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Causes and Mitigation Strategies of Delay in Power Construction Projects: Gaps between Owners and Contractors in Successful and Unsuccessful Projects

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Abstract: Few studies have verified the different causes of project delays between the owner and contractor perspectives. This article's goal is to find what the causes of delay are and how to mitigate this delay depending on project performance. Thus, this study investigated 82 owner-side experts and 106 contractor-side experts in Tanzanian power construction projects. In successful projects (less than 10% time delay), the owners and contractors weighted similar causes such as vandalism and permits from authorities. They suggested similar mitigation strategies such as close project supervision, capacity building training, and proper logistics management. While in unsuccessful projects (more than 10% time delay), they exhibited many different responses. In particular, contractors weighted the causes incurred by changes in scope, owner's poor supervision, delays in approval, failure in planning and designing risk more than contractors. Owners weighted the mitigation strategies such as top management support and timely procurement more than contractors. These findings will help project managers to understand owners' and contactors' different concerns and develop better solutions. This study mainly contributes to improving delay management in power construction projects in developing countries.

Keywords: time management; delay management; mitigation strategy; owner perspective; contractor perspective; power construction project; Tanzania

1. Introduction

A multitude of construction projects in many countries still suffers from project delays that lead to losses and claims on the part of both owners and contractors [1,2]. In the case of Tanzania, 32 among 39 power projects experienced on average six month delays compared to their planned completion date [3]. Therefore, many studies have investigated delay causes to achieve better construction project management [4–6]. Although these studies contribute to improved delay management, several aspects have not been studied well to date. First, previous studies usually analyzed the causes only from the owner's or contractor's perspective [4]. Even though some research compared the rank of causes from the owner and contractor, they did not verify the statistical significance of the difference between owner and contractor [7–9]. Besides, even if another research analyzed the gaps well between owners and contractors, their subjects focused on the risk, contract and conflict, which are relevant but some different issues with project delay [10–12]. Second, they did not consider the performance-oriented cause of delay. Depending on the project progress performance, the cause and mitigation strategies can be varied.

Project owners usually are responsible for the basic plan, providing funding, risk allocation, award criteria, payment rules, procuring some major items, the license, design approval, and so on [10,13]. Contractors play a role in design details, detail procurement, risk management, the process and scheduling, productivity, labor, equipment, environment, and so on [10,12]. The failure to meet any of these responsibilities is an important reason that projects are delayed. However, owners usually underestimate their responsibilities and blame the contractors. In contrast, contractors insist that the delays frequently are attributable to the owner's mismanagement. Thus, the same delays can be understood differently depending on the owner and contractor's perspectives, and these differences can be the root causes of delays. Moreover, this problem of shifting blame is more severe when the project's performance does not meet the original plan [14]. Thus, depending on the project progress performance, the delay causes and mitigation strategies can be varied.

Therefore, this study compares owners and contractors' different evaluations of the same causes of delay according to the project's performance. Then, it suggests more comprehensive mitigation strategies to reduce construction project delays that consider both owner and contractor perspectives. To do so, this study follows the research process, as shown in Figure 1. First, the study reviews previous research that deals with the causes of construction project delays and mitigation strategies. Second, this study derives the 35 factors of delay causes in 5 groups and 15 factors for mitigation strategies. The authors designed a questionnaire based on these factors. Third, this research surveyed and collected the valid responses from 82 owner-related and 106 contractor-related experts in Tanzania. Fourth, this study analyzed the delay cause rank and gaps between owner and contractor in the successful and unsuccessful project respectively. Last, this study analyzed the mitigation strategy rank and gaps between owner and contractor in the successful and unsuccessful project respectively.

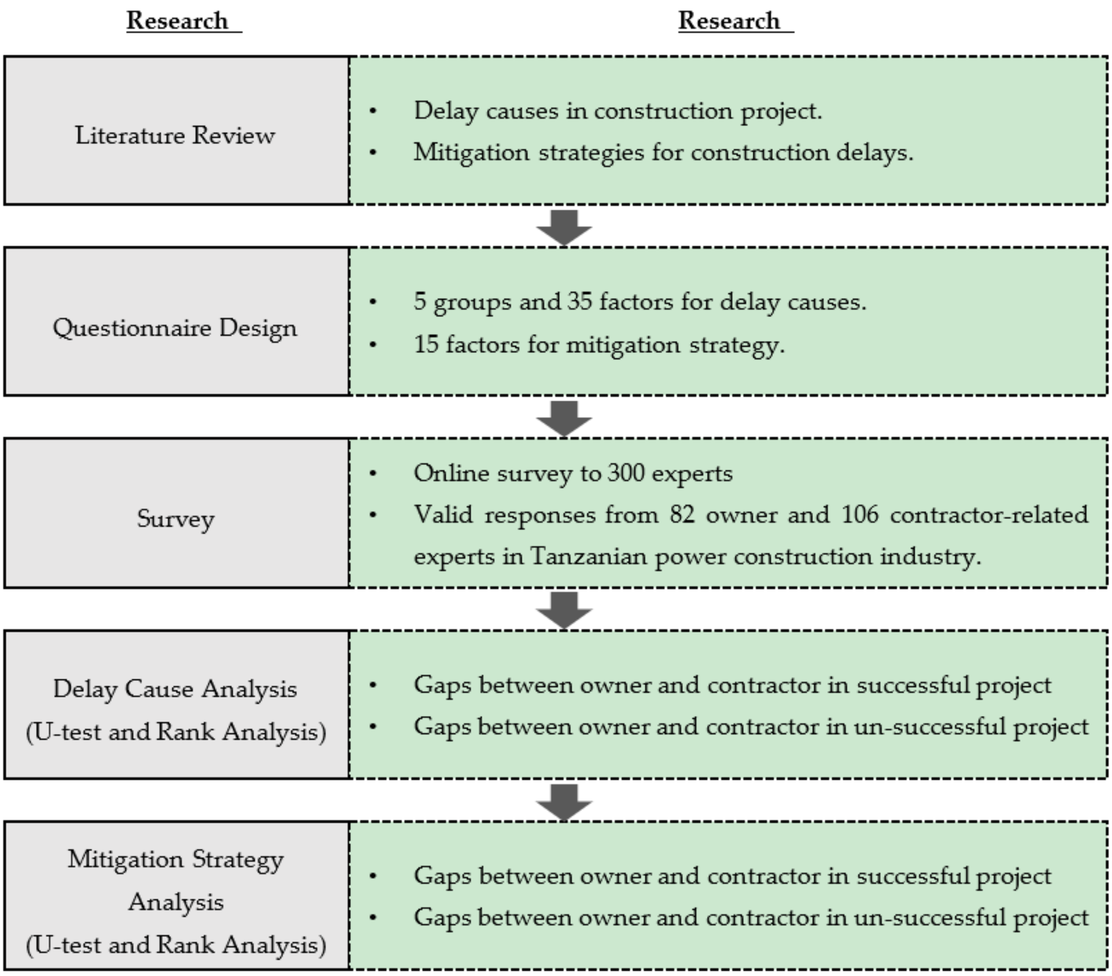


Figure 1. Research Procedure.

