buildings

MDPI

Article

Assessing Risk Factors Affecting the Accuracy of Conceptual Cost Estimation in the Middle East

Mohamed Abdel-Monem [1], Kareem Tarek Alshaer [1,*] and Karim El-Dash [2]

[1] Department of Civil Engineering, Shoubra Faculty of Engineering, Benha University, Cairo 4351026, Egypt; m.abdelmonem@feng.bu.edu.eg
[2] Department of Civil Engineering, Misr University for Science and Technology, 6th of October City 3236101, Egypt; karim.eldash@must.edu.eg
* Correspondence: k.elshaer89@gmail.com

Abstract: The construction industry is subjected to more risk and uncertainty than many other industries, in addition to poor risk-tracking records. This usually causes the late completion of projects, surpassing their estimated budgets even without achieving the desired quality and operational requirements. This study first identified the most critical factors affecting the accuracy of cost estimates. A questionnaire has been designed and distributed to construction experts; the results indicated stakeholders' perception to improve their cost estimation using a proper and predefined risk management plan. Following the respondents' judgment, this study identified 51 risk factors and their potential root causes and presents a response plan for the most critical risks that might affect cost estimates to improve construction-industry performance. Then, a new simple model has been developed to analyze risk factors affecting the accuracy of conceptual cost estimates, from both clients' and contractors' perspectives. The developed model will provide the decision-makers with a list of risks accompanied by guidelines/response plans to mitigate their effect on project cost to help the estimators identify the most effective cost contingency against the project's scope creep.

Keywords: risk management; construction management; cost estimation

Citation: Abdel-Monem, M.; Alshaer, K.T.; El-Dash, K. Assessing Risk Factors Affecting the Accuracy of Conceptual Cost Estimation in the Middle East. *Buildings* **2022**, *12*, 950. https://doi.org/10.3390/buildings12070950

Academic Editors: S.A. Edalatpanah and Jurgita Antucheviciene

Received: 30 May 2022
Accepted: 1 July 2022
Published: 4 July 2022

1. Introduction

Construction projects are more complex than before, technically and contractually, with the negative impacts on their execution having become higher due to increased risks. Thus, in order to manage the project's risks properly, it is mandatory to identify and analyze risks in a timely manner [1,2]. Cost estimation is an essential process in construction project management. There are numerous uncertainties in the project that may affect determining the probable construction-project cost to be handled by estimators [3]. Increasing uncertainties in any project will reduce the reliability of cost estimation and reduce the success of any project; hence, the application of risk management in the construction project in an early stage will increase the chances of the project's success [4,5]. Regardless of the contract type, any project must prepare a realistic cost estimate [6]. The construction industry's performance has always remained a matter of concern in the middle east, so identifying the root causes of the cost overrun helps in determining the response plans to reduce the impact on the project performance [7].

A cost estimate is divided into two steps (base estimate and cost contingency). The base estimate is the total estimate of the activities cost, and activities duration is considered as certain value (risk-free). The total allowance of time and cost to cover all uncertainties in the project is the definition of contingency. Monte Carlo simulation is one of the quantitative risk-analysis techniques that helps in improving the contingency. This technique is a process that leans on repeated random sampling and has been used successfully in many industries, including construction projects, for reliable and accurate prediction of project cost and associated probability. The most common cost estimation methodology is adding

a percentage of the estimated cost (risk-free) to cover the uncertainty in the construction project without applying the risk management; thus, this study aims to identify the common risks that might affect cost-estimate accuracy and also provides the decision-makers with guidelines enable them to determine the proper amount of money as a cost contingency to cover the expected uncertainties during the project construction. So, a new model will be developed to provide the cost estimator with a list of assessed risk factors and the recommended response plan for each risk according to the organization type, the project type, the project size, the contract type, and the project location.

2. Literature Review

Cost estimation is the summation of individual elements' costs using established methods based on the available data [8]. The most conventional method is summing all project components' costs and adding overall contingency cost according to project uncertainties [9]. So, the generated cost estimate represents only one potential scenario, based on multiple variables and assumptions, which are neither controllable nor quantifiable [10,11]. There are four methodologies for cost estimation (cost-based estimate, historical bid-based estimate, parametric estimate, and risk-based estimate).

In this paper a Risk-Based Estimate (RBE) methodology has been utilized, which includes qualitative and quantitative analysis based on the project complexity. The Risk-Based Estimate (RBE) methodology uses several techniques to improve the estimated cost of the construction project, inclusive cost-based estimating, historical data, and the experts' judgment.

The Risk-Based Estimate (RBE) methodology can be utilized by developing, implementing, and maintaining the risk management process starting with risk identification, followed by risk analysis, risk response, and finally monitoring and control [12]. Accordingly, the risk analysis process will prioritize risks according to their score, including qualitative and quantitative methods [12].

The risk identification process is very crucial for preparing or developing cost contingency regardless of the contract type for the construction project. Pham D. H. et al. [2] assures the importance of developing the risk-management process in the Design-Build contracts. The proper identification and risk assessment in the early stage can increase the probability of a project's success [2]. Thus, this paper reviewed previous literature studies related to cost estimation and cost contingency to get the common risk factors that may affect cost-contingency estimation. For example, 70% of Dubai projects are facing time overruns, which leads to cost overruns due to contractual problems [7–13]. Sunjka et al. [14] stated that unrealistic contractual duration affects the project's scope due to inadequate planning time. The contractor's poor technical performance is mostly linked to improper forecasting and project management, escalating project costs [14,15].

Identifying all the potential risks associated with the construction sector is challenging since they depend significantly on a project's context. However, it is possible to identify common risk categories based on analyzing the previous studies [16]. The current study addressed the most common categories and risk factors that might affect the cost estimation in the construction sector as shown in Table 1.

Table 1. Risk categories from previous studies.

#	Categories	Factors	Previous Studies
1	Contract	Contract type, and clarity. Variations and claims. Changes to standard general conditions. Completion date is not practical. The time allowed for the pre-tender stage is not enough.	[7,14,17–21]

Table 1. *Cont.*

#	Categories	Factors	Previous Studies
2	Technical	Not considering all factors at the cost estimation. Delaying in preparation or approval of submittals. Improper cost control procedures. Bad/incomplete planning. Low quality and integrity of the design. Unexpected changes from the client.	[14,20,22–26]
3	Construction project	Delay of construction permits. More cost due to project complexity and size. Improper investigation of project location and site conditions. Unexpected underground utilities. Material waste. Increase in material or equipment cost. Productivity loss issues. Weather conditions. Rework due to quality issues.	[7,14,26–32]
4	Financial	Failure to get funds or delayed payment. Currency stability, exchange rate variation. Errors in estimating cost. The value-added tax (VAT).	[18,27,33–35]
5	Resources	Not enough labor, materials, plant, and equipment. Improper procurement route. Improper delivery method. The need to import materials from abroad.	[15,31,36–39].
6	Safety, Security	Human errors. Equipment failure. Client safety procedures. Loss due to stealing or vandalism.	[29,31,40,41]
7	Procurement	Late/failure delivery by suppliers. No available alternative to the suppliers or subcontractors. Work failure or rework caused by the subcontractor. The subcontractor's inability to end the project.	[7,14,23–42]
8	Logistics	Availability problems or long duration. Roads, bridges, and tunnels constraints. Improper site access.	[29,40–43]
9	Project location (Offshore)	Poor communication (remoteness, poor infrastructure). Import/export restrictions. Difficulty in support (hardware, software, expertise).	[18,22,29–44]
10	Main contractor	Incomplete staff and manpower since the beginning of the project. Hiring an incompetent subcontractor. The contractor's inability to end the project.	[22,37–45]
11	Consultant	The consultant delays the approvals for designs and material. The inefficiency of the consultant. Changing the consultant during the project.	[7–14]
12	Environmental	The project disturbing the local population lifestyle and economy. The project problems are related to logistics. The project disturbing the area's ecology (contamination of river water, odors, noise, and erosion).	[29,46–49]

Ullah S. [4] highlighted the importance of identifying all risks related to the project location, the project complexity and size, contract type, and technical. Moreover, Riveros C. [16] summarized two case studies using root-cause analysis and pattern matching and presented common risk categories such as construction, financial, design, and contract

risks. On the other hand, Liu et al. [50] and Odeyinka et al. [51] stated that one of the most common critical risk categories in the construction industry is the financial category.

