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Risk Factors That Lead to Time and Cost Overruns of Building Projects in Saudi Arabia

Saad Alshihri *, Khalid Al-Gahtani and Abdulmohsen Almohsen

Department of Civil Engineering, King Saud University, P.O. Box 800, Riyadh 11421, Saudi Arabia; kgahtani@ksu.edu.sa (K.A.-G.); asmohsen@ksu.edu.sa (A.A.)
* Correspondence: toengsaad@gmail.com

Abstract: Rapid transformation across all sectors through Saudi Arabia's vision 2030 initiatives led to an increase in construction activities. However, the construction industry has been already facing huge cost and time overruns, affecting all stakeholders. The aim of this study is to identify and explore the influential risk factors that lead to completion delays and cost overruns of government-funded building construction projects in Saudi Arabia, all of which have been subjected to a traditional type of procurement method (Standard Public Works Contract). The literature examined in this study identified a total of 83 risk factors, which have been grouped into nine categories. A questionnaire-based survey was conducted to determine the participants' perspectives on the degree of probability of occurrence (*P*) of each risk and its potential impact on a project in terms of time (*IT*) and cost (*IC*). The questionnaire survey was distributed to 200 experts and professionals associated with Saudi building construction projects, which were grouped into four categories: clients, designers, consultants, and contractors. Fifty-five acceptable questionnaires were returned and analysed. The relative importance index (*RII*), and Risk Importance (*RI*) were used to identify the most influential risk factors, and an agreement test was conducted. The results of the survey revealed that the most significant risks factors contributing to the delay of building construction projects' completion are contractor's financial difficulties, owner's delay in making progress payments for completed works, contracts awarded to the lowest bidder, change orders during construction, ineffective project planning and scheduling by the contractor, shortage of manpower, and contractor's poor site management and supervision. In addition, change orders during construction and contracts awarded to the lowest bidder are the most significant risks factors of exceeding budgets. Based on the results, it is concluded that for achieving sustainable development, client, contractor, and labour-related risks must be effectively managed.

Keywords: Saudi Arabia; construction projects; time overrun; cost overrun; risks

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1. Introduction

The main evaluation dimension of the successful execution of construction projects is to examine the achievement of project objectives (time, cost, and quality) [1–3]. Previous research has elicited that construction projects experience underachievement in both developed and developing countries as a result of completion delays and cost-overruns, with resultant negative impacts experienced by all involved parties, including financial loss [4–6].

Project delay has been defined as 'the time overrun either beyond the completion date specified in the contract and the parties agreed upon for the delivery of the project, or a part of the project' [7,8]. The liability of the contract parties for construction projects delays can be classified into excusable with compensation delays, excusable without compensation delays, non-excusable delays or contractor responsible, and concurrent delays [9,10]. Construction cost overruns is the actual/final costs minus those estimated, presented as a percentage of the estimated costs [11].

Completion delays and cost-overruns typically stem from a multitude of severe risks and uncertainties [12]. Whilst an entire host of studies and research has sought to identify risk factors in the global construction industry, they have concurred that the risk factors are different from one project to another and also depend on the country, procurement route (i.e., PPP, design-bid-build, and design and build), and the type of construction project. In addition, the top causes of cost-overruns are subject to change over time (in each decade); therefore, knowledge of them needs to be kept up to date in order to manage complexity effectively so as to avoid or minimise risks [12]. There are four different categories of construction project, namely building construction, heavy/civil construction, industrial construction, and residential construction, with the foremost accounting for the highest segment at 35–40% of construction projects [13]. Therefore, it is important to limit identifying the risk factors to a certain category of construction project that experiences almost the same issues, challenges, and risks. However, there is a lack of research on identifying the risks and categorising them according to different types of projects [14]. Recent studies focused on specific types of projects such as oil and gas [15,16], manufacturing and buildings [17], and road projects [18,19], there is a need to increase the research in identifying the risk factors in different projects types and to assess the changes in risk factors importance and probability [20]. It is important to address this research gap, because these can have potentially serious consequences, such as cost and time overruns, and can add additional pressure to construction projects [21,22]. In this context, this study addresses the following research question.

RQ: What are the risk factors adversely affecting time and cost of execution of building construction projects?

Thus, this study addresses this research gap by identifying the influential risk factors that lead to completion delay and cost overrun specific to government-funded building construction projects (i.e., government buildings, hospitals, schools, and universities) in Saudi Arabia, all of which have been subjected to a traditional type of procurement method (Standard Public Works Contract). Accordingly, the following research objectives are outlined to address the RQ:

1. To explore and identify the influential risk factors leading to duration and cost overrun during the construction stage, with special consideration for building projects in Saudi Arabia (i.e., risk factors list and classification) through the completion of a comprehensive literature review.
2. To study, rank, and analyse the identified risk factors (i.e., 'risk impact × likelihood') by conducting questionnaires.

Addressing the RQ and the above-listed objectives could achieve interesting findings which can contribute to the literature in providing the risk factors by project type, i.e., government-funded building construction projects. It can also help decision makers in better understanding the risks in construction industry during COVID-19 in order to better formulate policies and decision making with respect to Vision 2030 objectives. Furthermore, the findings can aid the managers of building construction projects in designing effective risk management strategies.

2. Literature Review

2.1. Overview of Construction Industry

Construction, in simple terms, is the process of constructing an infrastructure that requires collaboration of multiple disciplines, including architectural design management, financial and legal management, engineering and technology, logistics and procurement, sustainability, risk management, project management, etc. Types of construction can be broadly classified into industry-specific, building, and residential constructions [23]. The construction industry is considered to be one of the sustainable and continuous businesses that has been recording steady growth in recent decades. However, there are various risk factors that influence this industry, such as geopolitics, economy, resources, technology, etc. The global construction output growth in 2019 reduced to 2.7%, which was less than 2018, and such deterioration was observed in many developing countries, especially the Middle East, while developed countries, such as the USA and Australia, have struggled to maintain growth momentum [24].

Various findings have been identified in different studies [25–28], reflecting the complexity and different influencing factors in the construction industry. It has been estimated that there will be 85% growth (USD 15.5 trillion) in construction output by 2030 (3.9% growth per annuum), out of which 57% of growth was contributed by a developed country, the US, and developing countries including India and China [26]. Faster growth is predicted in the USA (5% per annuum) compared to China, followed by India and Japan. In a report by Robinson [27], the construction market is predicted to grow by USD 8 trillion by 2030. A KPMG [25] survey revealed that only 20% of the global constructive companies were innovative, 60% were followers, and 20% were behind the curve. In addition, disparities were observed in strategies, practices, and performance of the companies', reflecting gaps in the process. Deloitte identified seven factors that can have an impact on growth in construction industry, including the following: innovation, competitive dynamics and margin improvement; internationalism, compliance, regulation, and transparency; and sustainability [28]. The findings from these studies indicate the complexity in construction industries, with there being various influencing factors, including geopolitics, environmental, technology, strategies, innovation, etc. Furthermore, the COVID-19 impact has significantly affected the construction industry, with many companies facing liquidity problems. Reduced spending and consumption capacity, operating restrictions and fear of contagion, supply chain disruptions, and lack of labour have all contributed to the impact, which have affected the sustainability of many SMEs across the globe [29]. A recent report on the construction industry predicted that smaller businesses and sub-contractors may fail rapidly; contract management can be a major issue as customers may seek to terminate or renegotiate contracts; internationalisation may become less viable as companies may reconsider the regions in which they want to operate in [30].

2.2. *Saudi Arabian Construction Industry*

Saudi Arabia's construction industry was severely affected during 2015–2016 following the crash in oil prices, which reduced the capital flow; as a result, many projects were halted, postponed, or even cancelled. However, the construction industry in the country is expected to grow exponentially in the next few years, with it gearing up towards a post-oil era, when new major cities will be developed and constructed [31]. According to a report published by Mordor Intelligence [31], more than 5200 construction projects are currently ongoing in Saudi Arabia, valued at USD 819 billion, out of which 3727 are urban construction active projects, and these are valued at USD 386.4 billion. There 733 are utility sector projects valued at USD 95.6 billion and 500 relating to transportation, valued at USD 156.2 billion. The Saudi construction industry is highly competitive with major international players [32]. The market presents opportunities of growth, which is expected to increase the market competition further. However, with a few players holding a significant market share, the Saudi Arabian construction market has an observable level of consolidation [33]. Focusing on the type of construction, Saudi Arabia spent USD 575 billion on public construction projects between the years of 2008 and 2013 [34,35]. A recent report [36] has forecasted a growth of 2.9% in 2021 in the Saudi Arabian construction industry and CAGR of 4% during 2022–2025. Furthermore, a Public Investment Fund (PIF) of USD 800 billion was underlined by the Crown Prince for funding projects over the next decade. Moreover, year-on-year growth of construction contract awards in Saudi Arabia are forecasted to reach 96 percent in 2022, which is diversified over different types of projects [37]. For instance, the total value of planned building contract awards alone in the Saudi Arabia is predicted to be USD 10.95 billion in 2022 [38]. Given these forecasts, the construction industry will be growing rapidly in the next few years.

