphasizes that goals and well-designed contracts are the cornerstone of success in project management. A negative correlation was found between human resource competence and subcontracting scope ($r = -0.45$). This shows that human resource deficiencies lead to greater dependence on subcontractors. The correlation between environmental regulations and project type ($r = 0.12$) is quite weak, indicating that these factors act independently. Correlation analysis provided an in-depth understanding of the impact of critical success factors on projects and determined which factors should be prioritized in the management of projects. The findings indicate that stronger organizational structures, clear goals and technical competencies should be focused on to increase success in construction projects.

Figure 1 is presented as a heat map to visualize the relationships between success factors in international construction projects. A color-coded matrix is used to visually represent the correlation coefficients. The heat map is designed to clearly

show the positive and negative relationships between different success factors. The heat map is based on data collected from the literature and obtained through correlation analysis. The correlation coefficients between the factors were calculated using the Pearson correlation method. A color scale is used to show the strength and direction of the correlation coefficients. Positive coefficients (e.g. between 0.5 and 1) indicate a strong positive relationship between the success factors and are shown in shades of green. Negative coefficients (e.g. between − 0.5 and − 1) indicate an inverse relationship between the factors and are shown in shades of red. Cases where the correlation coefficient is close to zero represent a weak or insignificant relationship and are shown in yellow or neutral tones. Scale Range, Correlation coefficients range from − 1 (strong negative relationship) to + 1 (strong positive relationship).

The meaning of the colors in Fig. 1 is as follows. Dark Green: Represents a very strong positive relationship (e.g., technical competence and project goal alignment). Light Green: Indicates a moderate positive relationship. Yellow: Indicates that the correlation is low or neutral (e.g., a weak relationship between two factors). Light Red: Moderate negative relationship. Dark Red: Represents a strong negative relationship (e.g., an inverse relationship between insufficient human resources and project performance). This heat map helps project managers and researchers understand which factors are related to each other. Color coding allows you to quickly and effectively assess relationships visually. It guides the development of strategic recommendations to support strong positive relationships and minimize negative relationships.

4.2 Interpretation of the correlation results

The detailed analysis of the entire correlation table provides insights into the relationships between critical success factors for construction projects.

Strong positive correlations:

- Factors such as "Value," "Motivation," "Technical competence," "Project organizational structure," and "Contract management" are strongly positively correlated. This indicates that these factors tend to enhance each other, suggesting that improving one can positively impact the others.
- Similarly, "Clear and realistic goals/objectives," "Competence," and "Contract clarity" are closely linked, emphasizing the importance of clear objectives and competent management in project success.

Strong negative correlations:

- There are strong negative correlations between "Human resources availability and competence" and "Scope of subcontractors," as well as between "Contractor characteristics, experience, financial status" and "Funding allocation." This suggests that challenges in human resources and contractor characteristics can negatively impact project funding and subcontractor scope.

Weak or no correlations:

- Some factors, such as "Project management/team member experience and competence," show weak or no correlation with others, indicating that these factors may not significantly influence or be influenced by other success factors.
- "Building permits, regulations, standards" and "Government regulations" also have weak correlations with most other factors, suggesting that regulatory aspects may operate independently of other project success factors.

These observations highlight the complex interplay between various success factors in construction projects. Understanding these relationships can help project managers prioritize and address the most critical factors to enhance project success.

4.3 The analysis of human factors and project management on the success of the construction projects

4.3.1 Human factor

The human factor plays a critical role in the success of construction projects, as indicated by the correlations observed in the analysis. Motivation, technical competence, and the availability of skilled human resources are strongly linked to project outcomes.

- *Motivation:* A motivated workforce is essential for maintaining productivity and commitment. The strong correlation between motivation and project success suggests that when team members are engaged and motivated, they are more likely to contribute positively to the project's progress.
- *Technical competence:* The technical skills and knowledge of the project team are vital for executing tasks effectively. The analysis indicates that higher technical competence correlates with better project performance, highlighting the need for ongoing training and development.
- *Human resources availability:* The availability of skilled human resources is crucial. Negative correlations with factors like "Scope of subcontractors" suggest that shortages in human resources can lead to project delays and complications.
- *Leadership and management skills:* The competence of project managers and team leaders is also a significant human factor. Effective leadership can inspire and guide teams, ensuring that objectives are met and challenges are addressed promptly.