Based on the literature review analysis, this paper will identify common risks affecting cost-estimate accuracy using the questionnaire technique. The questionnaire design will be based on a comprehensive review of previous studies for different countries and experts' interviews to identify the risk factors that might affect the cost of construction projects in the Middle East. Accordingly, we developed a new simple model to provide the cost estimators with various recommendations of risk factors that might affect the construction project cost, in order to determine the proper contingency as a proactive plan through developing, implementing, and maintaining a risk-management process to enhance an organizations' profitability and competitiveness.

3. Research Methodology

In order to identify the risk factors affecting construction projects in the Middle East, this paper started by conducting a literature review analysis to identify risk factors that might affect the cost of construction projects. The next step was to prepare and develop a questionnaire and distribute it to construction experts. The collected data from experts' responses was analyzed using statistical indicators to prioritize the factors through the importance index (I.I%). Then, we conducted a risk assessment and determined the proper contingency to cover those uncertainties and minimize the project's cost overrun. Figure 1 shows the flow chart of the methodology applied in this research.

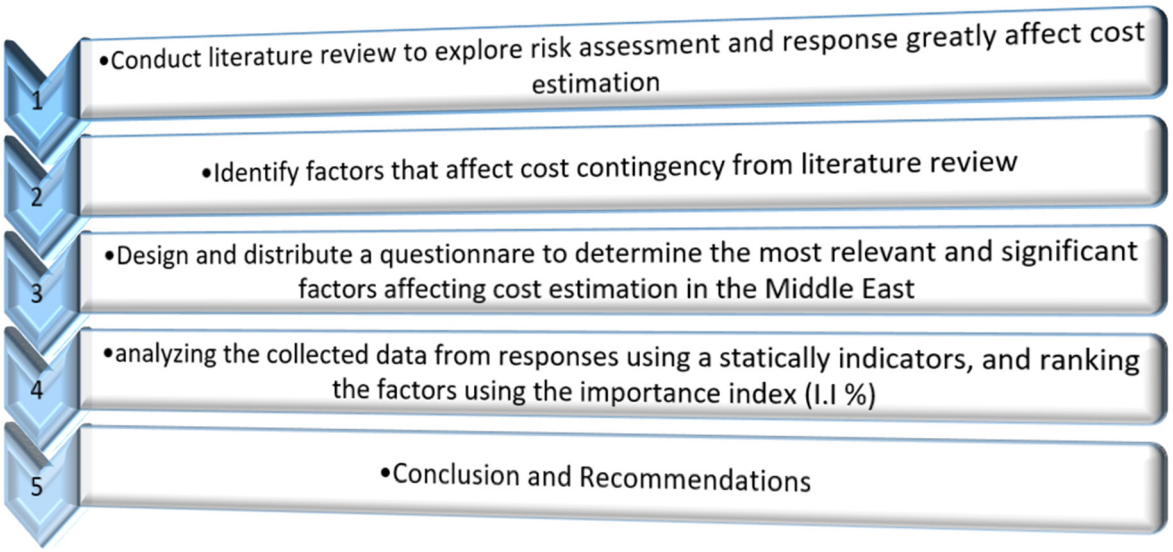

Figure 1. Methodology flow chart.

The fundamental data for this paper has been collected via a questionnaire survey that targeted consultants, contractors, and clients in the Middle East. The questionnaire consists of fifty questions and is grouped into three sections. These sections have been described as follows; 1. background information about the respondent and the organization; 2. risk assessment; 3. respondent's feedback and comment. Selected respondents were interviewed to discuss the survey results and to clarify their answers. The risk factors are grouped into twelve categories; each category has been divided into subcategories according to the Risk Breakdown Structure (RBS). These categories are as follows: contract, technical, construction, financial, resources, safety and security, suppliers and sub-contractors, transport, offshore location, main contractor, consultant, and environmental. Only chosen questions from the questionnaire are discussed, due to paper's length restrictions.

4. Data Collection

A pilot survey has been conducted to ensure the efficiency and clarity of the proposed questionnaire and improve it [52–54]. Ninety responses have been received from an extensive range of construction professionals in the industry, including site engineers, construction managers, project control managers, project managers, quantity surveyors, technical managers, cost engineers, and contracts managers as shown in Figure 2.

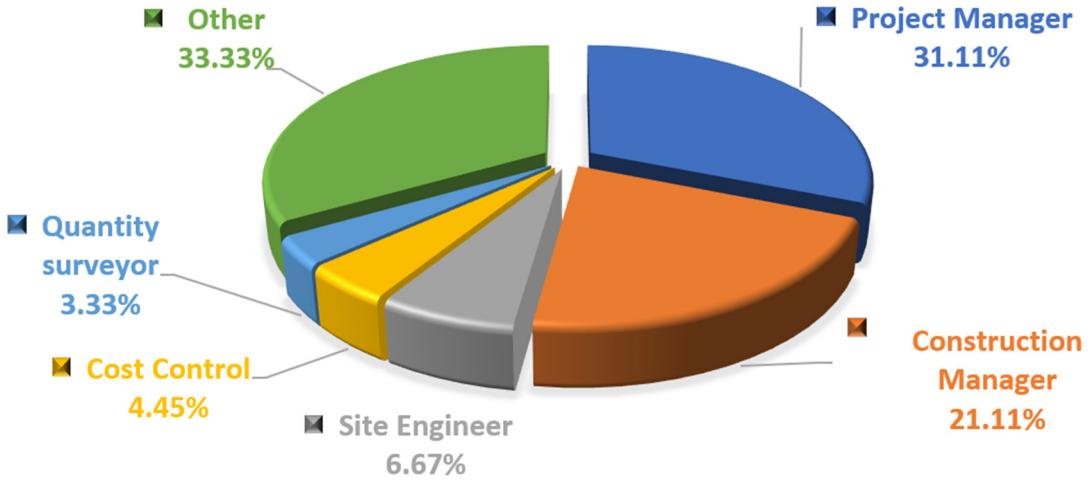

Figure 2. Designation of the respondents.

In this pilot study, a field survey for seven projects was conducted in several locations. Face-to-face interviews were held with six project managers, three project control managers, seven technical managers, and four consulting managers, with experience of 10–17 years to review and modify the risk factors of the proposed questionnaire. Moreover, the questionnaire was modified following their recommendations.

Following the received recommendations, some factors were removed such as (restricted working hours/routines, maintaining existing services, and appropriateness of specifications), and others were added, such as (unexpected underground utilities, improper procurement route, and environmental-related factors). Also, some modifications have been recommended including improving the questionnaire format, adding a question about the estimated extra cost for each risk factor, and removing the definition of risks.

Data was collected from different 25 construction projects located in the Middle East (Egypt, KSA, UAE, Qatar, Jordan, Palestine, Bahrain, Kuwait, and Iraq). Figure 3 shows the percentage of different project types surveyed. One hundred questionnaires were distributed to professionals in the construction industry to get their opinions about the risks that might affect the construction projects' cost estimation. Ninety questionnaires were completed with a participation rate of 90%. The respondents were classified into four categories depending on the job position, their experiences, type of organization, and the type of projects they completed. As shown in Figure 4, contractors represent 81.05%, consultants 14.74%, and owners' participation rate was 4.21%, which is low since consultants also represent the owners.