The Saudi Arabian construction market is expected to witness significant growth and offer lucrative potential, due to its Vision 2030, NTP (National Transformation Programme)

2020, and several ongoing reforms aimed at diversifying away from oil. The Vision 2030, NTP 2020, and private sector investment boost as well as the ongoing reforms are likely to be the growth drivers for the Saudi construction market in 2018 and beyond. Vision 2030, along with a significant investment in housing and infrastructure development promoted across the country by local authorities, is revitalizing the construction industry and generating interest in a growing number of international players. Due to these programmes, the construction industry might have access to various opportunities; however, there are challenges associated with these programmes. Changes in regulations, policies, and the granting of planning approval may create complexity in the commencement of new projects and the completion of those already in progress, as they will have to be modified according to these new regulations. In this context, it is worth noting that the Saudi contractors' classification system functions within five grades according to the value they hold for a contract to be signed and 29 fields. The Example of the fields as following: buildings, roads, industrial works, marine works, dams, electrical works, and mechanical works [39]. In addition, according to the Government Tenders and Procurement Law in Saudi Arabia, all government bodies and agencies must use Saudi Arabia's Public Works Contract (SPWC) for all government-funded public construction projects. In addition, an increase in the projects will require growth in the work force, as a result of which companies may well have to depend on expatriates, which might result in acquiring an unskilled workforce lacking experience and facing issues in regard to cultural integration. In addition, without proper estimations of costs and risks, the contractors may end up suffering from financial losses.

2.3. Risk Factors Leading to Cost and Time Overruns

Studies have identified various critical success factors for construction projects. These included time, cost, quality, safety, client's satisfaction, employees' satisfaction, cash-flow management, profitability, environment performance, learning and development, etc. [40]. However, the majority of the past research have extensively focused on the three major factors for success in construction industry, which included cost, time, and quality [41]. It has been elicited that over 70% of public construction projects in Saudi Arabia have experience delays [42]. Various risk factors and challenges explaining the time and cost overruns for these projects have been uncovered. Baghdadi and Kishk [43] identified 54 risk factors in the context of external, internal, and force majeure in aviation construction projects, which were causing duration delays as well as cost overruns. Mahamid [44], focusing on the factors affecting performance in construction projects, identified various risks, including poor communication among project participants, poor labour productivity, poor planning and scheduling, payment delays, escalation of material prices, poor labour productivity, and poor site management. Regarding the causes of disputes, Mahamid [44] identified 29 direct and 32 indirect dispute causes, of which major direct dispute causes included delay in progress payment by the owner, unrealistic contract duration times, change orders, poor quality of completed work, and labour inefficiencies. Major indirect dispute causes included inadequate contractor experience, lack of communication between the construction parties, ineffective planning and scheduling of the project by the contractor, cash problems during construction, and poor estimation practices.

Focusing on the design risks, Sha'ar et al. [45] identified unstable client requirements, lack of proper coordination between the various disciplines of the design team, awarding the contract to the lowest price regardless of the quality of services, lack of skilled and experienced human resources in the design firms, lack of skilled human resources at the construction site, delaying of due payments, lack of a specialised quality-control team, lack of professional construction management, delaying the approval of completed tasks, and deficient drawings and specifications. Various other challenges, such as those related to subcontractors, labour, machinery, availability of materials, and quality; and client-related risks such as financial issues, issues related to design documents, change in codes and regulations, scope of work, accidents on site, lack of expertise, re-designing, unqualified workforce, organisational culture, and poor contract management were identified from various studies conducted on Saudi Arabian construction industry [46–48].

Furthermore, the causes of the cost and time overruns factors differ between various projects/buildings. For instance, when comparing the delay factors between road infrastructure and building projects, a recent study [49] found that the major critical delay factors for road infrastructure projects included inadequate contractor experience and payment delays to the contractor, while the shortage of materials and financial difficulties of contractor were most salient for building projects. For tall building projects, the major causes of delay and cost overruns identified in [50] included "client's cash flow problems/delays in contractor's payment", "contractor's financial difficulties", and "poor site organization and coordination between various parties". Another study focusing on regular manufacturing and building construction [17] identified delays in progress payments, difficulties in financing the project by contractor/manufacturer, slowness in decision making, late procurement of materials, and delay in approving design documents as the major causes of cost and time overruns. In specialised construction projects, such as railways, the causes were found to be related to "Client's decision-making process and changes in control procedures", "Design errors (including ambiguities and discrepancies of details/specifications)", "Labor skills level", "Design changes by client or consultant", and "Issues regarding permissions/approvals from other stakeholders" [51]. In addition, Allahaim [14] emphasised causes and classifications as differing by project type and stakeholder, with overall cost overrun depending on the type of project: power and health projects (60% cost overruns), transport and water projects (40% cost overruns), and education projects (30% cost overruns). Aljohani et al. [52] carried out a review of the literature and identified 173 causes of cost overrun in seventeen contexts, with the main ones being frequent design change, contractors' financing, payment delay for completed work, lack of contractor experience, poor cost estimation, poor tendering documentation, and poor materials management. The authors concluded that the main causes differed from country to country, and that it would be an inaccurate method to use only the global literature to identify the causes for a specific country [14]. In contrast, Ahady et al. [53] found that most of causes of cost overruns in construction industries of development countries are similar, and the causes are different for every project. The most significant causes of cost overruns were fluctuations and increases in material price. Appendix A shows that various risk factors associated with construction projects from 17 studies [2,4,14,17,44,51,52,52–65].

Hence, the factors causing cost and time overruns may change by the types of construction projects. Therefore, there is a need to focus the research on specific building projects in the context of Saudi Arabia. Furthermore, most studies in the literature probed the causes of either cost or time overruns for the construction industry, but very few considered both. Given these gaps, it is essential that risk factors and risk management techniques in Saudi Arabia have to be studied from time to time in order to prevent any damage/losses and avoid cost and duration overruns in construction projects. Accordingly, the purpose of this study is to identify the influential risk factors that lead to completion delays and cost overruns of government-funded building construction projects in Saudi Arabia, all of which have been subjected to a traditional type of procurement method Standard Public Works Contract (SPWC).

3. Research Methodology

For this study, the researchers adopted a cross-sectional questionnaire-based survey to identify risk factors related to government-funded building construction projects in Saudi Arabia. Figure 1 illustrates the adapted research methodology phases used to achieve the study objectives. This methodology includes four phases: the identification of initial risk factors from the literature, questionnaire design, data collection, and then data analysis.

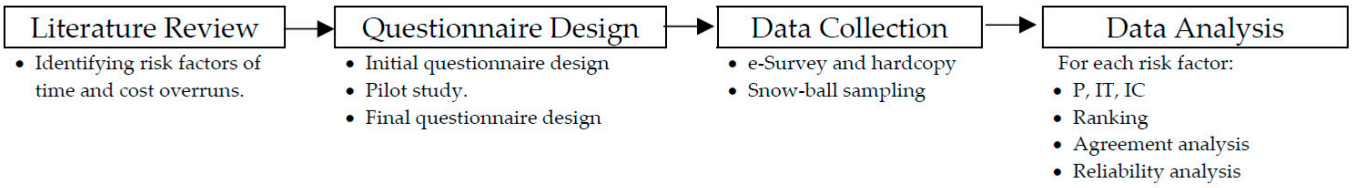

Figure 1. Research methodology process.

The first phase was the identification of initial risk factors from previous literature. A comprehensive literature review was carried out to uncover the various risk factors associated with construction projects. Then, the researchers identified the risk factors that were applicable in the context of Saudi Arabia. A final list of 83 risk factors, classified into nine different groups (client-related, designer-related, consultant-related, contractor-related, labour-related, material-related, equipment-related, external risks, and force majeure), was identified to be relevant for investigation in the context of this study, as shown in Appendix B.

The second phase was the questionnaire's design. The initial questionnaire was developed based on the findings in the previous phase. All these applicable risk factors were included in the questionnaire, which was divided into three sections. The first section of the questionnaire included the participants' demographic information, while the second focused on the level to which project delays and cost overruns affect construction projects. The third section pertained to identifying which risk factors caused project delays and cost overruns by asking three sub-questions for each risk. These included the probability of occurrence (*P*) in projects based on the respondents' perspective and experience, the negative impact of the risk on project's time (*IT*), and the negative impact of the risk on project's cost (*IC*). The questionnaire used a Likert scale of five ratings (1: very low; 2: low; 3: moderate; 4: high; 5: very high) and was designed in both English and Arabic to improve the participants' ease of accessibility and understandability. The researchers conducted a pilot study to validate the prepared questionnaire by distributing it to a set of experts in the construction field. The collected comments were reviewed to develop the final questionnaire.

The third phase of study was data collection. The questionnaire link was forwarded to the experts in construction industry who have been working in relevant building construction projects using various online networks. The researchers adopted snowball sampling [66], requesting the participants to forward the survey link to their colleagues and other relevant professionals. The survey was initially forwarded to 38 experts. Snowball sampling is a more conducive and practical technique for the research scope and to overcome the obstacle of the questionnaire's length, finding the target audience, and providing high-quality information. However, because of snowball sampling, 63 responses were received. After removing eight incomplete responses, the responses from 55 participants were included in the data analysis.