2. Literature Review

2.1. Causes of Construction Project Delays

Previous studies have largely identified causes of construction project delays based on literature reviews and expert interviews, and the delay factors were classified into various groups depending upon each paper's authors, as follows. Chan and Kumaraswamy [15] classified causes of delay into eight groups; project-, client-, design team-, and contractor-related, material, labor, equipment, and external factors. Odeh and Battaineh [16] studied causes of schedule delays in construction projects with traditional types of contracts and identified eight major groups of causes: client-, contractor-, consultant-, material-, labor and equipment-, contract-, and external-related factors. Aziz and Abdel-Hakam [17] used various categories to classify delay factors; project-, owner-, and contractor-related, financing, contract, design, site, labor, material, equipment, rules and regulations, scheduling and controlling, external, and contractual relationships. Alsuliman [18] investigated causes of delay according to stages in a public construction project, including before, during, and after the award, as well as general factors. Risk factors, which cause schedule delays in a construction project, can be categorized into various standards depending on the purpose of establishing the categorization [19]. This study reviews the literature related to causes of delay in power construction projects from five perspectives related to the: owner, contractor, design, infrastructure and social, and external factors.

2.1.1. Owner-Related Causes of Delay

The owner's insufficient project management capability affects delays significantly. Majid and McCaffer [20] suggested that inadequate fund allocation, insufficient communication among participants, and damaged materials and equipment are owner-related causes of delay, while Ogunlana et al. [21] suggested change orders and slow decision making. Long et al. [6] conducted a case study in Vietnam to identify common and general problems in large construction projects in developing countries. They suggested ten owner-related problems that cause delays, including lack of strategic management, construction requirements, improper project feasibility study, lack of a clear bidding process, excessive change orders, unclear responsibility, lack of capable representatives, owner's financial difficulties, poor contract management, and slow decision making. In addition, they specified delays attributable to participants' communication and coordination into seven factors. According to Frimpong et al.'s [22] study, participants, material procurement, and frequent breakdowns in the construction plant and equipment contributed to projects' schedule delays. Koushki et al. [23] studied the causes of time delays associated with the construction of private residential projects, particularly from the owner's and developer's perspectives. Their analysis of 450 questionnaires suggested three main causes of delays from the owner's perspective: change orders, financial constraints, and owner's lack of experience. Aziz and Abdel-Hakam [17] also identified a total of twenty highly frequent causes of delay in their literature review. Among them, owner-related causes were the owner's slow decisions, shop drawings and samples' slow preparation and approval, the owner's change orders during construction, owner's financial problems for the project, and owner's delay in contractors' progress payment. As owner-related causes of delay, Khatib et al. [24] suggested their financial problems and difficulties, change orders, delays and shortages of materials, poor site management and supervision, poor communication and coordination among construction parties, lowest bid awards, slow decisions, the contract type, delays in performing inspections and tests, and lack of clarity of the project's scope. Alsuliman [18] used a questionnaire to investigate the causes of delay according to stages of a public construction project. The results showed that the most significant group of causes of the delay was the factors associated with awarding tenders. In particular, the bid and award process, financial problems, approval delay, and owner's poor management capability were ranked among the top 20 causes of delays. Marques and Berg [10], showed that the lowest tender award system frequently fosters contractors to assume optimistic design and price estimation for winning awards.

This opportunism induces the changes in scope for increasing project contract price. Marques and Berg [11], also explained that the budget reduction by government frequently invokes the project delay.

Based on the factors reviewed above, this study selected seven owner-related causes of project delays: change in scope; owner's poor supervision; poor communication and coordination; approval delay; delay in procuring items, lowest bid tender award; owner's inadequate fund or budget allocation, and materials/equipment damaged during construction.

2.1.2. Contractor-Related Causes of Delay

Many delay factors are related to the contractor, who largely is responsible to execute a construction project and manage its schedule. Ogunlana et al. [21] identified material management problems, organizational deficiencies, planning, scheduling, and equipment allocation problems, financial difficulties, and inadequate site inspection as contractor-related causes of delay. Frimpong et al. [22] used a survey in their study of causes of delay in groundwater construction projects in developing countries. The survey showed that monthly payment difficulties, material procurement, and contractor's financial difficulties were ranked among the top 5 causes of delay. In addition, deficiencies in preparing cost estimates were ranked 10th in 25 delay factors. Long et al. [6] suggested 17 contractor-related causes of delay: improper planning and scheduling; inadequate experience; insufficient modern equipment; inaccurate time estimates; inaccurate cost estimates; poor site management; improper monitoring and control; poor labor and management relations; inappropriate construction methods; contractor's financial difficulties; incompetent project teams; poor contract management; severe overtime; material waste; lack of necessary skills; inadequate site inspection, and lack of competent subcontractors or suppliers. Koushki [23] argued that ensuring the delivery of materials and the contractor's capability are major factors that contribute to delays in construction projects in Kuwait. Aziz and Abdel-Hakam's [17] study also identified contractor-related factors, such as their poor site management and supervision, construction methods, ineffective project planning, and scheduling, financing during construction, and inadequate experience that caused errors as highly frequent causes of delay. Khatib et al. [24] suggested improper planning and scheduling, subcontractor's incompetence, contractor's lack of experience, discrepancies between drawings and specifications, construction mistakes and defective work, inaccurate estimates, inadequate tools and equipment, and price escalation.

Based upon this literature review, this study selected poor quality construction materials and equipment, poor cost management, poor project planning and scheduling, contractor's inadequate site supervision, additional work attributable to construction errors, misrepresentation of information before bid, poor cost estimation, late payments to suppliers or for contractor's work, late procurement orders for material and equipment, and changes in types and specifications, as contractor-related causes of delay.

2.1.3. Design-Related Causes of Delay

Poor design management causes delays in construction projects' schedules. Ogunlana et al. [21] suggested incomplete drawings and designers' slow responses are two major causes of delays related to design. In particular, nine of twelve cases they studied suffered from incomplete drawings. Razek et al. [5] also identified causes of delay in a construction project based on a questionnaire. In their study, these causes were the owner or his agent's design changes during construction, lack of a database to estimate activities' duration and resources, and designers' errors or incomplete designs. Khatib et al. [24] identified the following problems: design changes and modifications, errors, delays, shop drawings' slow preparation and approval, and erroneous sources of information. Furthermore, Alsuliman's [18] study indicated that variations in orders that occur during the project period and failure to determine quantities, specifications, and drawings accurately were the most frequent causes of delays related to the design of public construction projects.