Based on the respondents' position, education, and work experience, it can be summarized that the respondents have adequate knowledge about the detailed activities and their associated costs. The response rate for the completed questionnaires is 90%. This response rate represents evidence of the increased interest and awareness about the importance of risk management in the construction industry. In similar surveys, Wang et al. [55] received a 7.75% response rate, Panthi et al. [56] received 19.4%, and Ahmed et al. [57] received a 30.4% response rate. A sample size of more than or equal to twenty questionnaires can provide a statistically reliable conclusion [58].

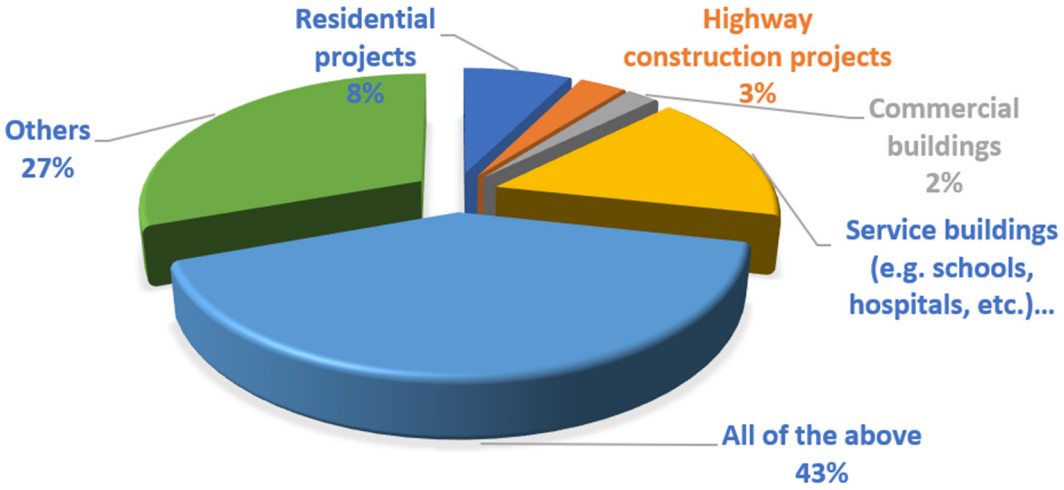

Figure 3. Percentage of the project types.

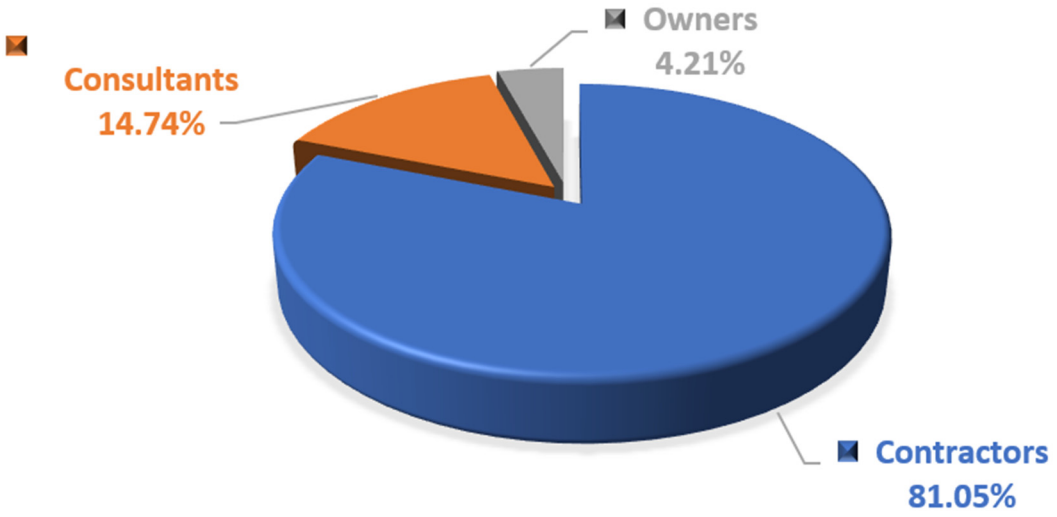

Figure 4. Percentage of the organization type (included in this study).

5. Data Analysis

The collected data from the ninety questionnaires were analyzed, and three important indicators were calculated which are: Frequency, Severity, and Importance, as shown in Equations (1)–(3) [37–59]. These indicators are significant to prioritize risk factors that might affect the cost estimation for each category. They also help in identifying the most critical factors with a high-risk index on cost estimation.

Frequency Index: a formula to calculate the probability of occurrence for the risk factor as identified by participants is shown in Equation (1).

$$\text{Frequency Index (F.I)}(\%) = \sum a\left(\frac{n}{N}\right) \times \frac{100}{5} \quad (1)$$

Severity Index: it is a formula to calculate the severity impact on cost estimation according to participants' opinions and can be calculated as shown in Equation (2) [37,59,60].

$$\text{Severity Index (S.I)}(\%) = \sum a\left(\frac{n}{N}\right) \times \frac{100}{5} \quad (2)$$

where: (a) is a constant expressing the weight given to each response (range from 1 very low to 5 very high), n is the response frequency, and N is the responses total number.

Importance Index: it can be calculated as a function of both frequency and severity indices. This indicator shows the impact of each risk factor on cost estimation as shown in Equation (3) [37,60].

$$\text{Importance Index (I.I)}(\%) = \frac{[\text{F.I}(\%) \times \text{S.I}(\%)]}{100} \quad (3)$$

where: F.I% and S.I% are the calculated Frequency and Severity indices for specific risk factor.

6. Results and Discussion:

The collected data were organized into one sheet, including all the factors that the survey obtained from all ninety respondents. The frequency index of each factor was calculated following Equation (1). The severity index was calculated following Equation (2). Finally, the importance index to rank all factors was calculated based on Equation (3). Based on data analysis, the next part will discuss each category and its related factors.

6.1. Contract Related Factors

Poor contract management has a massive impact on project costs. However, it is doubtful that no project can be delivered without variations during the construction phase [14–17]. The lack of management experience and contract preparation leads to misuse and misinterpretation of contractual agreements generating more disputes, and negatively impacting the project scope [18]. Contract change mostly leads to cost overruns due to variations in materials specification [19].

Table 2 shows the five factors related to the contract that may affect the project cost. According to experts' opinion, the most influential factor was "completion date not practical" as it is one of the main causes of cost overrun, it was ranked as the first among all factors with I.I = 53.84%. Compared to previous studies, it was the second in UAE study by Johnson et al. [7], ranked 8th in Egyptian study by Seif El-Din [20], and ranked 13th in Qatari study by Hassan et al. [21]. However, the second and third factors were contract type and clarity, and variations and claims.

Table 2. Risk factors categorization and ranking.