The fourth phase of study was the data analysis of the survey results using MS Excel. The relative importance index (*RII*) calculated the probability of occurrence (*P*) of each risk, the impact of the risk on project's time (*IT*), and the impact of the risk on project's cost (*IC*). Risk Importance (*RI*) was used to determine the level of importance of each identified risk associated with building construction projects by multiplying the probability and impact for each in terms of project time and cost. In addition, the reliability of factor analysis was used to measure the strength of the internal consistency of the identified risk factors, and an agreement analysis test (Cronbach's alpha) was conducted to measure the strength and direction of relationship between the parties involved in this study (client, contractor, and consultant).

3.1. Ranking of Risks

To carry out data analysis, the relative importance index (*RII*) for each risk was calculated by Equation (1) for the probability of occurrence (*P*) in projects based on the respondents' perspective and experience, and for negative impact (*I*) of the risk on project's time (*IT*) and for negative impact on project's cost (*IC*), using five point Likert scales:

$$RII = \sum_{i=0}^{n} \frac{W_i}{A \times N} = \sum_{i=0}^{n} \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + n_1}{5N} \quad (1)$$

where

RII—is the Relative Importance Index;
W_i—is the weight given to each factor by the respondents from 1, 2, 3, 4, and 5 for very low, low, moderate, high, and very high, respectively;
A—is the highest weight (i.e., 5 in five-point Likert scale);
N—is the total number of respondents for every variable.

To prioritise risks, the formula of Risk Importance (*RI*) was calculated by multiplying the probability and impact for each in terms of project time and project cost (see Equation (2)). Based on the calculations, risks were classified as "high", "moderate", or "low" importance. Risks that have an (*RI*) value equal to or greater than (0.6) were classified as "high" and were significantly important, and those between 0.6 and 0.4 were classified as "moderate" importance and less than 0.4 as "low" importance:

$$\text{Risk Importance}; RI = P \times I \quad (2)$$

where

RI—is the Risk Importance to determine the level of importance of each identified risk;
P—is the probability of risk occurrence;
I—is the impact of risk on time or cost.

3.2. Reliability of Factor Analysis

For this study, Cronbach's alpha ($C\alpha$) testing was used to measure the reliability and strength of the internal consistency of the identified risk factors. The $C\alpha$ range is between 0 and 1, and the acceptable reliability number is typically 0.7 or higher as identified by [67]. The $C\alpha$ formula for Likert scale is shown in Equation (3) below:

$$C\alpha = \frac{K}{K-1}\left[1 - \frac{\sum_{i=0}^{k} \sigma_b^2}{\sigma_t^2}\right] \quad (3)$$

where:

$C\alpha$—is Cronbach's alpha;
K—is many items;
σ_b^2—is the variance of test score;
σ_t^2—is the variance of item scores after weighing.

3.3. Agreement Analysis

Spearman's rank correlation coefficient (r_s) was used to measure the strength and direction of relationship between two ranked sets rather than the actual values. The coefficient was calculated by Equation (4) for ranked risk factors for pairs of the parties involved in this study (client, contractor, and consultant):

$$r_s = 1 - \frac{6\sum d^2}{n(n^2-1)} \quad (4)$$

where

r_s—is Spearman's rank correlation coefficient between two parties;
d—is the difference between ranks assigned to each risk;
n—is the number of pairs of rank.

4. Results and Discussion

4.1. Participants' Demographics

Out of 55 acceptable questionnaires, 30 respondents (54.55%) belonged to the public sector, whereas (34.55%) were from the private sector, and 5.45% belonged to semi-government sector; the remaining 5.45% belonged to academic and research institutions. Twenty-seven respondents (49.09%) designated themselves as the client (owner/government agency), eighteen respondents (32.73%) were designers and consultants, and eight respondents (14.55%) reported to be contractors. The majority indicated that they had a masters degree (MSc) (41.82%), and 23.64% responded that they held a PhD.

Furthermore, the majority of the participants (63%) in this study had an experience of more than 15 years on construction projects, and they were distributed across various areas in the construction sector, reflecting the quality inputs gathered from the diverse experts. The quality of the responses was considered reliable for the analysis due to personal level interaction, relevant experiences, and clear understanding of the questionnaire among the participates. Table 1 summarises the first part of the questionnaire responses, including the respondents' educational background and experience.

Table 1. Participants' demographic details.

Category	Respondent Number	Percentage	Category	Respondent Number	Percentage
Years of Experience			**Sector/Entity**		
Less than 5 years	1	1.82%	Public sector	30	54.55%
6–15 years	19	34.55%	Private sector	19	34.55%
16–25 years	26	47.27%	Semi-government sector	3	5.45%
More than 25 years	9	16.36%	Academic and research institutions	3	5.45%
		100.00%			100.00%
Educational Background			**Role**		
Civil Engineering	33	60.00%	Owner/government agency	27	49.09%
Architecture	7	12.73%	Designer	2	3.64%
Electrical Engineering	5	9.09%	Consultant	16	29.09%
Mechanical Engineering	10	18.18%	Contractor	8	14.55%
			Others	2	3.64%
		100.00%			100.00%

4.2. Delay and Cost Overrun in Construction Projects

Based on reported experience, more than 40% of projects had been subject to delays in the execution phase for thirty respondents (54.55%), and the percentage of project delays was more than 30%, as identified by 25 respondents. Fifty-four respondents had experienced project cost overruns in the execution phase and the average percentages of cost overruns were between 10% and 25% for 29 respondents, whereas 25 respondents (45.45%) have experienced projects cost overruns with less than 10% of average percentage of cost overruns. Table 2, below, summarises the results of second part of the questionnaire.

However, it has been documented that over 70% of the public projects in Saudi Arabia were delayed [68]. For instance, university construction projects were found to be experiencing delays from 50% to 150% [42]. The findings of this study indicate slightly fewer delays (45% of participants stating delays less than 40%) compared to previous studies [69,70], which have identified them as being from 70% to 75%.

Table 2. Performance of building construction projects.

Project Delays			Project Cost Overruns		
Category	**Respondent Number**	**Percentage**	**Category**	**Respondent Number**	**Percentage**
% Projects Exposed to Delays			**% of Projects Exposed to Cost Overruns**		
Never	0	0	Never	1	1.82%
Less than 10%	1	1.82%	Less than 10%	11	20.00%
11–20%	9	16.36%	11–20%	11	20.00%
21–30%	4	7.27%	21–30%	13	23.64%
31–40%	11	20.00%	31–40%	9	16.36%
More than 40%	30	54.55%	More than 40%	10	18.18
	55	100.00%		55	100.00%
Average delay %			**Average cost overruns %**		
Never	0	0%	Never	1	1.82%
Less than 10%	1	1.82%	Less than 5%	6	10.91%
11–20%	10	18.18%	6–10%	19	34.55%
21–30%	19	34.55%	11–15%	10	18.18%
31–40%	10	18.18%	16–20%	8	14.55%
More than 40%	15	27.27%	21–25%	8	14.55%
			More than 25%	3	5.45%
	55	100.00%		55	100.00%

4.3. Ranking of Risks

Risks that are associated with building construction projects in Saudi Arabia were assessed and ranked in terms of project delay and project cost overruns by calculating the Relative Importance Index (*RII*) of the probability of occurrence (*P*) for each risk, *RII* of impact of the risk on project time (*IT*), and (*RII*) of impact of the risk on project cost (*IC*). Then, Risk Importance (*RI*) was calculated for each risk in terms of project time (delay) and project cost (cost overruns), being subsequently ranked, as shown in Table A2 (Appendix B). The top ten risk factors that led to delay and cost overruns in building construction projects are shown in Table 3.

Table 3. Top 10 Risk factors that lead to delay and cost overruns in building construction projects.

No	Code	Risk Factors	Risk Importance						Category
			Project Delay		Project Cost Overruns		Overall		
			RI	Rank	*RI*	Rank	*RI*	Rank	
38	G4R2	Contractor's financial difficulties (ineffective cash flow management)	0.692	1	0.597	3	0.692	1	Contractor-related
4	G1R4	Owner's delay in making progress payments for completed works (Payment delays)	0.672	2	0.525	12	0.672	2	Client-related
6	G1R6	Contract awarded to lowest bidder	0.631	3	0.601	2	0.631	3	
11	G1R11	Change orders during construction	0.627	4	0.622	1	0.627	4	
40	G4R4	Ineffective planning and scheduling of project by contractor	0.627	5	0.528	9	0.627	5	Contractor-related
55	G5R1	Shortage of manpower (skilled, semi-skilled, unskilled)	0.608	6	0.531	7	0.608	6	Labour-related
39	G4R3	Contractor's poor site management and supervision	0.601	7	0.526	11	0.601	7	Contractor-related
37	G4R1	Inadequate contractor experience (lack of experience, and managerial skills)	0.595	8	0.529	8	0.595	8	
42	G4R6	Delays in sub-contractors' work or suppliers	0.588	9	0.474	24	0.588	9	
56	G5R2	Unqualified/inexperienced workers.	0.588	10	0.548	6	0.588	10	Labour-related

As a result of Risk Importance classification (high, moderate, and low), seven risk factors that were the most significant risks factors contributing to completion delay of building construction projects were (1) contractor's financial difficulties (*RI* = 0.692), (2) owner's delay in making progress payments for completed works (*RI* = 0.672), (3) contract awarded to lowest bidder (*RI* = 0.631), (4) change orders during construction (*RI* = 0.627), (5) ineffective planning and scheduling of project by contractor (*RI* = 0.627), (6) shortage of manpower (*RI* = 0.608), and (7) contractor's poor site management and supervision (*RI* = 0.601). On the other hand, there were two significant risks factors contributing to cost overruns: (1) change orders during construction (*RI* = 0.622) and (2) contract awarded to lowest bidder (*RI* = 0.601). The top ten risk factors that led to delay and cost overruns in building construction projects are shown in Table 3.