Based on the literature review, five design-related delay factors were used in this study: design changes during construction; inappropriate data collection; errors and delays in providing design documents; a failure in planning and designing risk, and poor resource estimation and allocation.

2.1.4. Infrastructure and Socially Related Causes of Delay

The surrounding infrastructure and social environment also influence a project's schedule. Majid and McCaffer [20] suggested that labor-related causes of delay include workers' low morale/motivation and strikes, and poor workmanship. Ogunlana et al. [21] argued that problems with neighbors, government agencies' slow issuance of permits, resources' late delivery, shortage of site workers, and shortage of technical personnel lead to schedule delays in construction projects. Long et al. [6] found that slow government permits and unsatisfactory site compensation were the 4th and 10th most frequent problems that cause delays among a total of 62 delay factors in large construction projects. In particular, unsatisfactory site compensation was the 7th most influential problem that caused delays. Aziz and Abdel-Hakam [17] suggested other resource-related delay factors, including shortages in construction materials, equipment, and labor, slow delivery of materials, and low work productivity. They also pointed out that obtaining permits from municipalities is one of the main causes of delay in road construction projects in Egypt. Khatib et al. [24] suggested that delays are attributable to shortages of skilled workers and equipment, lack of qualified and experienced personnel, poor labor productivity, difficulties obtaining work permits, poor site conditions, and frequent interruptions from the public.

We extracted the following nine delay factors that affect schedule: workers' absenteeism, low motivation and morale, and strikes; poor working conditions; unskilled or inexperienced labor; late delivery of materials and equipment; delays in obtaining permits from authorities; conflicts with neighbors, and vandalism.

2.1.5. Externally Related Causes of Delay

Some literature has addressed uncontrollable external factors that delay construction projects, such as the host country's political climate and site's geological status. Long et al. [6] identified unforeseen ground conditions and inclement weather as environmental causes of delay. Frimpong et al. [22] confirmed such uncontrollable delay factors as ground problems and inclement weather, as well as unexpected geological conditions. Khatib et al. [24] listed unforeseen ground and weather conditions, and political insecurity and instability. In particular, multiple studies have identified weather conditions as one of the major delay factors. In their literature review, Aziz and Abdel-Hakam [17] found that 21 academic papers identified weather conditions as the most frequent delay factor. Koushki et al. [23] also analyzed inclement weather as the fifth important factor that owners in Kuwait reported caused delays. In Frimpong et al.'s [22] study, both owners and contractors ranked bad weather in the top 10 among 25 factors.

According to the literature reviewed, the authors identified three externally related delay factors that cause schedule delays, including force Majeure related to natural disasters, unexpected geological conditions, and political instability or control.

2.2. Strategies to Mitigate Project Delays

Proactive efforts to mitigate risks help achieve a project's objectives [25]. Previous studies have suggested various strategies to mitigate delays' adverse effects on project performance. Wang et al. [26] suggested optimal mitigation strategies that respond to various risk events and developed a risk management framework that suggests a proper mitigation strategy in accordance with country, market, and project risks, respectively. Kim et al. [27] also developed a risk assessment and mitigation model to support decision-making for investment in a steel-plant project. They selected six representative risk factors related to the target project and measured various mitigation strategies' effectiveness. Asadi, et al. [28], insisted that project risk management is a critical method to improve the cost, schedule and quality management. They introduced the risk management guideline and suggested the risk management tool using fuzzy model. The strategies that mitigate project delays include three main critical factors: project mission; top management's support, and project scheduling, all of which affect project performance during different phases of implementation. Tripathi and Jha [13], derived the six organizational success factors for project performance. Among the experience and performance, top management competence, project factor, supply chain and leadership, availability of resources and effective cost control measures, they ranked the top management competency highest. Guo, et al. [29], validated the project performance difference between non-supervised project and supervised project by engineer using evolutionary game theory. They recommended that the compulsory supervision is effective way to control project performance. Su et al. [30], emphasized on the accurate the time estimation skill for delay management. In particular, they suggested the solution of float ownership to prevent the delay and conflict between owner and contractor.

Critical factors are key issues or areas of activities in which favorable results are necessary for a project manager to achieve his/her target [31]. Project mission and schedule, top management's support, client consultations and acceptance, technical tasks, monitoring as well as feedback, communication, and troubleshooting are some the factors that influence project success [32]. Nguyen, et al. [33], recommended five possible factors that may be used to minimize project delays, these includes experienced project manager, satisfactory funds throughout project life cycle, experienced project team, project stakeholder's commitment, and resources availability. Moreover, Nguyen's another journal [34] emphasized the relationship between client satisfaction and the team behavior-related strategies such as project planning and organizing, coordination, contractor assurance and empowerment. Aibinu and Jagboro [35], suggested that the speeding up of site activities, and incidental stipend could be applied to reduce project delays. Odeh and Battaineh [16], proposed the following approaches creating and classifying human resources through appropriate training; consideration of capability and experience of contractor more than price during contract award, and adoption of design-build and construction management contracts. Li, et al. [36] reviewed the publications from 2005 to 2018 on dealing critical success factors for project performance. Then, they suggested the most frequently cited success factors such as communication and cooperation, effective project planning and controlling, owner's involvement and commitment and clear goals and objectives in order.

This study adopted the mitigation factors Pinto and Kharbanda [32] proposed, including the project's adequate financing and arrangement, previous work experience on similar projects, donors' influence, close project supervision, suitable time estimation skills, availability and quality of the workforce, and availability of materials and equipment. Furthermore, timely payments of completion certificates, good presentation of information during tendering, finishing the design on time, workers' motivation and morale, capacity building training, good logistic management (Transportation), top management's support, and site location were identified as strategies to mitigate project delays.

3. Methodology

This study derived the delay causes and mitigation strategy factors from the literature review. Then, this study investigated the data from survey and conducted the rank analysis and U-test. This study has several methodological strengths: (1) relatively large number of samples; (2) quantitative comparison analyses between owner and contractor, and between successful project and unsuccessful project. However, this study also has several methodological weakness: (1) lack of in-depth qualitative analyses; (2) limited investigation conducted in one country.

3.1. Questionnaire Design

This questionnaire consists of five sections: (1) respondent information; (2) project information; (3) causes of project delay; (4) consequences of project delay; (5) mitigation strategy for delay management. This study does not use the "consequences of project delay" section.