#	Factors	F.I%	S.I%	I.I%	Category Ranking	Overall Ranking
	Contract risk factors ranking					
1	Contract type, and clarity.	65.4	76.4	49.97	2	4
2	Variations and claims.	66.4	73.4	48.74	3	6
3	Changes to standard general conditions.	49.6	67.6	33.53	5	39
4	Completion date is not practical.	69.2	77.8	53.84	1	1
5	The time allowed for the pre-tender stage is not enough.	66.2	72.4	47.93	4	9
	Technical risk factors ranking					
6	Not considering all factors at the cost estimation.	60.6	80.4	48.72	2	7
7	Delaying in preparation or approval of submittals.	65	74.2	48.23	3	8
8	Improper cost control procedures.	61.6	71	43.74	6	17
9	Bad/incomplete planning.	64	81.4	52.10	1	2
10	Low quality and integrity of the design.	59.4	77	45.74	4	12
11	Unexpected changes from the client.	60.4	75.4	45.54	5	14

Table 2. *Cont.*

#	Factors	F.I%	S.I%	I.I%	Category Ranking	Overall Ranking
	Construction project risk factors ranking					
12	Delay of construction permits.	58.8	70	41.16	3	25
13	More cost due to project complexity and size.	57	69.6	39.67	5	27
14	Improper investigation of project location and site conditions.	53.2	70.4	37.45	6	33
15	Unexpected underground utilities.	56.4	71.2	40.16	4	26
16	Material waste.	58.8	62.2	36.57	8	36
17	Increase in material or equipment cost.	60	71.8	43.08	2	19
18	Productivity loss issues.	66.6	71.8	47.82	1	10
19	Weather conditions.	48.8	54.6	26.64	9	46
20	Rework due to quality issues.	56	66.6	37.30	7	35
	Financial risk factors ranking					
21	Failure to get funds or delayed payment.	62	80	49.60	1	5
22	Currency stability, exchange rate variation.	47	63.2	29.70	3	44
23	Errors in estimating cost.	53.8	77.4	41.64	2	24
24	The value-added tax (VAT).	48.8	54.4	26.55	4	47
	Resources risk factors ranking					
25	Not enough labor, materials, plant, and equipment.	60	77.8	46.68	1	11
26	Improper procurement route.	59	75.8	44.72	2	15
27	Improper delivery method.	55.8	67.6	37.72	4	31
28	The need to import materials from abroad.	61.2	69.4	42.47	3	21
	Safety, Security risk factors ranking					
29	Human errors.	59.6	66	39.34	2	28
30	Equipment failure.	53.2	65.4	34.79	3	38
31	Client safety procedures.	63.8	68.8	43.89	1	16
32	Loss due to stealing or vandalism.	46.2	63.2	29.20	4	45
	Procurement risk factors ranking					
33	Late/failure delivery by suppliers.	66.2	76.8	50.84	1	3
34	No available alternative to the suppliers or subcontractors.	54.6	71.4	38.98	3	29
35	Work failure or rework caused by the subcontractor.	56	68.6	38.42	4	30
36	The subcontractor's inability to end the project.	56.8	74.4	42.26	2	22
	Logistics risk factors ranking					
37	Availability problems or long duration.	49	61.6	30.18	1	41
38	Roads, bridges, and tunnels constraints.	45.4	53.2	24.15	3	51
39	Improper site access.	47.4	55.8	26.45	2	48
	Project location (Offshore) risk factors ranking					
40	Poor communication (remoteness, poor infrastructure).	54.6	68.6	37.46	1	32
41	Import/export restrictions.	49	61.4	30.09	3	42
42	Difficulty in support (hardware, software, expertise).	51.6	61.6	31.79	2	40
	Main contractor risk factors ranking					
43	Incomplete staff and manpower since the beginning of the project.	60	70.8	42.48	1	20
44	Hiring an incompetent subcontractor.	58.8	71.8	42.22	2	23
45	The contractor's inability to end the project.	48.2	77.4	37.31	3	34

Table 2. *Cont.*

#	Factors	F.I%	S.I%	I.I%	Category Ranking	Overall Ranking
	Consultant risk factors ranking					
46	The consultant delays the approvals for designs and material.	61.2	74.6	45.66	1	13
47	The inefficiency of the consultant.	57.4	75.2	43.16	2	18
48	Changing the consultant during the project.	51.2	70.2	35.94	3	37
	Environmental risk factors ranking					
49	The project disturbing the local population lifestyle and economy.	44.4	58	25.75	2	49
50	The project problems are related to logistics.	47.8	62.2	29.73	1	43
51	The project disturbing the area's ecology (contamination of river water, odors, noise, and erosion).	43.6	58	25.29	3	50

6.2. Technical Related Factors

A practical cost estimate for a construction project needs a large amount of data to be collected and reviewed regularly and all related factors to be taken into consideration [22].

Table 2 shows the technical-related factors that involved six factors, which are considered one of the most critical groups affecting project cost estimation. The first three factors are delays in submittals, all factors are not considered at cost estimation, and bad/incomplete planning, which came first in this group and the second among all factors with I.I = 52.10%, as per experts' opinion. Saeed [23] stated that it is essential to plan accurately and completely for the project before commencing the work for successful completion. Mostly the contractors fail to provide realistic construction plans at the early stage, so it is hard to monitor project progress [14–24].

The second-ranked factor was "not considering all factors in the cost estimation" and ranked 7th among all factors with I.I = 48.72%. It was ranked 11th in Saudi study by Abdulaziz et al. [25], 12th in Jordanian study by G. Bekr [26], and 13th in Egyptian study by Seif El-Din [20].

6.3. Construction Project Related Factors

Construction-related factors contain many factors affecting cost estimation rather than other categories, seven factors have been analyzed and listed, as shown in Table 2. The top critical three factors are construction-permit delay, material or equipment cost increase, and productivity loss issues which came the first factor in this category with I.I = 47.82%, and 10th in overall ranking based on the survey result; however, it ranked 14th in an Iranian study by Towhid et al. [27], and 18th in an Emirati study by Johnson et al. [7], as well as in Jordanian study by G. Bekr [26].

Construction projects have a consistent record of cost overruns [28]. Sunjka et al. [14] stated that poor labor productivity leads to rework and cost overruns. Several studies have identified factors related to construction as major rework causes leading to cost overruns [29–32].

6.4. Financial Related Factors

Le-Hoai et al. [18] stated that both clients' and contractors' financial capabilities are essential for the continuous project flow. There is a potential increase in contractors' indirect costs due to payment delays by the owner leading to cost overruns [33].

Table 2 lists the four financial factors. The highest factor, which is the 5th among all factors, was "failure to get funds or delayed payment" with I.I = 49.60%, while it was the first in an Iranian study by Towhid et al. [27], and ranked 4th in both Kuwaiti studies by

N. Almutairi [34], and Omani study by Aisha M. [35], while the next two factors are cost estimation errors, and currency stability.

6.5. Resources Related Factors

Resources are one of the most effective factors in any successful construction project, and project success depends on an effective resource management plan [31]. The material-delivery delay has been identified as one of the leading causes to cost overrun in several studies [15,37–39].

According to survey results, resources related factors include four factors, as shown in Table 2. The most critical factor among this group is "Not enough labor, materials, plant, and equipment" and ranked 11th within overall factors with I.I = 46.68%. This result matches the study by Enshassi et al. [36], which stated that the unavailability of construction materials was a serious factor and led to numerous variation orders in Gaza Strip.

6.6. Safety, Security Related Factors

Fayek et al. [40] identified that lack of safety causes cost overrun. Failure to protect a construction site and lack of safety lead to project failure [31]. Table 2 shows that "client safety procedures" were the 1st factor among this group with I.I = 43.89% and 16th in the overall ranking. The Human errors factor was the 2nd factor; however, equipment failure was the 3rd. Client safety procedures, which ranked 1st in this category, and 16th in the overall ranking, has been ranked 61st in another study by Assim et al. [41], and 46th in a study by Enshassi et al. [29].

6.7. Procurement Related Factors

The selection of qualified suppliers and experienced subcontractors is essential to avoid cost overruns due to material delivery delays and reworks [14–23]. Table 2 lists the four factors related to the Suppliers, Sub-contractors group. It was found that the first rank is late/failure delivery by suppliers with I.I = 50.84%. It was the 3rd factor among all factors, and the 5th in the Emirati study by Johnson et al. [7] and the Turkish study by Gündüz et al. [42], while the subcontractor's inability to complete the project and no alternative suppliers or subcontractors were the second and third factors.