The most significant risks factors identified in this study are related to contractors (financial difficulties, ineffective planning and scheduling of projects, and poor site management and supervision), clients (delay in making payments, awarding contracts to the lowest bidder, and changing orders during construction), and labour (shortage of manpower). Contractors' financial difficulties (ineffective cash flow management) was ranked as the first major risk factor in this study. Shash and Qarra [71] conducted a study that revealed that 40% of contractors in Saudi Arabia experience financial failure due to poor cash flow management. Saudi contractors' classification system classifies contractors to a five-grade scale. Although these grades determine the maximum project budget size that allow contractors to bid for (an upper limit), it does not consider the maximum number of projects (the total financial limit of all awarded projects) [39]. Consequently, some contractors use the cash flow of one project to finance different project deficits [71]. This result is in line with some of the investigated studies [2,71–73]. The Saudi contractors need to adopt effective cash flow management practices that require planning, monitoring, and controlling cash inflow and outflow at both the company and project levels to achieve financial success and avoid project deficits.

The second ranked risk factor is the owners' delay in making progress payments to the contractor for completed works (payment delays). Most Saudi construction contractors suffer from progress payment delays. Although Saudi contractors receive 5.0% of the contract price at the beginning as an advance payment from the project's owner, the progress payments are the key sources of cash inflow to resolve deficit cash flow and avoid or minimise outsource finance. Delayed progress payments and high expenses of construction project leads to delaying construction work progress and increasing the project costs unless the contractor is capable financially. Approval process (65%) and bureaucracy (25%) are the primary reasons for delays in owners' progress payments [71]. This result is supported by [52,60,71,74].

Contracts awarded to the lowest bidder was ranked as the third most significant risk to building construction projects in Saudi Arabia. This risk can be attributed to the government's tender and procurement system and the contractors' classification system in Saudi Arabia. This practice creates uncertainty due to a lack of experience, lack of financial capability, incompetent contractors, and suicide tendering. It is supported by studies in different contexts and was also identified by [7,60,74] in Saudi Arabia as the most important significant risk factor in Saudi Arabia.

Changing orders during construction were considered the fourth most important risk for project delay in this study. It was also identified by [7] Assaf in Saudi Arabia and by [75] in Kuwait as the most significant risk factor causing project delays. Change orders usually lead to change project schedules and contract prices, claims and disputes, and poor quality of work. Khalifa and Mahamid [20] identified the factors causing change orders in Saudi Arabia. The top causes of change orders are owners' additional work, design errors and omissions, lack of coordination, defective workmanship, owners' financial difficulties, and differing site conditions.

Ineffective project planning and scheduling by contractors was ranked as the fifth among the top risk factors in this study. It was also identified by [7,70,74] in Saudi Arabia and by [2] in Malaysia as the most important risk factor. The shortage of manpower (skilled, semi-skilled, and unskilled) was ranked the sixth major risk factor in this study, which is similar to the findings observed in [42]. However, studies [68,76] identified shortage of labour as being less influential compared to the other factors among the top ten terms of risk. Disruptions in supply chain and movement of labour due to the recent COVID-19 pandemic could be one of the reasons for the higher ranking for shortage of labour. Although COVID-19 may be considered as a force majeure risk, the impact it caused may affect all three stakeholders, including clients, consultants, and contractors. Furthermore, the number of risk factors identified in Saudi Arabia in previous studies [68,76,77] was from 45 to 60, and they were mostly related to owners (clients) and contractors. Finally, contractors' poor site management and supervision was ranked as the seventh most important risk factor in this study. It was identified by [72] in Vietnam and by [2] in Malaysia.

Changing orders during construction and contracts awarded to the lowest bidder were ranked as the first and second most significant risks to construction projects in Saudi Arabia that caused project cost overruns, which were client-related risks. This result is supported by previous research conducted by [52,54].

Furthermore, from the perspective of the three groups of respondents (clients, consultants, and contractors), they indicated the risks related to their areas with low *RI* compared to the other groups (as shown in Table A3, Appendix B). For instance, *RI* for almost all the client-related risks was less than 0.6, as rated by the participants who were in this category, whereas some of these risks were rated with an that was *RI* more than 0.6 by consultants and contractors. However, no major differences among the groups were identified in rating the risks pertaining to designer-related, labour-related, material-related, equipment-related, and external risk factors. Table A3 (Appendix B) presents the ranking according to the perspectives of the three groups of respondents.

Among the identified risk groups, contractor-related risks were identified to be the major risk factors causing both time and cost overruns. Considering the remaining categories, materials-related, labour-related, consultant-related, and external risks had greater impact on cost overruns; materials-related, force-majeure, and consultant-related risks had greater impact of time overruns. The findings clearly indicated the disruptions in supply chain, which may be attributed to the recent pandemic and issues in planning and implementation.

In addition, analysing the risks of each group in order to identify the most important group of risk in building projects in Saudi Arabia, as shown below in Table 4.

Table 4. The most important group of risk factors.

Group No.	Risk Factor Group	*RI*	Rank	Category
G1	Client-related Risks	0.55	1	Internal
G4	Contractor-related Risks	0.505	2	Internal
G5	Labour-related Risks	0.477	3	External
G2	Designer-related Risks	0.455	4	Internal
G6	Materials-related Risks	0.431	5	External
G3	Consultant-related Risks	0.421	6	Internal
G8	External Risks	0.397	7	External
G7	Equipment-related Risks	0.395	8	External
G9	Force Majeure Risks	0.342	9	External

The results revealed four groups as the most important groups with score more than 0.45, which include client-related risks, contractor-related risks, labour-related risks, and design-related risks, all of which were found to have a greater impact on both cost and time overruns. Client-related risks were ranked highest in government-funded projects. However, this finding contrasts with some studies on Saudi Arabian construction where contractor-related risks were given the highest importance [69,74], while in [22] client-related risks were identified as being in this place. Contractor-related risks have been elicited as being the second most important risk in this study, which contrasts with its rankings in other studies [69,70,74]; however, it was identified as being one of the most significant risks in [43]. Moreover, labour- and design-related risks were identified as being significant in studies [43,78] conducted in Saudi Arabia, while other studies [69,70,74] did not find this to be the case.

The risk factors identified in this study, although they reflected similar risks identified in other recent studies in different project types in Saudi Arabia, had few differences identified in terms of the nature of significant risks and their priority. For instance, in the study focusing on the oil and gas industry [15], client-related risks included changes in design and contractor-related risk, and poor planning and implementation were identified as the significant risks; On the other hand, in the study focusing on manufacturing and building projects [17], contractor-related risks including financial difficulties and delays in procurement of raw-materials were identified to be significant risks. In another project related to roads construction, poor planning and poor labour productivity and unskilled labour were identified to be the significant risks. Lean practices can be an effective approach in this context for improving the planning and implementation of construction projects in Saudi Arabia, as it can result in social, economic, and environmental benefits [79]. Although lean practices were identified to be effective in different countries [79,80], different barriers such as traditional practices, client related, technological, performance and knowledge, and cost-related barriers were identified, which limit the implementation of lean practices in Saudi Arabia [81]. Therefore, there is a need to address these barriers for effective implementation of lean practices for addressing the various types of risks in Saudi Arabian construction industries. It is evident from these studies that the nature of risks and its significance may change with the types of projects and countries; therefore, risk management strategies and approaches have to be adjusted accordingly.

These research findings provide a good lesson to not only Saudi Arabia but also the construction industries in other countries, especially the Middle East countries, where there is a lack of skilled resources, high dependency on expatriates, and rising demand for new construction projects. Furthermore, the findings in this study contrasted with studies conducted in other developing countries. For instance, in Malaysia [2,61], design and contract risks were identified to be of high priority, followed by labour risks. However, with increase in FDIs, the clients of the governments may require different changes or raise issues in agreements that may lead to an increase in such risks, as identified in this study in Saudi Arabia, which is focusing on acquiring huge FDIs. Similar results may be identified in China [59], where client risks and contractor-related risks were identified to be the significant risks. Therefore, for developing countries looking for FDIs in the construction industry, client-related risks may emerge as top risks in the near future. While other risks such as material and labour-related risks would be commonly identified in developing countries with limited technical and human resources [55].

4.3.1. Reliability of Factor Analysis

It was calculated for the nine groups and the overall factors, as shown in Table 3. The results of Cronbach's alpha were all more than 0.8, thus indicating an acceptable level of reliability was achieved, as shown in Table 5.