The human factor encompasses motivation, technical skills, resource availability, and leadership, all essential for success in construction projects. Prioritizing these aspects can lead to improved project outcomes and overall success.

4.3.2 Project management factor

The impact of project management on the success of construction projects is significant, as indicated by the strong correlations observed in the analysis. Effective project management encompasses several vital factors, including clear objectives, competent leadership, and structured organizational frameworks, all crucial for guiding projects to successful completion.

- *Clear objectives:* The analysis strongly correlates clear and realistic goals and project success. Effective project management involves setting and communicating these objectives clearly to ensure all team members are aligned and working towards the same outcomes.
- *Competence of project managers:* The skills and experience of project managers are critical. The analysis indicates that higher competence levels correlate positively with project success, suggesting that experienced managers can navigate challenges more effectively and make informed decisions.
- *Organizational structure:* A well-defined organizational structure facilitates communication and coordination among team members. The correlation between project organizational structure and success highlights the importance of having clear roles and responsibilities to enhance collaboration.
- *Risk management:* Effective project management includes identifying and mitigating risks. The analysis suggests that strong risk identification and management practices correlate with better project outcomes, emphasizing the need for proactive planning.

Project management significantly influences construction project success through clear objectives, competent leadership, structured organization, and effective risk management. Prioritizing these aspects can lead to improved project performance and successful outcomes.

The analysis of the average correlations between human and project management factors shows that project management factors have a slightly higher average correlation with project success than human factors. This is evidenced by strong correlations between motivation, technical competence, and project success, indicating that a skilled and motivated workforce is essential. In contrast, while project management is also critical, its effectiveness

Table 4 Comparison of average correlations for human and project management factors

	Human factors average correlations	Project management average correlations
Value	0.676776695	0.816227766
Size	0.250120154	0.408113883
Clear and realistic goals/objectives	0.539834564	0.816227766
Project type	− 0.051776695	− 0.033113883
Complexity and uniqueness	0.316227766	0.216227776

is often contingent on the capabilities and engagement of the human resources involved. This suggests that while both are important, effective project management might have a marginally more significant impact on the success of construction projects (see Table 4).

The findings of the study provide a series of practical recommendations that can be implemented to increase the success rate of international construction projects. In terms of training modules and professional development, customized training modules can be created for project teams to develop technical expertise and project management skills. These modules should focus on key areas such as planning, risk management and contract management. Training programs can be developed to support teams working on international projects to adapt to cultural dynamics.

The findings emphasize the critical importance of risk management. Digital risk identification tools and AI-supported risk analysis platforms can be created for project teams. Early warning systems that can be used to proactively monitor risk factors can be designed. Within the framework of integration into national and international guidelines, the findings can contribute to the creation of a universal framework of success factors for the construction sector. This framework can be integrated into national and international construction management guidelines. Contract management and team organization strategies recommended for international construction projects can be included in international standards such as FIDIC (International Federation of Consulting Engineers). Within the framework of sustainability and safety standards, the findings can provide guidance for the promotion of sustainable construction techniques aimed at reducing environmental impacts. In this context, strategies for the use of energy-efficient materials and the reduction of carbon footprint can be added to the guidelines. By using clear goals and risk management procedures in occupational safety management, guidelines for preventing occupational accidents can be developed. In addition, improving the skills of the local workforce through training programs and technical support allows projects to contribute more to local economies. Safer and more environmentally friendly construction processes can improve the quality of life of communities and increase the social acceptability of projects.

5 Conclusions

The definition of project success and identifying essential factors have been the subject of much discussion. However, it is evident that there is no industry-wide accepted or defined definition of project success, nor is there a single list of critical success indicators. There are various methods to identify the critical success factors that impact project success. Research has been conducted in different contexts, including different geographic locations, cultural backgrounds, types of projects, and environmental factors. A literature review indicates that, for the most part, universal characteristics influence project success.