6.8. Logistics Related Factors

Transport-related factors directly affect the material and equipment delivery, which are considered critical factors for the project scope [29,40–43]. Three risk factors included in this group are shown in Table 2. Availability problems or long-duration came first with I.I = 30.18% among this group and 41st overall. This result conforms to several prior studies; it was ranked 52nd by Enshassi et al. [29].

6.9. Project Location (Offshore) Related Factors

In order to mitigate the cost overruns and successfully deliver projects, it is substantial to have effective communication between a project's internal and external stakeholders, especially for megaprojects located offshore [44]. The project may be delayed due to failure to solve the problem in the proper time, which may be caused by delays in the instructions flow [18]. The three factors in this group are poor communication, difficulty in support, and import/export restrictions as listed in Table 2. The first is poor communication (remoteness, poor infrastructure) with I.I = 37.46%, which ranked 32nd among overall factors and was included in several previous studies, such as in a study by Aljohani et al. [22] wherein it came in 4th place among the project's owner causes, and 39th in a study by Enshassi et al. [29].

6.10. Main Contractor Related Factors

A lack of contractor experience in the project type and scope leads to project delays and cost overruns. It has been cited as a critical cause affecting the construction

projects' performance [37–45]. Table 2 lists three risk factors related to the main contractor. The "incomplete staff and manpower since the beginning of the project" came in 1st place with I.I = 42.48%, and overall ranking 20th which ranked 2nd among contractor causes [22].

6.11. Consultant Related Factors

Sunjka et al. [14] mentioned that delay in releasing contractual documents and the full design before execution will affect the commencement of the project leading to accumulated delay; additionally, the project progress will be negatively affected by frequent and prolonged inspections.

Table 2 lists three factors within the group of the consultant. The consultant delays the approvals for designs and material was the first with an importance index of 45.66%. This overall ranking of 13th, which was included in several previous studies such as Johnson et al. [7], was the 6th factor.

6.12. Environmental Related Factors

Identifying environmental risks is a crucial matter that should be considered in the construction industry [46]. Construction logistics inefficient plan leads to lower productivity, delays in the project, and higher building costs [47,48]. Table 2 lists three factors within the environmental group. The project problems related to logistics was the first ranked (I.I = 29.73%), supported by several studies such as Wasim Haji [47], Groves [48], and Guerlain [49], but ranked 45th in a study by Enshassi et al. [29].

6.13. Top Ten Critical Factors

Figure 5 shows the top ten critical factors among 51 factors according to I.I% that may affect the projects' cost estimation in the Middle East. All ten factors have I.I% above 45%. The most critical factor is "the completion date not practical" with 53.84%, and the last one is "productivity loss issues" with 47.82%.

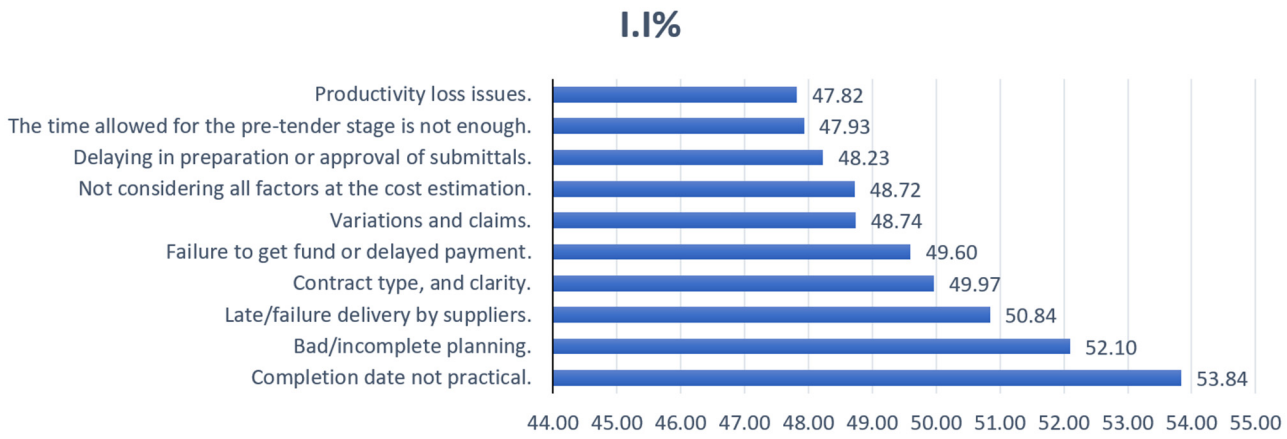

Figure 5. Top Ten critical factors in the Middle East.

6.14. Risk Response Based on Experts' Opinions

Table 3 shows the risk responses for the most serious factors affecting cost estimation for the construction projects, which the experts have identified based on meetings and discussions with them.

6.15. Comparison between the Top Ten Factors with Previous Studies in the Middle East Countries

This section presents the top ten risk factors in this study compared with the results from previous studies, as follows:

Construction projects around the world have an abysmal performance record of finishing projects within planned cost, time, and quality requirements [61,62]. Factors that may affect the cost estimation in construction projects in the Middle East have been summarized

and compared to the previous studies' results (KSA, UAE, Egypt, Oman, Kuwait, Iraq, Jordan, Qatar, Turkey, and Iran).

Table 3. Risk responses for the most critical factors that might affect the cost estimation.

Risk No.	Risk Name	Risk Response Strategy	Action Plan Based on Experts' Opinion
1	Completion date is not practical.	Mitigation	Check previous similar projects. Ensure that there is a contingency for the potential increase in project duration. Make sure to follow the Change Management (if needed).
2	Bad/incomplete planning.	Avoid	Ensure that the planning team has the proper experience. All quantity surveys and plans are to be checked. All assumptions in planning to be documented.
3	Late/failure delivery by suppliers.	Avoid	Ensure the use of a proper supply chain plan. Hire top suppliers with a firm contract. Ensure that you have the required funds. Consider alternative suppliers.
4	Contract type, and clarity.	Avoid	Ensure the contract is clear with proper risk allocation and achieving the company's strategy.
5	Failure to get funds or delayed payment.	Avoid	Study/analyze your clients/contractors before signing contracts. Clearly, document terms and conditions. Make sure invoices are prepared and approved promptly. Create a payment reminder process.
6	Variations and claims.	Mitigation	Ensure contracts contain provisions that enable request variations and set out clear processes for claims. Ensure preparing and approving a proper change management plan.
7	Not considering all factors at the cost estimation.	Avoid	Ensure the use of an experienced team. Closely monitor forecast costs at completion and actual costs and use two methods of cost estimation. Ensure all information and data are available.
8	Delaying in preparation or approval of submittals.	Mitigation	Make sure all submittals are prepared and submitted on time. Ensure the availability of an appropriate communication plan. Ensure contracts contain provisions that clarify the consequences of delay in approval.
9	The time allowed for the pre-tender stage is not enough.	Acceptance: Active	Ensure the availability of an adequately qualified team to cover the shortage in the allowed time.
10	Productivity loss issues.	Mitigation	Ensure the use of skilled workers and using a proper incentive bounce system.

These studies indicated that the factors with a high impact on the cost estimation differ from one country to another. For example, the most critical factor in this study, "completion date not practical" came in second place in the UAE study by Johnson et al. [7] while it ranked 49th in the Turkey study by Gündüz et al. [42]. Bad/incomplete planning came as the second factor in this study, as well as in a Saudi study by Abdulaziz et al. [25], and a Turkish study by Gündüz et al. [42]. However, it came as 16th in G. Bekr [60] in Iraq. The fifth factor in KSA, UAE, and Turkey on average was "late/failure delivery by suppliers", which came third in this study and 37th in Iraq. Contract type and clarity factor was ranked as the 4th factor in this study and the 5th by Al Nuaimi et al. [35] in Oman. Failure to get funds or delayed payment factor is the fifth in this study, while it ranked 8th on average in the previous studies.