4.3.2. Agreement Analysis

As shown in Table 6, the results indicate positive agreement between the pairs of parties, with the highest level being between the client and consultant, at 82.8%, and 73.8% agreement between the consultant and contractor, and then 64.1% agreement between the client and contractor. The lowest degree of agreement appears to between client and contractor (43.3% with impact on project cost overruns and 34.1% with risk importance of cost overrun). The overall agreements between the parties in ranking the risk factors and other major findings in this study can be used for further research and analysis.

Table 5. Reliability analysis (Cronbach's alpha) for the risk factors.

Group No.	Risk Factor Group	No. of Risk Factors	Probability (P)		Impact on Time (IT)		Impact on Cost (IC)	
			$C\alpha$	Result	$C\alpha$	Result	$C\alpha$	Result
G1	Client-related Risks	16	0.825	Good	0.813	Good	0.847	Good
G2	Designer-related Risks	10	0.862	Good	0.824	Good	0.842	Good
G3	Consultant-related Risks	10	0.866	Good	0.865	Good	0.897	Good
G4	Contractor-related Risks	18	0.915	Excellent	0.906	Excellent	0.940	Excellent
G5	Labour-related Risks	8	0.860	Good	0.847	Good	0.901	Excellent
G6	Materials-related Risks	6	0.867	Good	0.884	Good	0.937	Excellent
G7	Equipment-related Risks	22	0.853	Good	0.837	Good	0.841	Good
G8	External Risks	9	0.873	Good	0.828	Good	0.877	Good
G9	Force Majeure Risks	4	0.839	Good	0.864	Good	0.862	Good
	Overall		**0.9858**	**Excellent**				

Table 6. Spearman's rank correlation coefficient between parties **.

Parties	Spearman Rank Correlation Coefficient
Client and Consultant	0.834
Client and Contractor	0.653
Consultant and Contractor	0.736

Parties	Probability (P)	Impact (I)		Risk Importance (RI)		
		Project Delay	Project Cost Overruns	Project Delay	Project Cost Overruns	Overall
Client and Consultant	0.814	0.778	0.788	0.817	0.830	**0.828**
Client and Contractor	0.650	0.633	0.433	0.655	0.341	**0.641**
Consultant and Contractor	0.756	0.683	0.610	0.765	0.548	**0.738**

** Correlation is significant at the 0.01 level (2-tailed).

Regarding the level of agreement amongst the different stakeholders, it is evident from Table 6 that client–consultant had the highest, while client–contractor had average levels of agreement, thus indicating the major issues relating to the clients–contractors' relationships and transactions. The low probability in client and contractor relationship can be understood in different perspectives and interests. The relationship between client and contractor can be influenced by various factors. For instance, commitments from the contractors and competence trust of the clients are very volatile, which can significantly affect the relationship between them [82]. While time, cost, and quality were considered as important client values, they were not considered as exclusive values for assessing contractors service, indicating the differences in the values, attitudes of both parties, and the relationships between them [83]. The major issues identified in this study and previous ones [68,76,77] have revealed that the majority of the risk factors of high priority pertain to client–contractor relationships. Hence, it can be concluded that the companies and consultants in Saudi Arabian construction industry should focus on improving the client/contractors' relationships, the tendering process, project planning and execution, and financing.

5. Conclusions

The construction industry in Saudi Arabia has suffered from completion delays and cost overruns, which have caused financial losses for all parties involved in such a competitive environment. The survey results revealed the seven risk factors that were the most significant risk factors contributing to the completion delays of building construction projects out of the eighty-three risk factors identified from literature review. These risk factors included contractors' financial difficulties, owners' delay in making progress payments for completed works, contracts awarded to the lowest bidder, change orders during construction, ineffective project planning and scheduling by contractor, shortage of manpower, and contractors' poor site management and supervision. Additionally, changing orders during construction and contracts awarded to the lowest bidder were the most significant risks that caused projects cost overrun, which were client-related risks. It revealed four risk groups as the most significant: client-related risks, contractor-related risks, labour-related risks, and design-related risks. Each group was found to have a notable impact on both cost and time overruns. The statistical analyses revealed an acceptable level of reliability of the identified risk factors and a positive agreement between the clients, consultants, and contractors.

The findings have revealed issues in the client/contractor relationship and tender allocation process, which may help industry experts and government agencies in future plans to mitigate the risks identified in this study. Furthermore, with uncertainty continuing due to the COVID-19 pandemic and the opening of the markets, future studies could focus on investigating the force majeure risks and the impact these have on the relationships between the stakeholders and supply chain systems in the Saudi Arabian construction industry. To achieve sustainable development, client-, contractor-, and labour-related risks must be effectively managed.

The novelty of contributions in this study can be reflected in the findings achieved in specific to government funded building construction projects in Saudi Arabia, which previous studies have not focused, although the difference in the risk factors with project types were highlighted in previous studies. Furthermore, the findings of this study are novel, due to the situations created by external factors such as COVID-19 pandemic, which has greatly affected resource management and continuity in construction. However, there are certain limitations that can be observed in this study. This study adapted snowball sampling methods and only considered government-funded building construction projects through SPWC processes, while there are also other project types. These limitations can be addressed in future research works. Future research can focus on another project types in the context of Saudi Arabia, such as roads, industrial projects, etc. However, various implications can be drawn from the findings in this study. Firstly, the results from this study aids decision makers to better understand the impact of the COVID-19 pandemic on the construction industry, based on which necessary policy-related decisions may be taken to strengthen the construction industry and better implement vision 2030 objectives. Secondly, the findings in this study contribute to the literature on the risk factors by project types, as this study focused only on government-aided building construction projects.

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Appendix A

Table A1. List of major risk factors identified from the literature review.

Studies	Methodologies	Country	No. of Factors Identified	Major Risk Factors	Impact on Construction Projects
Mahamid et al. (2015) [60]	Survey and Literature Review	Saudi Arabia	31	Bid awarded for lowest price, changes in material types and specifications during construction, contract management, duration of contract period, fluctuation of prices of materials, frequent changes in design, improper planning, inflationary pressure, lack of adequate manpower, long period between design and time of implementation, payments delay, poor labour productivity and rework	Time overrun
Memon et al. (2012) [61]	Interviews and surveys	Malaysia	35	Design and documentation issues, financial resource management, project management and contract administration, contractors site management, information and communication technology, material and machinery resource, labour (human) resource, external factors	Time and cost overrun
Aljohani et al. (2017) [52]	Literature Review	Multiple countries	173	Increase in material cost, inaccurate material estimates, shortage of skilled labour, client's late contract award, project complexity, increase in labour costs, bidding differences, shortage manpower, design issues, poor planning and implementation, lack of talent resources	Cost overrun
Allahaim and Liu (2015) [14]	Literature Review and Surveys	Saudi Arabia	41	Market conditions, unrealistic estimations, decision-making errors, payment issues, project size, lack of talent resources, poor planning and implementation, waste on site, currency fluctuations, lack of technology and material resources, changes in design and scope, political obstacles, poor strategies	Cost overrun
Creedy et al. (2010) [57]	Case studies	Australia	37	Design issues, political issues, requirements changes, cultural issues, material costs increase, contract failures, administration issues, location changes, inflation	Time, cost, quality, performance
Jackson (2002) [58]	Interviews	UK	341	Design changes, project management, site conditions, commercial pressures, lack of talent resources, external factors, estimation methods, information availability	Time, cost, quality, performance, planning, project management
Baloyi and Bekker (2011) [55]	Literature Review and Surveys	South Africa	18	Increase in material cost, inaccurate material estimates, shortage of skilled labour, client's late contract award, project complexity, increase in labour costs, bidding differences, shortage manpower, design issues, poor planning and implementation, labour issues, poor information availability, delay in approvals	Time, cost, quality, performance, planning, project management
Subramani et al. (2014) [63]	Case studies and Literature Review	India	10	Slow decision making, poor schedule management, increase in material/machine prices, poor contract management, poor design/ delay in providing design, rework due to wrong work, problems in land acquisition, wrong estimation/ estimation method, and long period between design and time of bidding/tendering	Cost overrun
Memon et al. (2011) [2]	Case studies and Survey	Malaysia	30	Practice of assigning contract to lowest bidder, contractor's poor site management, cash flow and financial difficulties faced by contractors, ineffective planning and scheduling by contractors, problems with subcontractors, inadequate contractor experience, material procurement, poor estimate project duration, incompetent designers, shortage of site workers, lack of communication among parties, unforeseen ground condition, changes in scope of projects, low speed of decision making, frequent changes by owners, escalation of material prices, owner interference, change in management	Time overrun