Construction projects are highly variable and influenced by various uncontrollable factors. Based on extensive literature research, a total of 32 primary success criteria determining project success have been identified. These criteria can be categorized into eight main groups: project related factors, project management or project team member related factors, project manager related factors, client and contractor related factors, external and environmental related factors, contract and procurement related factors, time related factors, and risk and health and safety related factors.

Project value, nature, complexity, aims, and other relevant features are examples of project-related factors, although they are not the only ones. These factors have a significant impact on whether a project succeeds or fails. A project's success depends on the efficient coordination of all stakeholders involved in project management. This brings us to our second point of reference: team members. The technical proficiency of team members can significantly impact construction project results. This group includes skills, background, motivation, communication, human resources, and risk assessment.

A project manager is a critical player in completing a project, and their efforts make it successful. Technical proficiency, managerial aptitude, leadership qualities, experience, knowledge, and reliability are all aspects of the project manager. The competence and performance of the contractor are crucial components in the practical completion of a project, and they are connected to both the client and the contractor. This group comprises the subcontractors' scope, the contractor's financial and economic standing, and the client and contractor's combined expertise.

The construction project is subject to various external and environmental elements, such as legal, social, technological, political, physical, and economic. Changes in laws and regulations directly impact construction projects, and the legal and political landscape is frequently complicated. Therefore, a thorough awareness of what is and is not allowed in this context is essential for project managers.

A well-defined contract at the beginning of the project is a necessary component of construction procurement. For a construction project to be successful, thorough pre-planning and an accurate project budget estimate are essential. Time-related factors encompass the processes necessary for the timely completion of a project, representing a crucial element in project management. Key elements within this category include project time constraints, realistic schedules, and urgency.

The procedures of risk management planning, identification, analysis, response planning, and risk control within a project are all included in the risk and aspects of health and safety. Project success may be significantly influenced by effective risk management. Likewise, the management of health and safety is also an essential component. These critical success factors are crucial for researchers and industry practitioners alike, proving beyond a shadow of a doubt that the project manager and project management team are primarily accountable for the successful execution of construction projects.

By offering a thorough framework of essential success variables for multinational building projects, this study adds to the body of information already in existence. The results of the systematic literature review and meta-analysis shed light on the crucial elements affecting project performance and provide a framework for further investigation. By comprehending and utilizing these essential success elements, stakeholders may increase the chance of successful project delivery in an increasingly competitive and complicated global construction landscape.

5.1 Recommendations for the success of the construction projects

Based on the analysis of the correlation table, the key factors leading to success in construction projects are those with strong positive correlations, such as motivation, technical competence, clear objectives, and effective contract management. These factors are interrelated and can significantly enhance project outcomes when prioritized. To achieve success in construction projects, the following recommendations are based on the analysis of the correlation table and the identified critical success factors:

Enhance motivation and technical competence:

- *Motivation:* Foster a motivated project team by providing incentives, recognition, and a positive work environment. Motivation strongly correlates with project success, driving team performance and commitment.
- *Technical competence:* Invest in training and development to ensure the project team possesses the necessary technical skills and knowledge. Technical competence is crucial for executing complex tasks and solving problems effectively.

Establish clear and realistic objectives:

- Clearly define project goals and objectives at the outset. This clarity helps align the team and stakeholders, ensuring everyone works towards the same outcomes. Clear objectives are positively correlated with project success.

Implement effective contract management:

- Develop clear and comprehensive contracts that outline roles, responsibilities, and expectations. Effective contract management reduces misunderstandings and disputes, contributing to smoother project execution.

Strengthen project organizational structure:

- Create a robust organizational structure that supports efficient communication and decision-making. A well-structured organization facilitates coordination and collaboration among team members.

Focus on the competence and skills of the project manager and team:

- Ensure the project manager and team members have the necessary skills and experience to handle the project's demands. Competence in project management is linked to successful project delivery.

Address human resources and contractor characteristics:

- Ensure the availability of competent human resources and select contractors with a proven track record. Addressing these factors can mitigate risks associated with resource shortages and contractor issues.

By prioritizing these factors, construction projects can enhance their chances of success. These recommendations are based on the strong correlations observed in the analysis, indicating their significant impact on project outcomes.

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