The variations and claims factor was ranked as the first factor in three studies out of five studies; however, it was ranked as the sixth factor in this study. Not considering all factors at the cost estimation was missing in six out of ten studies and ranked 12th in

the other four countries (KSA, Egypt, Jordan, and Iran), while it ranked 7th in this study. Delays in the preparation or approval of submittals ranked 7th in this study, which rated the eleventh factor on average through previous studies in the Middle East. In this study, the ninth factor, "the time allowed for the pre-tender stage," ranked 4th and 5th, respectively, in KSA, Iraq, and Egypt. Finally, the tenth factor in this study is productivity loss issues, which did not get enough attention from researchers in previous studies, unlike this study; it ranked 14th to 45th in previous studies.

7. Case Study Application

An application model has been developed in order to apply the result of this paper and provide the cost estimator engineers with a list of recommended risks-inclusive risk score, as well as the recommended response strategies and actions to identify the most effective cost contingency against the project's scope creep. This list will be generated automatically depending on the required inputs such as the kind of organization (client/consultant or contractor), project type (infrastructure/tunnels or buildings construction), project size (medium or mega), contract type (EPC or Design and Build), and the project location (remote or non-remote location).

This application will help the decision-makers to identify the proper contingency at the early stage of the project. Estimator Engineers can use this application to identify the potential events that might affect the project cost using the recommended risk factors from the application outputs. They can also identify the estimated contingency through the recommended response actions included in the output report from this application.

The case study presented in this paper for an Infrastructure/Tunnels megaproject located in a non-remote area in KSA is from a contractor's point of view. Figure 6 shows the input screen where it is required to choose from a dropdown list of the inputs in order to generate the recommended risks and risk responses, which are in our case study; kind of organization is contractor, the project type is infrastructure/tunnels project, project size is mega, contract type is EPC, and the project location is non-remote location. The next step is the output screen to export an excel sheet for the output data and/or generate a report file, as shown in Figure 7.

Figure 6. Application input screen.

Recommended Risk Factors	Prob...	Imp...	Risk Overall...	Recommended Response ...	Recommended Response Action
Not considering all factors at the cost estimation.	3	5	15	Avoid	1. Ensure hiring an experienced team2. Use two methods of cost estimatio.
Delaying in preparation or approval of submittals.	4	4	16	Mitigate	1. Make sure all submittals are prepared and submitted on time.2. Ensure t
Improper cost control procedures.	3	4	12	Mitigate	1. Ensure hiring an experienced team.2. Ensure that the procedures are a..
Bad/incomplete planning.	3	5	15	Avoid	1. Ensure that the planning team has the proper experience.2. Check all ..
Unexpected changes from the client.	1	5	5	Acceptance : Active	Follow the approved Change management Plan
Contract type, and clarity.	3	5	15	Avoid	Ensure that the contract is clear with proper risk allocation and achieving.
Variations and claims.	4	5	20	Mitigate	1. Ensure that contracts contain provisions that enable to request variation.
Changes to standard general conditions.	1	5	5	Acceptance : Active	Follow the approved Change management Plan
Completion date not practical.	3	5	15	Mitigate	1. Check previous similar projects. Ensure that there is a contingency for t..
The time allowed for the pre-tender stage is not enough	3	5	15	Acceptance : Active	Ensure the availability of an adequately qualified team to cover the short..

Figure 7. Application output screen.

Figure 8 shows the generated report, which provides 125 recommended risk factors including probability, impact, and risk score, as well as the recommended response strategy and response action for each risk following the result of this paper and experts' judgment depending on our inputs. Only selected factors from the report are discussed due to paper length restrictions. The 1st risk factor was not considering all factors at the cost estimation, which is one of the top ten in this paper with a 15 risk score; as the risk score for this risk is high, it is recommended to avoid it by ensuring the hiring of an experienced team, using two cost estimation methods, and ensure that all information and data are available.

Risk Identification

Kind Of Oragnization: Contractor

Project Type: Infrastructure/Tunnels

Project Size: Mega

Contract Type: EPC

Project Location: Non-Remote Location

Probability Impact Scoring_To be adjusted according to project scale				
			Impact Criteria	
Score Ref	Rank	Probability	Cost	Schedule
5	VH	>=81%	> 20M SAR	>25d
4	H	61%-80%	10M SAR - 20M SAR	16d-25d
3	M	41%-60%	5M SAR - 10M SAR	11d-15d
2	L	21%-40%	1M SAR - 5M SAR	6d-10d
1	VL	<= 20%	< 1M SAR	< 5d

Number	Recommended Risk Factors	Probability	Impact	Risk Overall Score	Recommended Response Strategy	Recommended Response Action
1	Not considering all factors at the cost estimation.	3	5	15	Avoid	1. Ensure hiring an experienced team 2. Use two methods of cost estimation and carefully track actual costs and forecast cost at completion 3. Ensure that all information and data are available.
2	Delaying in preparation or approval of submittals.	4	4	16	Mitigate	1. Make sure all submittals are prepared and submitted on time. 2. Ensure the availability of an appropriate communication plan. 3. Ensure that contracts contain provisions that clarify the consequences of delay in approval.
3	Improper cost control procedures.	3	4	12	Mitigate	1. Ensure hiring an experienced team. 2. Ensure that the procedures are approved by all stakeholders

Figure 8. Application output report.

The second factor on the list was delaying in preparation or approval of submittals which is one of the top ten factors. It is a high risk according to expert opinion, so it is recommended to have a mitigation action by ensuring that all submittals are prepared and submitted on time, and an appropriate communication plan to be followed. The recommendation list presented unexpected changes from the client as a potential event that might affect the project cost; however, in such case, we cannot deal with the probability, so the recommended response strategy is active acceptance, and the response action is to follow the change-management plan.

This application model can be advantageous for decision-makers with no or minimum experience in risk assessment. Another benefit of this application is the ability to use the exported report as a support document for assigning the project-cost contingency. The output report provides recommendations for the probability and impact matrix, including the range of each rank as shown in Figure 8. For example, the risk will be considered very high if the probability of occurrence is more than or equal to 81% and the impact on the cost is more than twenty million.

Undoubtedly, reliable databases of potential risk factors will greatly assist decision-makers in identifying a more accurate risk list, although each project has certain characteristics and circumstances, so the risk factors for each project will be different and difficult to identify [63]. The previous studies allowed the authors to develop a reliable database of hundreds of risk factors that have been used as a base for the application model. The developed model enables estimators to assign accurate cost contingency for the estimated cost before project commencement. One of the top features of the presented model is that it can be used by all project stakeholders.

The conducted literature review proved that despite the fact that there are several research studies in the field of risk management, there is still no study assessing the risk factors affecting the cost estimation in the construction industry.

8. Conclusions

Nine out of ten projects normally experience cost overrun, which presents a poor reputation for construction industries with regard to finishing projects on budget [22–63]. This paper extensively reviewed the previous literature studies related to cost overruns in construction projects in the Middle East to identify the potential root causes, based on which 51 risk factors were identified and categorized into twelve different groups, such as contract, technical, construction project, etc.

A questionnaire survey has been conducted among experts in the Middle East with a 90% participation rate. Accordingly, this study concluded that ten out of 51 are the most critical factors affecting the cost estimate: (bad/incomplete planning, late/failure delivery by suppliers, failure to get funds or delayed payment, and delays in preparation or approval of submittals, etc.). Previous studies concluded that the root causes of cost overrun vary from country to country. So, it would not be accurate to identify the cost overrun causes for a certain country based only on previous studies or literature.

This paper also developed a simple analysis model following the concluded results for risks that might affect the project cost estimate, giving the estimator the ability to prioritize the risk factors and identify the most effective cost contingency and a forecasted vision of the project's success.