Table A1. *Cont.*

Studies	Methodologies	Country	No. of Factors Identified	Major Risk Factors	Impact on Construction Projects
Mahamid et al. (2015) [60]	Survey and Literature Review	Saudi Arabia	31	Bid awarded for lowest price, changes in material types and specifications during construction, contract management, duration of contract period, fluctuation of prices of materials, frequent changes in design, improper planning, inflationary pressure, lack of adequate manpower, long period between design and time of implementation, payments delay, poor labour productivity and rework	Time overrun
Mahamid (2017) [44]	Case studies and survey	Saudi Arabia	34	Improper planning, poor labour productivity, additional works, rework, and lack of contractor experience, disputes, arbitration, litigation, and poor quality	Time overrun, Performance
Tebeje Zewdu and Teka Aregaw (2015) [64]	Survey and Literature Review	Ethiopia	41	Poor planning, fluctuation of price of materials, poor productivity, inflationary pressure and project financing, economic instability, lack of talented labour	Cost overrun, Performance
Sharma and Goyal (2019) [62]	Literature Review and Expert opinion	India	55	Fluctuation in price of materials, lowest bid procurement policy, inflation inappropriate govt. Policy, mistakes and discrepancies in the contract document, inaccurate time and cost estimate, additional work, frequent design change, unrealistic contract duration and financial difficulty faced by contractors	Cost overrun, Performance
Cirovic and Sudjic (2012) [56]	Literature Review and Case studies	Montenegro	16	Local market issues, Montenegrin legislation, local infrastructure, poor resources management, delay in approvals, lack of planning, lack of labour	Cost and duration overrun
Bahamid et al. (2019) [54]	Literature Review	Multiple countries	111	Inflation/price fluctuation, technology issues, incomplete design scope, changes, labour equipment, delays in approvals, financial issues, poor estimations, poor designs, political instability, criminal acts, poor communication, poor planning and control	Time, cost, quality, performance, planning, project management
Liu et al. (2016) [59]	Survey and Literature Review	China	20	Host government–related risk, contractor's lack of experience, and lack of managerial skills had significant effect on project cost, quality, and schedule objectives, resource price fluctuation	Time, cost, quality, performance, planning, project management
Iqbal et al. (2015) [4]	Survey	Pakistan	24	Financial issues for projects, accidents on site and defective design, subcontractors, labour, machinery, availability of materials and quality, issues related to design documents, changes in codes and regulations, political instability, and scope of work	Time, cost, quality, performance, planning
Zhao et al. (2016) [65]	Survey	Singapore	28	Inaccurate cost estimation, cost overrun, poor planning, external factors	Time, cost, quality

Appendix B

Table A2. *RII* for risk factors of building construction projects and ranking.

No	Code	Risk Factors	Probability		Impact on Time		Impact on Cost		Risk Importance (*RI*)					
									Project Delay		Cost Overrun		Overall *RI*	
			RII	Rank	*RII*	Rank	*RII*	Rank	*RI*	Rank	*RI*	Rank	*RI*	Rank
		Clients-Related Risks												
1	G1R1	Client's lack of experience about construction project.	0.665	33	0.724	40	0.713	25	0.482	35	0.474	25	0.482	39
2	G1R2	Excessive bureaucracy in owner's administration	0.735	11	0.742	33	0.665	44	0.545	18	0.489	19	0.545	18
3	G1R3	Client's financial difficulties	0.665	33	0.818	8	0.720	19	0.544	19	0.479	22	0.544	19
4	G1R4	Owner's delay in making progress payments for completed works (payment delays)	0.767	3	0.876	1	0.684	37	0.672	2	0.525	12	0.672	2
5	G1R5	Selecting consultant, or designer, based on the lowest price	0.760	4	0.756	29	0.742	11	0.575	14	0.564	4	0.575	14
6	G1R6	Contract awarded to the lowest bidder	0.818	1	0.771	24	0.735	13	0.631	3	0.601	2	0.631	3
7	G1R7	Unrealistic/Inadequate original contract duration (tight schedule)	0.702	19	0.822	5	0.720	19	0.577	13	0.505	16	0.577	13
8	G1R8	Political pressure to complete the project and speed up construction processes	0.549	71	0.644	70	0.753	9	0.353	68	0.413	49	0.413	58
9	G1R9	Delay in land acquisition/Handover to the contractor	0.571	65	0.684	55	0.524	77	0.390	61	0.299	76	0.390	64
10	G1R10	Difficulties in obtaining work permits from the authorities	0.640	44	0.760	27	0.589	69	0.486	31	0.377	55	0.486	35
11	G1R11	Change orders during construction	0.756	5	0.829	3	0.822	1	0.627	4	0.622	1	0.627	4
12	G1R12	Scope of work reduction by owner during execution phase	0.535	72	0.545	79	0.575	74	0.292	80	0.307	75	0.307	78
13	G1R13	Delay penalty clause in the Saudi Public Works Contract is inefficient	0.582	60	0.680	57	0.596	65	0.396	58	0.347	62	0.396	61
14	G1R14	Inaccurate estimation of construction cost by owner	0.684	24	0.669	63	0.771	3	0.457	43	0.527	10	0.527	27
15	G1R15	Project suspension by owner	0.556	68	0.789	17	0.684	37	0.439	46	0.380	53	0.439	47
16	G1R16	Delays due to dispute resolution	0.673	31	0.789	17	0.698	31	0.531	24	0.470	28	0.531	24
		Designer-Related Risks												
17	G2R1	Unclear and inadequate drawings, specifications, bills of quantities (BOQ)	0.724	13	0.804	12	0.767	4	0.582	11	0.555	5	0.582	11
18	G2R2	Discrepancies between project documents (contract, BOQ, specifications, and drawings)	0.647	41	0.749	31	0.738	12	0.485	32	0.478	23	0.485	36
19	G2R3	Mistakes and deficiencies in design documents	0.651	40	0.742	33	0.727	18	0.483	34	0.473	26	0.483	38
20	G2R4	Inaccurately estimated quantities (BOQ)	0.680	26	0.695	51	0.764	5	0.472	40	0.519	13	0.519	28

Table A2. *Cont.*

No	Code	Risk Factors	Probability		Impact on Time		Impact on Cost		Risk Importance (*RI*)					
									Project Delay		Cost Overrun		Overall *RI*	
			RII	Rank	*RII*	Rank	*RII*	Rank	*RI*	Rank	*RI*	Rank	*RI*	Rank
21	G2R5	All existing underground utilities information not available on the design documents (e.g., live cables and pipelines) for the contractor	0.687	23	0.782	21	0.705	28	0.537	20	0.485	20	0.537	20
22	G2R6	Inadequate geotechnical investigations report about ground conditions of the project site (if available)	0.647	41	0.731	39	0.778	2	0.473	39	0.504	17	0.504	32
23	G2R7	Complexity of design	0.495	79	0.665	64	0.665	44	0.329	74	0.329	68	0.329	74
24	G2R8	Absence of contractor's involvement in the design stage	0.615	49	0.509	82	0.524	77	0.313	76	0.322	70	0.322	76
25	G2R9	Speeding up of design phase's schedule	0.676	28	0.665	64	0.691	34	0.450	45	0.467	30	0.467	43
26	G2R10	Limited budget for design	0.647	41	0.662	66	0.676	42	0.428	50	0.438	38	0.438	48
		Consultant-Related Risks												
27	G3R1	Lack of experience and competence of consultant's staff.	0.691	22	0.764	26	0.680	39	0.528	26	0.470	27	0.528	26
28	G3R2	Slowness in decision making for approval (shop drawings, submittals, sample materials, change orders, etc.)	0.716	17	0.793	14	0.655	46	0.568	15	0.469	29	0.568	15
29	G3R3	Consultant's rejection of submittals (shop drawings, equipment, and material samples)	0.596	52	0.720	43	0.607	60	0.429	49	0.362	57	0.429	53
30	G3R4	Consultant's delay in performing inspection and testing, and giving instructions	0.567	66	0.695	51	0.571	75	0.394	59	0.324	69	0.394	62
31	G3R5	Poor coordination and communication between consultant and other parties	0.636	46	0.753	30	0.615	59	0.479	37	0.391	51	0.479	41
32	G3R6	Poor quality control and assurance	0.662	37	0.684	55	0.687	35	0.452	44	0.455	32	0.455	46
33	G3R7	Consultant's corruption	0.585	58	0.724	40	0.720	19	0.424	52	0.422	46	0.424	55
34	G3R8	Inflexibility (rigidity) of consultant	0.575	64	0.676	59	0.560	76	0.389	63	0.322	71	0.389	65
35	G3R9	Excessive safety consideration	0.447	81	0.505	83	0.491	83	0.226	83	0.220	83	0.226	83
36	G3R10	Internal company problems (at consultant company's head office)	0.535	72	0.604	77	0.509	80	0.323	75	0.272	80	0.323	75
		Contractor-Related Risks												
37	G4R1	Inadequate contractor experience (lack of experience, and managerial skills)	0.724	13	0.822	6	0.731	15	0.595	8	0.529	8	0.595	8
38	G4R2	Contractor's financial difficulties (ineffective cash flow management)	0.789	2	0.876	1	0.756	7	0.692	1	0.597	3	0.692	1
39	G4R3	Contractor's poor site management and supervision	0.731	12	0.822	6	0.720	19	0.601	7	0.526	11	0.601	7
40	G4R4	Ineffective planning and scheduling of project by contractor	0.756	5	0.829	3	0.698	31	0.627	4	0.528	9	0.627	4
41	G4R5	Ineffective control of the project progress	0.676	28	0.782	21	0.676	42	0.529	25	0.457	31	0.529	25