3.1.1. Delay Factors

This study derived the causes of delay in the literature review (Section 2.1) and grouped them in five categories as shown in Table 1. These delay factors were used in the questionnaire survey. The questionnaire asked the respondents to evaluate the importance of causes of delay based on their experience with projects. The importance levels were measured using five-point Likert scales: one point (less than 1-month delay); two points (approximately 1-month delay); three points (approximately 2-months delay); four points (approximately 3-month delay); five points (more than 3-months delay).

Table 1. Major Practices Causing Project Delays.

Group	Number	Delay Causes	References
Owner-related	O1	Change in scope	[6,10,11,17,18,20–24]
	O2	Owner's poor supervision	
	O3	Poor communication and coordination	
	O4	Delays in approval	
	O5	Delays in procuring materials	
	O6	Lowest bid tender award	
	O7	Owner's inadequate funds or budget allocation	
	O8	Damaging materials/equipment during construction	
Contractor-related	C1	Poor quality construction materials and equipment	[6,17,21–24]
	C2	Poor cost management	
	C3	Poor project planning and scheduling	
	C4	Contractor's poor site supervision	
	C5	Additional work attributable to mistakes	
	C6	Misrepresentation of information before bid	
	C7	Poor cost estimation	
	C8	Contractor's late payment to suppliers or works	
	C9	Late procurement order of material and equipment	
	C10	Change in types and specifications	
Design-related	D1	Design changes during construction	[5,18,21,24]
	D2	Inappropriate data collection	
	D3	Mistakes and delays in design documents	
	D4	Failure in planning and design risk	
	D5	Poor resource estimation and allocation	
Infrastructure and Socially related	I1	Worker's absenteeism	[6,17,20,21,24]
	I2	Workers' low motivation and morale	
	I3	Worker's strikes	
	I4	Poor working conditions	
	I5	Unskilled or inexperienced labour	
	I6	Late delivery of material and equipment	
	I7	Delay in obtaining permits from authorities	
	I8	Neighbor's conflicts	
	I9	Vandalism	
Externally related	E1	Force Majeure attributable to natural disaster	[6,17,22–24]
	E2	Unexpected geological condition	
	E3	Political instability or controls	

3.1.2. Mitigation Strategy Factors

The study summarizes the delay mitigation strategies found in the literature review (Section 2.2) that contribute to project success as shown in Table 2. The mitigation strategy factors were used in the questionnaire survey, in which the respondents weighted the importance using five-point Likert scales. The importance levels were measured using five-point Likert scales: one point (very low, approximately 0–20% contribution); two points (low, approximately 20–40% contribution); three points (medium, approximately 40–60% contribution); four points (high, approximately 60–80%); five points (very high, approximately 80–100%).

Table 2. Major Mitigation Strategies for Project Success.

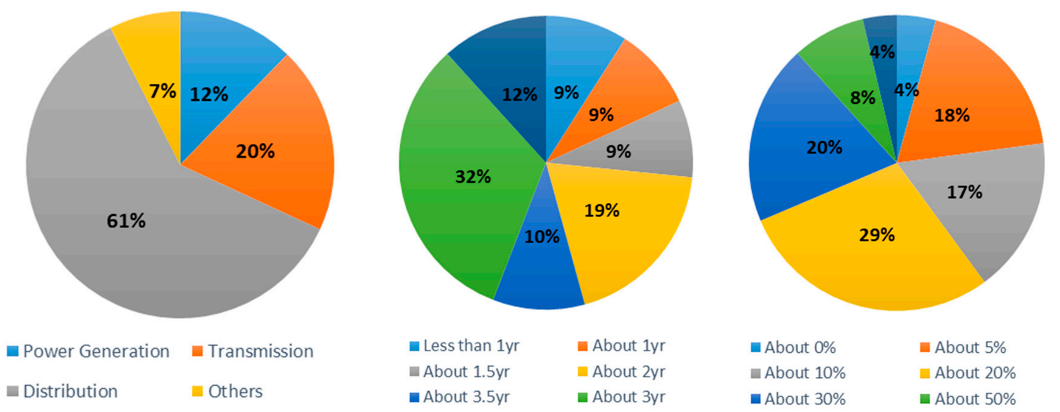
Number	Mitigation Strategy Factors	References
M1	Proper planning of project financial arrangements	
M2	Use of skilled labors with and experience on similar projects	
M3	Consideration of Donor’s Influence	
M4	Close project supervision	
M5	Use of suitable time estimation skills	
M6	Conducting capacity building training	
M7	Timely procurement and supply of materials and equipment	
M8	Timely payments of completion certificates	[13,16,25–28,30–33,35,36]
M9	Proper presentation of information during tendering	
M10	Finishing design on time	
M11	Timely site visits	
M12	Motivating workers to raise morale	
M13	Risk identification and assessment	
M14	Proper logistics management	
M15	Top management’s support	

3.2. Survey

The authors circulated 300 questionnaires electronically to different professional project owners and contractors throughout Tanzania. Table 3 describes the respondents’ profiles including the experience of the respondents. All respondents were asked to evaluate the causes of delay as well as mitigation strategies based on their project experiences. One-hundred ninety-nine responses were collected and 188 were confirmed valid. Eighty-two responses were collected from the project owner group and 106 from the project contractor group, as shown in Table 3. Figure 2 indicates the project profile to which the respondents referred to answer the questions. The distribution of projects planned and schedule performance varied and is relatively uniform. Project types are skewed slightly toward distribution rather than power generation and transmission projects.

Table 3. Respondents Profile.

	Owner		Contractor		Total	
	Number (Respondents)	Experience (Years)	Number (Respondents)	Experience (Years)	Number (Respondents)	Experience (Years)
Project Managers	37	8	27	2.5	64	13
Engineers	32	13	48	13	80	8
Technicians	9	2.5	20	8	29	2.5
Consultants	4	15	11	15	15	15
Total	82		106		188	



(**a**) (**b**) (**c**)

Figure 2. Project Profile: (**a**) Project Types; (**b**) Planned Project Duration; (**c**) Schedule Performance (Delay Schedule/Planned Schedule).

3.3. Analysis Method

To compare the owners' and contractors' different perspectives on the causes of delays and mitigation strategies, this study tested the data sample's normality first with the Shapiro–Wilk test; the result indicated that the sample was not distributed normally at $p < 0.05$ (average p-value = 0.015). Therefore, the study uses the Mann–Whitney U-test rather than the t-test with SPSS software. The Mann–Whitney U-test is a non-parametric statistical analysis that verifies the difference between two sample groups in cases of non-normal distributions [37]. If the U-test meets the significance level, the two groups compared differ significantly.