9. Recommendations

The following recommendations by experts should be followed to enhance cost estimation accuracy.

The client should take into his consideration that the selection criteria for the contractors should not only be about the lowest bid, but should take into account the technical capability, manpower, and equipment for their projects, and sufficient experience as well, and to reduce the variation requests, it is required to minimize interference during the

execution of the project; finally, to avoid impairing the contractor's ability to finish the work, interim payments are to be paid on time.

The contractors should become involved only in a project they have adequate expertise in, assigning a competent project-management team to mitigate the project's scope creep. It is highly recommended that a maintenance plan is prepared for equipment to prevent frequent breakdowns and to provide enough resources for work execution.

Another study can be conducted for a certain type of construction project, such as highway construction, utility, dam construction projects, etc. A similar study on the effects and causes of cost overrun can be conducted in other regions of the Middle East.

Author Contributions: Conceptualization, K.E.-D., M.A.-M. and K.T.A.; methodology, M.A.-M. and K.T.A.; software, K.T.A.; validation, K.E.-D., M.A.-M. and K.T.A.; formal analysis, M.A.-M. and K.T.A.; investigation, K.T.A.; resources, K.T.A.; data curation, K.T.A.; writing original draft preparation, K.T.A.; writing—review and editing, M.A.-M. and K.T.A.; visualization, M.A.-M. and K.T.A.; supervision, K.E.-D. and M.A.-M.; project administration, K.E.-D. and M.A.-M.; funding acquisition, M.A.-M. and K.T.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available upon request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Cohen, M.W. Risk Identification and Mechanisms for Mitigation. In Proceedings of the First International Conference on Construction in the 21st Century, Miami, FL, USA, 25–26 April 2002; pp. 119–125.
2. Pham, D.-H.; Ly, D.-H.; Tran, N.-K.; Ahn, Y.-H.; Jang, H. Developing a Risk Management Process for General Contractors in the Bidding Stage for Design-Build Projects in Vietnam. *Buildings* **2021**, *11*, 542. [CrossRef]
3. An, S.H.; Cho, H.; Lee, U.K. Reliability assessment of conceptual cost estimates for building construction projects. *Int. J. Civ. Eng.* **2010**, *9*, 9–16.
4. Ullah, S.; Mufti, N.A.; Qaiser Saleem, M.; Hussain, A.; Lodhi, R.N.; Asad, R. Identification of Factors Affecting Risk Appetite of Organizations in Selection of Mega Construction Projects. *Buildings* **2022**, *12*, 2. [CrossRef]
5. Mahmoud, H.; Ahmed, V.; Beheiry, S. Construction Cash Flow Risk Index. *J. Risk Financ. Manag.* **2021**, *14*, 269. [CrossRef]
6. Holm, L.; Schaufelberger, J.E.; Griffin, D.; Cole, T. *Construction Cost Estimation Process and Practice*; Pearson Prentice Hall: Hoboken, NJ, USA, 2005.
7. Reshma, M.J.; Robin, I.I.B. Time and cost overruns in the UAE construction industry: A critical analysis. *Int. J. Constr. Manag.* **2018**, *20*, 402–411. [CrossRef]
8. Richey, C. Cost Estimating and Assessment Guide, GAO-20-195G, March 2020. Available online: https://www.gao.gov/assets/gao-20-195g.pdf (accessed on 12 March 2020).
9. Maher, M.L.J.; McGoey-Smith, A.D. *Risk-Based Cost and Schedule Estimation for Large Transportation Projects*; Association for European Transport: Warwickshire, UK, 2006.
10. Anderson, S.; Molenaar, K.; Schexnayder, C. Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction. Final Report for NCHRP Report 574, September 2006. Available online: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w98.pdf (accessed on 10 January 2007).
11. Paulsen, C.; Gallivan, F.; Chavez, M.; Venner, M. *NCHRP 8-36/Task 72: Guidelines for Cost Estimation Improvements at State DOTs*; Transportation Research Board of the National Academies: Washington, DC, USA, 2008.
12. Franck, M.; Ludovic, A.V. *Project Management Traditional Principles in Managing Complex, High Risk Projects*; Springer Nature: London, UK, 2016; pp. 30–32. ISBN 978-1-4471-6787-7.
13. Maceda, C. 70% of Dubai Projects Facing Delays-Analyst. Gulf News Property, 2016. Available online: http://gulfnews.com/business/property/70-of-dubai-projects-fac-ing-delays-analyst-1.1669124 (accessed on 9 February 2016).
14. Sunjka, B.P.; Jacob, U. Significant Causes and Effects of Project Delays in the Niger Delta Region Nigeria. SAIIE25 Proceedings: Stellenbosch South Africa # 2013 SAIIE, 2013. Available online: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.882.9428&rep=rep1&type=pdf (accessed on 18 June 2013).