Table A2. *Cont.*

No	Code	Risk Factors	Probability		Impact on Time		Impact on Cost		Risk Importance (*RI*)					
									Project Delay		Cost Overrun		Overall *RI*	
			RII	Rank	*RII*	Rank	*RII*	Rank	*RI*	Rank	*RI*	Rank	*RI*	Rank
42	G4R6	Delays in sub-contractors' work or caused by suppliers	0.745	9	0.789	17	0.636	51	0.588	9	0.474	24	0.588	9
43	G4R7	Delay in preparation of shop drawings and material samples	0.709	18	0.782	21	0.604	62	0.554	16	0.428	45	0.554	16
44	G4R8	Delay in site mobilization.	0.662	37	0.698	49	0.524	77	0.462	41	0.347	63	0.462	44
45	G4R9	Rework and wastage on site, due to errors or quality of work (poor quality of workmanship)	0.665	33	0.749	31	0.680	39	0.498	30	0.453	34	0.498	34
46	G4R10	Variations in quantities	0.684	24	0.629	73	0.731	15	0.430	47	0.500	18	0.500	33
47	G4R11	Cost of penalties	0.589	53	0.582	78	0.622	54	0.343	71	0.366	56	0.366	69
48	G4R12	The contractor does not carry out a field visit to the site during the bidding process	0.655	39	0.724	40	0.695	33	0.474	38	0.455	33	0.474	42
49	G4R13	New existing underground utilities not mentioned on the design documents (e.g., live cables and pipelines)	0.676	28	0.793	14	0.756	7	0.536	21	0.512	15	0.536	21
50	G4R14	Health and Safety requirements (in light of COVID-19)	0.589	53	0.629	73	0.585	70	0.371	66	0.345	64	0.371	68
51	G4R15	Accidents on site	0.524	74	0.524	81	0.509	80	0.274	81	0.267	81	0.274	81
52	G4R16	Conflict between contractor and consultant	0.702	19	0.735	37	0.622	54	0.516	28	0.436	40	0.516	30
53	G4R17	Tender-winning prices are unrealistically low (suicide tendering)	0.640	44	0.804	12	0.749	10	0.514	29	0.479	21	0.514	31
54	G4R18	Unavailability of incentives for contractor for finishing ahead of schedule or to reduce the cost	0.720	15	0.673	61	0.625	52	0.484	33	0.450	35	0.484	37
		Labour-Related Risks												
55	G5R1	Shortage of manpower (skilled, semi-skilled, and unskilled)	0.753	7	0.807	10	0.705	28	0.608	6	0.531	7	0.608	6
56	G5R2	Unqualified/inexperienced workers	0.745	9	0.789	17	0.735	13	0.588	9	0.548	6	0.588	9
57	G5R3	Low productivity level of manpower/labourers	0.720	15	0.807	10	0.713	25	0.581	12	0.513	14	0.581	12
58	G5R4	Low payment for labour force	0.665	33	0.640	71	0.622	54	0.426	51	0.414	48	0.426	54
59	G5R5	Injuries to labourers on the construction site	0.556	68	0.545	79	0.505	82	0.303	77	0.281	79	0.303	79
60	G5R6	Delayed salary payments to staff by the contractor	0.753	7	0.735	37	0.596	65	0.553	17	0.449	37	0.553	17
61	G5R7	High turn-over of personnel	0.622	47	0.651	69	0.578	72	0.405	56	0.360	59	0.405	59
62	G5R8	Labour strikes	0.498	78	0.709	45	0.622	54	0.353	69	0.310	74	0.353	71
		Materials-Related Risks												
63	G6R1	Shortage of construction materials—special building materials not available in the local market	0.509	76	0.705	46	0.655	46	0.359	67	0.333	67	0.359	70
64	G6R2	Delay in delivery of materials	0.622	47	0.738	35	0.607	60	0.459	42	0.378	54	0.459	45

Table A2. *Cont.*

No	Code	Risk Factors	Probability		Impact on Time		Impact on Cost		Risk Importance (*RI*)					
									Project Delay		Cost Overrun		Overall *RI*	
			RII	Rank	*RII*	Rank	*RII*	Rank	*RI*	Rank	*RI*	Rank	*RI*	Rank
65	G6R3	Delay in the special manufacture of building materials/equipment	0.673	31	0.793	14	0.647	49	0.533	23	0.435	41	0.533	23
66	G6R4	Delay in procurement of materials	0.680	26	0.760	27	0.604	62	0.517	27	0.410	50	0.517	29
67	G6R5	Damage to material in storage/at site	0.487	80	0.618	76	0.644	50	0.301	78	0.314	73	0.314	77
68	G6R6	Rejecting materials' submittals	0.585	58	0.713	44	0.585	70	0.417	53	0.343	65	0.417	56
		Equipment-Related Risks												
69	G7R1	Inadequate or inefficient equipment, tools, and plants	0.582	60	0.687	53	0.604	62	0.400	57	0.351	61	0.400	60
70	G7R2	Equipment availability and failure	0.578	63	0.676	59	0.593	68	0.391	60	0.343	66	0.391	63
		External Risks												
71	G8R1	Economic instability	0.582	60	0.738	35	0.713	25	0.429	48	0.415	47	0.429	52
72	G8R2	High fluctuation in cost (e.g., money exchange rate; taxes and burdens; and interest rates charged by bankers on loan)	0.589	53	0.662	66	0.731	15	0.390	62	0.431	44	0.431	51
73	G8R3	Inflation (e.g., material, equipment, and labour prices)	0.607	50	0.633	72	0.720	19	0.384	64	0.437	39	0.437	49
74	G8R4	Changes in government regulations and laws (e.g., economy, tax, safety, environment, industrial, recruitment and workers' visas, and localization)	0.604	51	0.687	53	0.720	19	0.415	55	0.435	42	0.435	50
75	G8R5	Delay in connecting services with external parties (e.g., electricity, water, sewage, etc.)	0.695	21	0.771	24	0.625	52	0.535	22	0.434	43	0.535	22
76	G8R6	Delay in recruitment and workers' visa approval	0.589	53	0.705	46	0.596	65	0.416	54	0.351	60	0.416	57
77	G8R7	Corruption (fraudulent practices, kickbacks, and lack of respect for the law)	0.560	67	0.622	75	0.687	35	0.348	70	0.385	52	0.385	66
78	G8R8	Legal disputes between various parties	0.556	68	0.680	57	0.651	48	0.378	65	0.362	58	0.378	67
79	G8R9	Import/Export restrictions	0.516	75	0.662	66	0.618	58	0.342	73	0.319	72	0.342	73
		Force Majeure Risks												
80	G9R1	Earthquakes, fires, and floods	0.356	83	0.702	48	0.702	30	0.250	82	0.250	82	0.250	82
81	G9R2	Severe weather conditions	0.509	76	0.673	61	0.578	72	0.342	72	0.294	77	0.342	72
82	G9R3	Wars in region/Political instability	0.425	82	0.698	49	0.680	39	0.297	79	0.289	78	0.297	80
83	G9R4	Spreading of disease, epidemic or pandemic (e.g., COVID-19)	0.589	53	0.815	9	0.764	5	0.480	36	0.450	36	0.480	40

Table A3. Risk Importance (RI) for risk factors of building construction projects and ranking, according to the perspective of the three groups of respondents.

No	Code	Risk Factors	Client		Consultant		Contractor		*RI* Overall	
			RI	Rank	*RI*	Rank	*RI*	Rank	*RI*	Rank
		Client-Related Risks								
1	G1R1	Client's lack of experience about the construction project.	0.504	29	0.497	40	0.438	65	0.482	39
2	G1R2	Excessive bureaucracy in owner's administration.	0.538	16	0.529	32	0.581	29	0.545	18
3	G1R3	Client's financial difficulties.	0.489	34	0.566	23	0.713	6	0.544	19
4	G1R4	Owner's delay in making progress payments for completed works (payment delays).	0.632	1	0.680	2	0.809	1	0.672	2
5	G1R5	Selecting consultant, or designer, based on the lowest price.	0.527	17	0.640	9	0.700	7	0.575	14
6	G1R6	Contract awarded to the lowest bidder.	0.593	6	0.676	3	0.743	4	0.631	3
7	G1R7	Unrealistic/Inadequate original contract duration (tight schedule).	0.556	13	0.577	20	0.656	13	0.577	13
8	G1R8	Political pressure to complete the project and speed up construction processes.	0.397	58	0.403	62	0.474	55	0.413	58
9	G1R9	Delay in land acquisition/Handover to the contractor.	0.406	55	0.315	76	0.440	64	0.390	64
10	G1R10	Difficulties in obtaining work permits from the authorities.	0.450	43	0.495	42	0.595	25	0.486	35
11	G1R11	Change orders during construction.	0.591	9	0.657	6	0.675	11	0.627	4
12	G1R12	Scope of work reduction by owner during execution phase.	0.290	77	0.308	79	0.325	78	0.307	78
13	G1R13	Delay penalty clause in the Saudi Public Works Contract is inefficient.	0.508	27	0.308	78	0.281	81	0.396	61
14	G1R14	Inaccurate estimation of construction cost by owner.	0.523	20	0.530	31	0.578	31	0.527	27
15	G1R15	Project suspension by owner.	0.413	52	0.432	54	0.532	39	0.439	47
16	G1R16	Delays due to dispute resolution.	0.435	44	0.646	8	0.619	19	0.531	24
		Designer-Related Risks								
17	G2R1	Unclear and inadequate drawings, specifications, bills of quantities (BOQ)	0.592	7	0.586	16	0.638	15	0.582	11
18	G2R2	Discrepancies between project documents (contract, BOQ, specifications, and drawings).	0.472	38	0.511	37	0.574	33	0.485	36
19	G2R3	Mistakes and deficiencies in design documents.	0.486	35	0.505	38	0.520	42	0.483	38
20	G2R4	Inaccurately estimated quantities (BOQ).	0.524	19	0.505	38	0.638	15	0.519	28
21	G2R5	All existing underground utilities information not available on the design documents (e.g., live cables and pipelines) for the contractor.	0.508	27	0.596	13	0.495	50	0.537	20
22	G2R6	Inadequate geotechnical investigations report about ground conditions of the project site (if available).	0.495	32	0.566	23	0.371	72	0.504	32
23	G2R7	Complexity of design.	0.326	72	0.361	70	0.338	77	0.329	74
24	G2R8	Absence of contractor's involvement in the design stage.	0.362	66	0.260	82	0.316	79	0.322	76
25	G2R9	Speeding up of design phase's schedule.	0.516	23	0.459	48	0.374	71	0.467	43
26	G2R10	Limited budget for design.	0.429	46	0.459	47	0.471	57	0.438	48