Furthermore, this study analyzes the differences from the successful project group's perspective and the unsuccessful group's perspective because the experts' responses and suggestions can vary depending on their experience with project performance. Thus, the sample data are divided into two groups. Successful projects are those that had less than a 10% increase in the originally planned project duration, while unsuccessful projects had more than a 10% increase in project duration.

4. Results

4.1. Causes of Project Delays

4.1.1. Causes of Delays in Successful Projects

Table 4 shows the causes of delay in successful power projects. In the group overall, the owner's inadequate funding or budget allocation (O7_1st Rank), vandalism (I9_2nd Rank), the contractor's late payment to suppliers or workers (C8_3rd Rank), late delivery of materials and equipment (I6_4th Rank), and delays in obtaining permits from authorities (I7_5th Rank) rank the highest. In the owner group, the owner's inadequate funds or budget allocation (O7_1st Rank), misrepresentation of information before the bid (I6_2nd Rank), late delivery of materials and equipment (C8_3rd Rank), vandalism (I6_4th Rank), and changes in scope (7_5th Rank) rank as the top five. In the contractor group, the contractor's late payment to suppliers or workers (C8_1st Rank), lowest bid tender award (O6_2nd Rank), delays in procuring materials (O5_3rd Rank), late material and equipment procurement orders (I9_4th Rank), and poor communication and coordination (O3_5th Rank) rank as the top five. The owner and contractor groups ranked the top five delay factors somewhat differently.

Table 4. Delay Causes in Successful Projects.

Group	Number	Total		Owner		Contractor		U-test
		Mean	Rank	Mean	Rank	Mean	Rank	Sig.
Owner-related	O1	2.53	6	2.41	5	2.69	11	0.421
	O2	2.19	27	2.05	27	2.39	24	0.169
	O3	2.45	13	2.18	19	2.82	5	0.042
	O4	2.38	17	2.10	23	2.73	9	0.118
	O5	2.49	8	2.23	16	2.86	3	0.068
	O6	2.48	9	2.08	24	3.04	2	0.009
	O7	2.74	1	2.90	1	2.55	19	0.265
	O8	2.17	28	2.16	20	2.19	33	0.930
Contractor-related	C1	2.27	23	2.24	15	2.31	29	0.684
	C2	2.45	14	2.38	8	2.54	20	0.515
	C3	2.27	24	2.21	17	2.36	26	0.452
	C4	2.51	7	2.31	10	2.79	6	0.145
	C5	2.35	20	2.14	21	2.62	14	0.065
	C6	2.32	21	2.26	14	2.39	25	0.484
	C7	2.46	11	2.37	9	2.59	17	0.754
	C8	2.64	3	2.29	11	3.14	1	0.023
	C9	2.43	15	2.27	12	2.68	12	0.278
	C10	2.46	12	2.40	6	2.56	18	0.864

Table 4. *Cont.*

Group	Number	Total		Owner		Contractor		U-test
		Mean	Rank	Mean	Rank	Mean	Rank	Sig.
Design-related	D1	2.37	18	2.27	13	2.50	21	0.593
	D2	2.17	29	2.07	25	2.30	30	0.683
	D3	2.39	16	2.13	22	2.75	8	0.148
	D4	2.26	25	2.00	32	2.64	13	0.087
	D5	2.32	22	2.05	28	2.71	10	0.056
Infrastructure and Socially related	I1	1.87	34	1.74	35	2.03	34	0.466
	I2	2.13	32	2.05	29	2.23	32	0.608
	I3	1.8	35	1.86	33	1.71	35	0.317
	I4	2.21	26	2.05	26	2.41	23	0.178
	I5	2.47	10	2.50	3	2.43	22	0.909
	I6	2.56	4	2.54	2	2.59	16	0.936
	I7	2.55	5	2.39	7	2.77	7	0.346
	I8	2.02	33	1.82	34	2.29	31	0.193
	I9	2.65	2	2.50	4	2.85	4	0.430
Externally related	E1	2.16	30	2.02	31	2.36	27	0.664
	E2	2.15	31	2.03	30	2.32	28	0.441
	E3	2.37	19	2.19	18	2.61	15	0.218

In particular, the contractors ranked contractors' late payment to suppliers or workers (C8), lowest bid tender award (O6) and poor communication and coordination (O3) significantly more highly than did owners. Contractors' late payments to suppliers or workers are from the financial crises that contractors face. Furthermore, it is very common to find cases in which a contractor or subcontractor who has not been paid what s/he is due intimidates workers or suspends work under the contract until the balance is paid in full. The lowest bid tender award is a significant challenge to contractors and most often results in poor performance. Contractors may bid at the lowest price to obtain the award but ultimately may adopt low-quality techniques that can save cost. Hence, this factor has a greater effect on the contractor than the owner. Poor communication and coordination can result from work stress, poor communication skills on workers' part, unclear and inconsistent site information, and misinterpretation of instructions.

However, as Table 4 shows, there are not many significant differences between the owners and contractors in successful projects, compared to the unsuccessful projects in Table 5. If the project goes well, owners and contractors understand each other and reduce the gaps between their different views.

Table 5. Delay Causes in Unsuccessful Projects.

Group	Number	Total		Owner		Contractor		U-test
		Mean	Rank	Mean	Rank	Mean	Rank	Sig.
Owner-related	O1	3.09	26	2.60	32	3.36	15	0.000
	O2	2.94	33	2.34	35	3.25	23	0.000
	O3	2.87	35	2.74	28	2.94	35	0.389
	O4	3.28	16	2.97	24	3.44	10	0.018
	O5	3.00	32	2.76	27	3.13	29	0.107
	O6	3.16	21	3.03	20	3.23	24	0.321
	O7	3.48	9	3.61	5	3.42	11	0.228
	O8	3.05	29	3.03	21	3.06	31	0.902
Contractor-related	C1	3.17	20	2.95	25	3.29	21	0.370
	C2	3.59	6	3.50	8	3.64	5	0.700
	C3	3.37	10	3.38	10	3.37	14	0.472
	C4	3.31	12	3.24	14	3.34	17	0.777
	C5	3.32	11	3.35	12	3.31	19	0.767
	C6	3.08	27	2.54	33	3.37	13	0.000
	C7	3.86	1	3.76	3	3.92	2	0.937
	C8	3.54	7	3.53	7	3.54	7	0.421
	C9	3.61	4	3.84	2	3.49	8	0.082
	C10	3.13	23	3.05	19	3.17	28	0.818