15. Frimponga, Y.; Oluwoye, J.; Crawford, L. Reasons of delay and cost overruns in construction of groundwater projects in a developing country; Ghana as a case study. *Int. J. Proj. Manag.* **2003**, *21*, 321–326. [CrossRef]
16. Riveros, C.; Ruiz, A.L.; Mesa, H.A.; Guevara, J.A. Critical Factors Influencing Early Contract Termination in Public Design-Build Projects in Developing and Emerging Economies. *Buildings* **2022**, *12*, 614. [CrossRef]
17. Alsuliman, J.; Bowles, G.; Chen, Z. *Current Practice of Variation Order Management in the Saudi Construction Industry, Proceedings of the 28th Annual ARCOM Conference, Edinburgh, UK, 3–5 September 2012*; Smith, S.D., Ed.; Association of Researchers in Construction Management: Edinburgh, UK, 2012.
18. Le-Hoai, L.; Lee, Y.D.; Lee, J.Y. Delay and Cost Overruns in Vietnam Large Construction Projects: A Comparison with other selected Countries. *KSCE J. Civ. Eng.* **2008**, *12*, 367–377. [CrossRef]
19. Shanmugapriya, S.; Subramanian, K. Investigation of significant factors influencing time and cost overruns in Indian construction projects. *Int. J. Emerg. Technol. Adv. Eng.* **2013**, *3*, 734–740.
20. Seif El-Din, E.N.; Ossama, H.; Khaled, N. Owner Time and Cost Contingency Estimation for Building Construction Projects in Egypt. Master's Thesis, The American University in Cairo, Cairo, Egypt, 2017.
21. Emam, H.; Farrell, P.; Abdelaal, M. *Causes of Delay on Infrastructure Projects in Qatar, Proceedings of the 31st Annual ARCOM Conference, Lincoln, UK, 7–9 September 2015*; Raidén, A.B., Aboagye-Nimo, E., Eds.; Association of Researchers in Construction Management: Edinburgh, UK, 2015; pp. 773–782.
22. Aljohani, A.; Ahiaga-Dagbui, D.; Moore, D. Construction Projects Cost Overrun: What Does the Literature Tell Us? *Int. J. Innov. Manag. Technol.* **2017**, *8*, 140–142. [CrossRef]
23. Saeed, S.A.A. Delay to Projects–Cause, Effect and Measures to Reduce/Eliminate Delay by Mitigation/Acceleration. Unpublished Project Management Programme Dissertation. Master's Thesis, The British University in Dubai, Dubai, United Arab Emirates, 2009; pp. 1–137.
24. Sambasivan, M.; Soon, Y.W. Reasons and consequences of delays in Malaysian. *Int. J. Proj. Manag.* **2007**, *25*, 517–526. [CrossRef]
25. Bin Seddeeq, A.; Assaf, S.; Abdallah, A.; Hassanain, M.A. Time and Cost Overrun in the Saudi Arabian Oil and Gas Construction Industry. *Buildings* **2019**, *9*, 41. [CrossRef]
26. Bekr, G.A. Identifying Factors Leading to Cost Overrun in Construction Projects in Jordan. *J. Constr. Eng. Technol. Manag.* **2015**, *5*, 25–33.
27. Pourrostam, T.; Ismail, A. Causes and Effects of Delay in Iranian Construction Projects. *Int. J. Eng. Technol.* **2012**, *4*, 598. [CrossRef]
28. Morris, S. Cost and time overruns in public sector projects. *Econ. Political Wkly.* **1990**, *25*, M154–M168.
29. Enshassi, A.; Sundermeier, M.; Zeiter, M.A. Factors Contributing to Rework and their Impact on Construction Projects Performance. *Int. J. Sustain. Constr. Eng. Technol.* **2017**, *8*, 12–33.
30. Love, P.E.; Edwards, D.J. Forensic project management: The underlying causes of rework in construction projects. *Civ. Eng. Environ. Syst.* **2004**, *21*, 207–228. [CrossRef]
31. Raghuram, S.; Nagavinothini, R. Investigation on the Causes and Adverse Effects of Reworks in Construction Projects and Developing A Rework Reduction Model to Mitigate Time and Cost. *Int. J. Innovative Res. Sci. Eng. Technol.* **2016**, *5*, 5790–5796.
32. Kakitahi, J.M.; Alinaitwe, H.M.; Landin, A.; Mone, S.J. Impact of construction-related rework on selected Ugandan public projects. *J. Eng. Des. Technol.* **2016**, *14*, 238–251. [CrossRef]
33. Assaf, S.A.; Abdulaziz, A.B.; Sulaiman, A.; Mohammed, A. The management of construction company overhead costs. *Int. J. Proj. Manag.* **2001**, *19*, 295–303. [CrossRef]
34. Almutairi, N.S. Causes of delays on Construction Projects in Kuwait according to opinion of engineers working in Kuwait-Int. *J. Eng. Res. Appl.* **2016**, *6*, 84–96.
35. Latif, Q.B.A.I.; Al-Nuaimi, A. Perspectives on Construction Cost Overrun in Oman. In Proceedings of the 1st National Conference on Civil and Architectural Engineering, Muscat, Oman, 26–28 March 2018.
36. Enshassi, A.; Arain, F.; Al-Raee, S. Causes of variation orders in construction projects in the Gaza Strip. *J. Civ. Eng. Manag.* **2010**, *16*, 540–551. [CrossRef]
37. Assaf, S.A.; Al-Hejji, S. Causes of delay in large construction projects. *Int. J. Proj. Manag.* **2006**, *24*, 349–357. [CrossRef]
38. Koushki, P.; 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]
39. Odeh, A.M.; Battaineh, H.T. Causes of construction delay: Traditional contracts. *Int. J. Proj. Manag.* **2002**, *20*, 67–73. [CrossRef]
40. Fayek, A.R.; Dissanayake, M.; Campero, O. Measuring and classifying construction field rework: A pilot study, Research report, Construction Owners Association of Alberta (COAA). Ph.D. Thesis, The University of Alberta, Edmonton, AB, Canada, 2003.
41. Al-Janabi, A.M.; Abdel-Monem, M.S.; El-Dash, K.M. Factors Causing Rework and Their Impact on Projects' Performance in Egypt. *J. Civ. Eng. Manag.* **2020**, *26*, 666–689. [CrossRef]
42. Gündüz, M.; Nielsen, Y.; Özdemir, M. Quantification of Delay Factors Using the Relative Importance Index Method for Construction Projects in Turkey. *J. Manag. Eng.* **2013**, *29*, 133–139. [CrossRef]
43. Josephson, P.E.; Larsson, B.; Li, H. Illustrative benchmarking rework and rework costs in Swedish construction industry. *J. Manag. Eng.* **2002**, *18*, 76–83. [CrossRef]
44. Yong, Y.C.; Mustaffa, N.E. Clients, consultants and contractors' perception of critical success factors for construction projects in Malaysia. In Proceedings of the 27th Annual Conference of the Association of Researchers in Construction Management, Bristol, UK, 5–7 September 2011.

45. Clough, R.H.; Sears, G.A. *Construction Contracting*; Wiley: New York, NY, USA, 1994.
46. Abdullah, A.; Pedram, F.A.; Hamid, B.; Mahshab, F.A. Environmental risk assessment of urban area construction project. In Proceedings of the 11th International Congress on Civil Engineering, Tehran, Iran, 8–10 May 2018.
47. Haji, W.; Anand, N. Challenges and Potentials for Construction Logistics in Urban Areas. 2016. Available online: https://www.researchgate.net/publication/329281652_Challenges_and_potentials_for_construction_logistics_in_urban_areas (accessed on 12 August 2016).
48. Groves, D. The construction industry's productivity problem. In *The Economist*; The Economist Group: London, UK, 2017.
49. Cindy, G.; Samuel, R.; Francesco, F. Understanding Construction Logistics in Urban Areas and Lowering Its Environmental Impact: A Focus on Construction Consolidation Centres. *Sustainability* **2019**, *11*, 6118. [CrossRef]
50. Liu, J.; Jin, F.; Xie, Q.; Skitmore, M. Improving risk assessment in financial feasibility of international engineering projects: A risk driver perspective. *Int. J. Proj. Manag.* **2017**, *35*, 204–211. [CrossRef]
51. Odeyinka, H.A.; Lowe, J.; Kaka, A. An evaluation of risk factors impacting construction cash flow forecast. *J. Financ. Manag. Prop. Constr.* **2008**, *13*, 5–17. [CrossRef]
52. Fellows, R.R.; Liu, A. *Research Methods for Construction*, 3rd ed.; Wiley-Blackwell Publishing: Oxford, UK, 2008.
53. Eze, E.C.; Idiake, J.E.; Ganiyu, B.O. Rework risks triggers in the Nigerian construction industry: A view of built environment professionals. *Indep. J. Manag. Prod.* **2018**, *9*, 448–472. [CrossRef]
54. Eze, E.C.; Idiake, J.E.; Ganiyu, B.O. Analysis of rework risk triggers in the Nigerian construction industry. *Organ. Technol. Manag. Constr.* **2018**, *10*, 1778–1793. [CrossRef]
55. 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]
56. Panthi, K.; Ahmed, S.M.; Azhar, S. Risk Matrix as a Guide to Develop Risk Response Strategies. In Proceedings of the 43rd ASC National Annual Conference, Flagstaff, AZ, USA, 12–14 April 2007.
57. Ahmed, S.M.; Azhar, S. Risk Management in the Florida Construction Industry. In Proceedings of the 2nd Latin American and Caribbean Conference for Engineering and Technology, Miami, FL, USA, 2–4 June 2004.
58. Baker, S.W. Risk Management in Major Projects. Ph.D. Thesis, University of Edinburgh, Edinburgh, UK, 1997.
59. Mahamid, I. Analysis of Rework in Residential Building Projects in Palestine. *Jordan J. Civ. Eng.* **2016**, *10*, 86792. [CrossRef]
60. Bekr, G.A. Causes of delay in public construction projects in Iraq. *Jordan J. Civ. Eng.* **2015**, *9*, 83746.
61. Merrow, E.W. *Industrial Megaprojects: Concepts, Strategies, and Practices for Success*; John Wiley & Sons: Hoboken, NJ, USA, 2011.
62. Flyvbjerg, B.; Bruzelius, N.; Rothengatter, W. *Megaprojects and Risk: An Anatomy of Ambition*; Cambridge University Press: Cambridge, UK, 2003.
63. Kowalski, J.; Połoński, M.; Lendo-Siwicka, M.; Trach, R.; Wrzesiński, G. Method of Assessing the Risk of Implementing Railway Investments in Terms of the Cost of Their Implementation. *Sustainability* **2021**, *13*, 13085. [CrossRef]