Table A3. *Cont.*

No	Code	Risk Factors	Client		Consultant		Contractor		*RI* Overall	
			RI	Rank	*RI*	Rank	*RI*	Rank	*RI*	Rank
		Consultant-Related Risks								
27	G3R1	Lack of experience and competence of consultant's staff.	0.499	30	0.596	14	0.540	38	0.528	26
28	G3R2	Slowness decision making for approval (shop drawings, submittals, sample materials, change orders, etc.)	0.520	21	0.620	11	0.598	23	0.568	15
29	G3R3	Consultant's rejection of submittals (shop drawings, equipment, and material samples).	0.430	45	0.411	60	0.471	57	0.429	53
30	G3R4	Consultant's delay in performing inspection and testing and giving instructions.	0.378	64	0.404	61	0.453	59	0.394	62
31	G3R5	Poor coordination and communication between consultant and other parties.	0.427	48	0.586	16	0.531	40	0.479	41
32	G3R6	Poor quality control and assurance.	0.464	39	0.490	43	0.446	63	0.455	46
33	G3R7	Consultant's corruption.	0.394	60	0.517	36	0.413	68	0.424	55
34	G3R8	Inflexibility (rigidity) of consultant.	0.359	67	0.381	66	0.516	43	0.389	65
35	G3R9	Excessive safety consideration.	0.227	82	0.227	83	0.273	83	0.226	83
36	G3R10	Internal company problems (at consultant company's head office).	0.257	79	0.449	51	0.344	76	0.323	75
		Contractor-Related Risks								
37	G4R1	Inadequate contractor experience (lack of experience, and managerial skills).	0.569	11	0.666	4	0.574	33	0.595	8
38	G4R2	Contractor's financial difficulties (ineffective cash flow management).	0.627	2	0.798	1	0.763	2	0.692	1
39	G4R3	Contractor's poor site management and supervision.	0.592	7	0.664	5	0.553	36	0.601	7
40	G4R4	Ineffective planning and scheduling of project by contractor.	0.598	5	0.657	7	0.678	9	0.627	4
41	G4R5	Ineffective control of the project progress.	0.556	12	0.552	29	0.453	59	0.529	25
42	G4R6	Delays in sub-contractors work or due to suppliers.	0.570	10	0.562	27	0.675	11	0.588	9
43	G4R7	Delay in preparation of shop drawings and material samples.	0.526	18	0.595	15	0.616	20	0.554	16
44	G4R8	Delay in site mobilization	0.489	33	0.473	45	0.375	70	0.462	44
45	G4R9	Rework and wastage on site, due to errors or quality of work (poor quality of workmanship).	0.456	41	0.521	34	0.591	28	0.498	34
46	G4R10	Variations in quantities.	0.511	25	0.520	35	0.508	45	0.500	33
47	G4R11	Cost of penalties.	0.369	65	0.400	63	0.300	80	0.366	69
48	G4R12	The contractor does not carry out a field visit to the site during the bidding process.	0.499	30	0.465	46	0.488	53	0.474	42
49	G4R13	New existing underground utilities not mentioned on the design documents (e.g., live cables, pipelines).	0.518	22	0.566	23	0.580	30	0.536	21
50	G4R14	Health and Safety requirements (in light of COVID-19).	0.338	70	0.364	69	0.506	46	0.371	68
51	G4R15	Accidents on site.	0.250	81	0.284	80	0.413	67	0.274	81
52	G4R16	Conflict between contractor and consultant.	0.464	40	0.579	18	0.595	25	0.516	30

Table A3. *Cont.*

No	Code	Risk Factors	Client		Consultant		Contractor		*RI* Overall	
			RI	Rank	*RI*	Rank	*RI*	Rank	*RI*	Rank
53	G4R17	Tender-winning prices are unrealistically low (suicide tendering).	0.481	36	0.557	28	0.595	25	0.514	31
54	G4R18	Unavailability of incentives for contractor for finishing ahead of schedule or to reduce the cost.	0.410	54	0.497	40	0.744	3	0.484	37
		Labour-Related Risks								
55	G5R1	Shortage of manpower (skilled, semi-skilled, and unskilled).	0.616	3	0.612	12	0.678	9	0.608	6
56	G5R2	Unqualified/inexperienced workers.	0.610	4	0.579	19	0.630	17	0.588	9
57	G5R3	Low productivity level of manpower/labourers.	0.553	14	0.629	10	0.616	20	0.581	12
58	G5R4	Low payment for labour force.	0.429	47	0.422	57	0.523	41	0.426	54
59	G5R5	Injuries to labourers on the construction site.	0.292	76	0.309	77	0.359	74	0.303	79
60	G5R6	Delayed salary payments to staff by the contractor.	0.548	15	0.562	26	0.680	8	0.553	17
61	G5R7	High turnover of personnel.	0.419	49	0.387	65	0.489	52	0.405	59
62	G5R8	Labour strikes.	0.320	73	0.397	64	0.474	55	0.353	71
		Materials-Related Risks								
63	G6R1	Shortage of construction materials—special building materials not available in the local market.	0.327	71	0.373	68	0.495	50	0.359	70
64	G6R2	Delay in delivery of materials.	0.454	42	0.436	53	0.578	31	0.459	45
65	G6R3	Delay in the special manufacture of building materials/equipment.	0.512	24	0.568	22	0.598	23	0.533	23
66	G6R4	Delay in procurement of materials.	0.509	26	0.552	29	0.560	35	0.517	29
67	G6R5	Damage to material in storage/at site.	0.339	69	0.315	75	0.281	81	0.314	77
68	G6R6	Rejecting materials' submittals.	0.412	53	0.375	67	0.553	36	0.417	56
		Equipment-Related Risks								
69	G7R1	Inadequate or inefficient equipment, tools, and plants.	0.418	51	0.350	72	0.504	47	0.400	60
70	G7R2	Equipment availability and failure.	0.404	56	0.338	73	0.504	47	0.391	63
		External Risks								
71	G8R1	Economic instability.	0.386	62	0.442	52	0.613	22	0.429	52
72	G8R2	High fluctuation in cost (e.g., money exchange rate; taxes and burdens; and interest rates charged by bankers on loan).	0.378	63	0.422	58	0.630	17	0.431	51
73	G8R3	Inflation (e.g., material, equipment and labour prices).	0.403	57	0.459	49	0.503	49	0.437	49
74	G8R4	Changes in government regulations and laws (e.g., economy, tax, safety, environment, industrial, recruitment and workers' visas, and localisation).	0.418	50	0.450	50	0.453	59	0.435	50
75	G8R5	Delay in connecting services with external parties (e.g., electricity, water, sewage, etc.)	0.473	37	0.570	21	0.656	13	0.535	22

Table A3. *Cont.*

No	Code	Risk Factors	Client		Consultant		Contractor		*RI* Overall	
			RI	Rank	*RI*	Rank	*RI*	Rank	*RI*	Rank
76	G8R6	Delay in recruitment and workers' visa approval.	0.355	68	0.474	44	0.516	43	0.416	57
77	G8R7	Corruption (fraudulent practices, kickbacks, and lack of respect for law).	0.396	59	0.414	59	0.356	75	0.385	66
78	G8R8	Legal disputes between various parties.	0.313	75	0.432	54	0.488	53	0.378	67
79	G8R9	Import/export restrictions.	0.320	73	0.359	71	0.450	62	0.342	73
		Force Majeure Risks								
80	G9R1	Earthquakes, fires, and floods.	0.225	83	0.277	81	0.360	73	0.250	82
81	G9R2	Severe weather conditions.	0.267	78	0.424	56	0.435	66	0.342	72
82	G9R3	Wars in region/political instability.	0.252	80	0.334	74	0.407	69	0.297	80
83	G9R4	Spreading of disease, epidemic, or pandemic (e.g., COVID-19).	0.386	61	0.523	33	0.736	5	0.480	40

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