Table 5. *Cont.*

Group	Number	Total		Owner		Contractor		U-test
		Mean	Rank	Mean	Rank	Mean	Rank	Sig.
Design-related	D1	3.12	25	3.21	16	3.07	30	0.207
	D2	3.03	31	2.66	30	3.22	25	0.009
	D3	2.88	34	2.63	31	3.01	34	0.071
	D4	3.28	17	2.92	26	3.47	9	0.002
	D5	3.29	14	3.18	17	3.35	16	0.689
Infrastructure and Socially related	I1	3.13	24	3.03	22	3.18	27	0.642
	I2	3.04	30	3.03	23	3.04	32	0.476
	I3	3.16	22	2.68	29	3.42	12	0.015
	I4	3.06	28	2.51	34	3.34	18	0.000
	I5	3.60	5	3.22	15	3.79	3	0.317
	I6	3.74	3	3.92	1	3.65	4	0.193
	I7	3.29	15	3.49	9	3.19	26	0.029
	I8	3.30	13	3.30	13	3.30	20	0.883
	I9	3.86	2	3.76	4	3.92	1	0.598
Externally related	E1	3.20	19	3.08	18	3.26	22	0.995
	E2	3.23	18	3.59	6	3.04	33	0.012
	E3	3.50	8	3.38	11	3.56	6	0.817

4.1.2. Causes of Delays in Unsuccessful Projects

Table 5 shows the causes of delay in unsuccessful power projects. Poor cost estimation (C7_1st Rank), vandalism (I9_2nd Rank), late delivery of material and equipment (I6_3rd Rank), late procurement orders for material and equipment (C9_4th Rank), and additional work attributable to errors (I5_5th Rank) rank as the top 5 in the group overall. In the owner group, late delivery of material and equipment (I6_1st Rank), late procurement orders for material and equipment (C9_2nd Rank), poor cost estimation (C7_3rd Rank), vandalism (I9_4th Rank), and the owner's inadequate funds or budget allocation (O7_5th Rank) rank as the top five. In the contractor group, vandalism (I9_1st Rank), poor cost estimation (C7_2nd Rank), unskilled or inexperienced labor (I5_3rd Rank), late delivery of material and equipment (I6_4th Rank), and poor cost management (C2_5th Rank) rank as the top five. As such, the owner and contractor groups ranked the top five delay factors similarly, which indicates that the two do not have significantly different perspectives on delay factors.

However, there are some significant differences between the owners and contractors at the rank level. Owners ranked delays in obtaining permits from authorities (I7) and unexpected geological conditions (E2) significantly higher than did contactors. In contrast, contractors ranked change in scope (O1), owner's poor supervision (O2), delays in approval (O4), misrepresentation of information before bid (C6), inappropriate data collection (D2), failure in planning and designing risk (D4), workers' strikes (I3), and poor working conditions (I4) significantly higher than did owners. These causes usually are attributable not to the contractor, but to owners or external factors.

4.2. Mitigation Strategies

4.2.1. Mitigation Strategies in Successful Projects

Table 6 shows the project delay mitigation strategies in successful power construction projects. Close project supervision (M4_1st Rank), conducting capacity building training (M6_2nd Rank), and proper logistics management (M14_3rd Rank) rank as the top three in the total group. In the owner group, close project supervision (M4_1st Rank), top management's support (M15_2nd Rank), and proper logistics management (M14_3rd Rank) rank as the top three, while in the contractor group, conducting capacity building training (M6_1st Rank), proper logistics management (M14_2nd Rank), and timely site visits (M11_3rd Rank) rank as the top three. The Mann–Whitney U-test found no significant differences between owners and contractors in all strategies as shown in Table 6, which implies that if project schedule goes well, owner and contractor have similar delay management strategy.

Table 6. Mitigation Strategy in Successful Projects.

Number	Total		Owner		Contractor		U-test
	Mean	Rank	Mean	Rank	Mean	Rank	Sig.
M1	3.29	14	3.24	12	3.35	14	0.683
M2	3.32	12	3.19	14	3.52	9	0.328
M3	3.16	15	2.95	15	3.48	11	0.093
M4	3.65	1	3.67	1	3.62	7	0.922
M5	3.54	5	3.43	6	3.69	4	0.296
M6	3.64	2	3.50	4	3.86	1	0.256
M7	3.41	9	3.33	10	3.54	8	0.430
M8	3.38	11	3.45	5	3.26	15	0.583
M9	3.42	8	3.37	9	3.50	10	0.580
M10	3.43	7	3.31	11	3.63	5	0.257
M11	3.53	6	3.40	8	3.71	3	0.248
M12	3.32	13	3.24	13	3.45	12	0.461
M13	3.39	10	3.40	7	3.36	13	0.796
M14	3.61	3	3.52	3	3.72	2	0.381
M15	3.59	4	3.57	2	3.63	6	0.975

Conducting capacity building training ranked highest as a mitigation strategy from the contractors' perspective. Capacity building training offers a good opportunity for any industry to enhance its workers' knowledge and skills, as well as teams' self-esteem. Some of the benefits of conducting capacity building training are improved worker performance, satisfaction, and retention, an increased number of qualified workers, and workers who are updated on technology changes. Top management's support also ranked high. This indicates that the owners believe that top management's support contributed significantly to reducing power projects' delay. Furthermore, management usually defines the project's scope, facilitates the provision of resources, and selects the project team. They also ensure appropriate project funding and make some very critical decisions, such as approving funding allocation, authorizing scope changes, and whether to allow schedule overruns.

4.2.2. Mitigation Strategies in Unsuccessful Projects

Table 7 presents the project delay mitigation strategies in unsuccessful power construction projects. The results are significantly different from those in Table 6, and eight of fifteen mitigation strategies differed significantly between owners and contractors, which implies that if the project does not go well, owners and contractors think different solutions. If these different strategies are not understood and integrated, the project delay is not difficult to be solved.

Timely payments of completion certificates (M8_1st Rank), proper planning of project financial arrangements (M1_2nd Rank), and consideration of Donor's Influence (M3_3rd Rank) rank as the top three in the group overall. In the owner group, timely procurement and supply of materials and equipment (M7_1st Rank), top management's support (M15_2nd Rank), and proper planning of project financial arrangements (M1_3rd Rank) rank as the top three, while in the contractor group, conducting capacity building training (M6_1st Rank), timely payments of completion certificates (M8_2nd Rank), and finishing the design on time (M10_3rd Rank) rank as the top three. The Mann–Whitney U-test found no significant differences between owners and contractors, as shown in Table 7.

The practice of effective and well-timed payment in construction projects is a major factor that contributes to a project's success. For example, if the employer makes a late payment to the contractor, the payment due to the subcontractors or suppliers who are bound contractually to supply goods or services also will be late. Various reasons for delayed payment include the client's poor financial management, delays in certification, and disagreements on the valuation of the work performed.

Table 7. Mitigation Strategy in Unsuccessful Projects.

Number	Total		Owner		Contractor		U-test
	Mean	Rank	Mean	Rank	Mean	Rank	Sig.
M1	4.09	2	4.48	3	3.87	4	0.001
M2	3.87	10	4.10	10	3.75	8	0.104
M3	3.95	6	4.28	7	3.78	7	0.001
M4	3.83	13	4.03	12	3.72	9	0.106
M5	3.95	7	4.38	5	3.71	10	0.001
M6	4.04	3	3.95	14	4.10	1	0.325
M7	3.98	5	4.58	1	3.65	12	0.000
M8	4.13	1	4.23	8	4.07	2	0.356
M9	4.03	4	4.38	6	3.84	5	0.005
M10	3.95	8	4.03	13	3.90	3	0.487
M11	3.77	14	4.21	9	3.53	14	0.001
M12	3.74	15	3.82	15	3.70	11	0.667
M13	3.86	12	4.40	4	3.56	13	0.000
M14	3.89	9	4.10	11	3.78	6	0.095
M15	3.87	11	4.53	2	3.51	15	0.000

5. Discussions

Many studies have dealt with delay causes and mitigation strategies in construction projects. However, so many construction projects are still frequently delayed, which results in poor project performance such as cost and time overruns, disputes, arbitration, litigation, and complete termination [35,38,39]. Thus, this study tried to find knowledge more specific to owners and contractors respectively because owners and contractors have different roles and capabilities to deal with delay management. In addition, depending on the project's difficulty and performance, the delay causes and mitigation strategy can be varied. Thus, this study suggested the delay causes and mitigation strategies separately in successful project and unsuccessful projects.

If the project progress meets the planned schedule or delays less than 10% of planned schedule, the owner and contractor can refer to Tables 4 and 6. Owner and contractor are likely to think that the delay is caused for similar reasons. They need to take care of inadequate funding or budget allocation, vandalism, the contractor's late payment to suppliers or workers, late delivery of materials and equipment, and delays in obtaining permits from authorities. They can establish mitigation plans such as close project supervision, conducting capacity building training, and proper logistics management.

However, if the project delay more than 10% of the planned schedule, the owner and contractor can refer to Tables 5 and 7. Owner and contractor have to scrutinize the delay cause and mitigation strategy. Owners and contractors are likely to transfer their poor performance to the counter party's responsibility. The owner needs to review the late delivery of material and equipment, late procurement orders for material and equipment, poor cost estimation, vandalism, and owner's inadequate funds or budget allocation. The contractor needs to check the vandalism, poor cost estimation, unskilled or inexperienced labor, late delivery of material and equipment, and poor cost management. After analyzing the delay causes, owner can establish mitigation strategies such as timely procurement and supply of materials and equipment, top management's support, and proper planning of project finance arrangements. Whereas the contractor can build mitigation strategies such as conducting capacity building training, timely payments of completion certificates, and finishing the design on time.

These results make a contribution not only to delay management but also to risk and conflict management. As a result, there are some gaps between owner and contractor for perceiving the delay causes and mitigation strategies differently. These differences frequently induce conflicts between them, which further delays the project schedule. Owners, particularly when also decision makers, should build reasonable benefit-sharing mechanism, risk allocation of resource arrangement [14], which increase the contractor's trust in the owner. This trust builds a strong foundation for contractors to conduct their responsibility [12].

6. Conclusions

This study analyzed the delay causes and mitigation strategies between owner and contractor in successful and unsuccessful power construction project. This study found that the delay causes and mitigation strategies significantly varies depending on project progress performance as shown following.

First, if the project progress meets the plan well, there are not many different gaps between owner and contractors. Owner and contract can easily converge the delay causes and build mitigations strategy for their success. In particular, the owner should manage the funding well and control the budget, whereas the contractor should take care of late payments to suppliers or work.

Second, if the project progress delays much, there are serious different gaps between owner and contractors. Even more, owner and contract differently evaluate the delay causes and mitigations strategy to catch up the progress. Therefore, the decision makers should encourage the owner and contractor-side experts to perceive the various gaps and communicate each other. Then, they together should build the mitigation strategies. In particular, the owner should manage the monitoring of late delivery of material and equipment, reviewing the cost estimation, funding and budget control, whereas the contractor should take care of vandalism, poor cost estimation, unskilled and unexperienced labors.

Third, several causes and mitigation strategy are much related to decision makers. Lowest bid tender award and inadequate funds or budget allocation causes the project delay. Top management support ranks high in the mitigations strategy. These causes and mitigation strategy should be improved by the involvement of the decision maker.

Even though this study contributes to improving the delay management of construction projects, this has several limitations. First, the investigation of this study was conducted at a power construction project in Tanzania. Thus, if the practitioners use this study in other industry or country, they have to consider these specific conditions. Second, this study did not reflect the project size, detail types of project and experience level of respondents. These attribute can affect the causes and mitigation strategy. Therefore, in the future, this study will analyze the delay causes and mitigation strategies according to the project size and experience level of respondents.

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References

1. Sambasivan, M.; Soon, Y.W. Causes and effects of delays in Malaysian construction industry. *Int. J. Proj. Manag.* **2007**, *25*, 517–526. [CrossRef]
2. Kikwasi, G.J. Causes and effects of delays and disruptions in construction projects in Tanzania. *Australas. J. Constr. Econ. Build.* **2012**, *1*, 52–59. [CrossRef]
3. *Tanzania Electric Supply Company Limited (TANESCO 2018)*, Power Project Report; Unpublished.
4. Shubhan, V. Causes of delay in project construction in developing countries. *Indian J. Commer. Manag. Stud.* **2013**, *4*, 24–29.
5. El-Razek, M.E.A.; Bassioni, H.A.; Mobarak, A.M. Causes of Delay in Building Construction Projects in Egypt. *J. Constr. Eng. Manag.* **2008**, *134*, 831–841. [CrossRef]
6. Long, N.D.; Ogunlana, S.; Quang, T.; Lam, K.C. Large construction projects in developing countries: A case study from Vietnam. *Int. J. Proj. Manag.* **2004**, *22*, 553–561. [CrossRef]

7. Assaf, S.A.; Al-Hejji, S. Causes of Delay in Large Building Construction Projects. *J. Manag. Eng.* **2006**, *1*, 45–50. [CrossRef]
8. Olajide, T.I.; Timo, O.O.; Onaopepo, A.; Idowu, V.E. Analysis of Non-Excusable Delay Factors Influencing Contractors' Performance in Lagos State Nigeria. *J. Constr. Dev. Ctries.* **2013**, *18*, 53–72.
9. Pillai, N.; Kannan, K.P. *Time and Cost Over-Runs of Power Projects in Kerala*; Working Paper No. 320; Centre for Development Studies: Thiruvananthapuram, India, 2001.
10. Marques, R.C.; Berg, S. Risks, Contracts, and Private-Sector Participation in Infrastructure. *J. Constr. Eng. Manag.* **2011**, *137*, 925–932. [CrossRef]
11. Marques, R.C.; Berg, S. Revisiting the Strengths and Limitations of Regulatory Contracts in Infrastructure Industries. *J. Infrastruct. Syst.* **2010**, *16*, 334–342. [CrossRef]
12. Xu, Z.; Yin, Y.; Li, D.; Browne, G.J. Owner's Risk Allocation and Contractor's Role Behavior in a Project: A Parallel-mediation Model. *Eng. Manag. J.* **2018**, *30*, 14–23. [CrossRef]
13. Tripathi, K.K.; Jha, K.N. Determining Success Factors for a Construction Organization: A Structural Equation Modeling Approach. *J. Manag. Eng.* **2018**, *34*, 04017050. [CrossRef]
14. Wu, G.; Wang, H.; Chang, R. A Decision Model Assessing the Owner and Contractor's Conflict Behaviors in Construction Projects. *Adv. Civ. Eng.* **2018**, *2018*, 1347914. [CrossRef]
15. Chan, D.W.; Kumaraswamy, M.M. A comparative study of causes of time overruns in Hong Kong construction projects. *Int. J. Proj. Manag.* **1997**, *15*, 55–63. [CrossRef]
16. Odeh, A.M.; Battaineh, H.T. Causes of construction delay: Traditional contracts. *Int. J. Proj. Manag.* **2002**, *20*, 67–73. [CrossRef]
17. Aziz, R.F.; Abdel-Hakam, A.A. Exploring delay causes of road construction projects in Egypt. *Alex. Eng. J.* **2016**, *55*, 1515–1539. [CrossRef]
18. Alsuliman, J.A. Causes of delay in Saudi public construction projects. *Alex. Eng. J.* **2019**, *58*, 801–808. [CrossRef]
19. Jung, W.; Han, S.H. Which Risk Management Is Most Crucial for Controlling Project Cost? *J. Manag. Eng.* **2017**, *33*, 04017029. [CrossRef]
20. Majid, M.Z.A.; McCaffer, R. Factors of Non-Excusable Delays That Influence Contractors' Performance. *J. Manag. Eng.* **1998**, *14*, 42–49. [CrossRef]
21. Ogunlana, S.; Promkuntong, K.; Jearkjirm, V. Construction delays in a fast-growing economy: Comparing Thailand with other economies. *Int. J. Proj. Manag.* **1996**, *14*, 37–45. [CrossRef]
22. Frimpong, Y.; Oluwoye, J.; Crawford, L. Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study. *Int. J. Proj. Manag.* **2003**, *21*, 321–326. [CrossRef]
23. Koushki, P.A.; Al-Rashid, K.; Kartam, N. Delays and cost increases in the construction of private residential projects in Kuwait. *Constr. Manag. Econ.* **2005**, *23*, 285–294. [CrossRef]
24. Khatib, B.; Poh, Y.S.; El-Shafie, A. Delay Factors in Reconstruction Projects: A Case Study of Mataf Expansion Project. *Sustainability* **2018**, *10*, 4772. [CrossRef]
25. Zhang, Y.; Fan, Z.P. An optimization method for selecting project risk response strategies. *Int. J. Proj. Manag.* **2014**, *32*, 412–422. [CrossRef]
26. Wang, S.Q.; Dulaimi, M.F.; Aguria, M.Y. Risk management framework for construction projects in developing countries. *Constr. Manag. Econ.* **2004**, *22*, 237–252. [CrossRef]
27. Kim, M.-S.; Lee, E.-B.; Jung, I.-H.; Alleman, D. Risk Assessment and Mitigation Model for Overseas Steel-Plant Project Investment with Analytic Hierarchy Process-Fuzzy Inference System. *Sustainability* **2018**, *10*, 4780. [CrossRef]
28. Asadi, P.; Zeidi, J.R.; Mojibi, T.; Yazdani-Chamzini, A.; Tamošaitienė, J. Project risk evaluation by using a new fuzzy model based on Elena guideline. *J. Civ. Eng. Manag.* **2018**, *24*, 284–300. [CrossRef]
29. Guo, S.; Zhang, P.; Yang, J. System dynamics model based on evolutionary game theory for quality supervision among construction stakeholders. *J. Civ. Eng. Manag.* **2018**, *24*, 318–330. [CrossRef]
30. Su, Y.; Lucko, G.; Thompson, R.C., Jr. Application of Voting Theory to the Float Ownership Problem. *JCEM* **2018**, *144*, 04017094. [CrossRef]
31. Rockart, J.F. The changing role of the information systems executive: A critical success factors perspective. *Sloan Manag. Rev.* **1982**, *24*, 3–13.
32. Pinto, J.K.; Kharbanda, O.P. *Successful Project Managers Leading Your Team to Success*; Van No Strand Reihnhold: New York, NY, USA, 1995.

33. Nguyen, L.D.; Ogunlana, S.O.; Lan, D.T.X. A study on project success factors in large construction projects in Vietnam. *Eng. Constr. Arch. Manag.* **2004**, *11*, 404–413. [CrossRef]
34. Nguyen, L.H. Relationships between Critical Factors Related to Team Behaviors and Client Satisfaction in Construction Project Organizations. *J. Constr. Eng. Manag.* **2019**, *145*, 04019002. [CrossRef]
35. Aibinu, A.; Jagboro, G. The effects of construction delays on project delivery in Nigerian construction industry. *Int. J. Proj. Manag.* **2002**, *20*, 593–599. [CrossRef]
36. Li, Y.; Song, H.; Sang, P.; Chen, P.-H.; Liu, X. Review of Critical Success Factors (CSFs) for green building projects. *Build. Environ.* **2019**, *158*, 182–191. [CrossRef]
37. Weiner, I.B.; Craighead, W.E. *Corsini Encyclopedia of Psychology*, 4th ed.; John Wiley & Sons, Inc.: Hoboken, NJ, USA, 2010; pp. 960–961.
38. Kassanga, E.J. Comparative Analysis of Cost Performance in Contracted Projects with Internally Done Projects in Tanzania. Master's Thesis, University of Dar es Salaam, Dar es Salaam, Tanzania, 2011.
39. Koushki, P.A.; Kartam, N. Impact of construction materials on project time and cost in Kuwait. *Eng. Constr. Arch. Manag.* **2004**, *11*, 126–132. [CrossRef]