Assessment of Risks Associated with Saudi Aviation Construction Projects and of the Risks' Importance

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***Abstract*—This study assesses the significance of risks inherent to Saudi Arabian aviation construction projects in terms of their probability of occurrence and their impact on these projects. Data were collected from a questionnaire distributed to fifty- four respondents. The analysis revealed that labour issues, design changes by the client, corruption, the designers' project relevant knowledge and skills, incomplete designs, changes of law, poor quality design, design errors and the obtaining or issuing of the required approvals are the most significant risks to aviation projects in Saudi Arabia. The authors developed a structure for risks associated with aviation projects in Saudi Arabia. This contained three levels of risk and a number of categories; it was found that designer related, client related, and consultant related risks were the three major categories. The authors made use of a one-way ANOVA test to calculate the differences between the groups of respondents. This established the validity of the results of the study.**

***Index Terms*—Aviation, construction, GACA, risk analysis.**

I. Introduction

Risk in construction projects is an important research topic. This is because of the potentially serious consequences that risks can have on construction projects in terms of cost and time overruns [1]. This can add additional pressure to construction projects, and particularly to complex projects such as aviation construction [2]. Baghdadi and Kishk [3] identified eight challenges that increase the complexity of Saudi aviation construction projects. These include the continual expansion of current projects, the wide variety of stakeholders involved, the multiple activities and functions, the tight time schedules, the special requirements of specifications and systems, the high level of security required the mission of the country and the economic returns.

In a study conducted by [3] which investigated the risks and their consequences in the context of Saudi Arabian aviation construction projects, a number of projects were found to be affected by cost and time overruns. For instance, Hail Airport suffered several stops during its expansion; an additional 10% was added to the design costs of Al-Qassim Airport; and the construction of Al-Jawf Airport was started late. These consequences are common occurrences due to the mismanagement of risk.

The process of managing risk in construction, explained as 'the process of identifying and analysing programme areas and critical technical process risks to increase the likelihood of meeting cost, performance and schedule objectives' [4]. This is a vital tool to be used in avoiding the harmful consequences of risks. Risk analysis aims to determine the likelihood, severity and impact of risks [5]. In construction projects, risks are generally evaluated from two perspectives: impact (severity) and likelihood (probability) [6]. Mills [7] measures risk impact (RI) by multiplying the likelihood of occurrence of the risk (L) by the negative consequence of the risk (C) to give the following equation: $RI = L \times C$.

II. Literature Review

A number of studies have focused on the risks inherent to construction projects. However, no study has been conducted on aviation construction projects in Saudi Arabia to identify and analyse the risks. For this reason, a number of studies that highlight risks in other construction projects have been considered in this research. An important factor in considering the selection of studies for a review is the context of the studies. The prime reason for selecting a study for review was that it had been conducted in the context of Saudi Arabia. However, a number of studies from other contexts were also reviewed, some conducted in nearby locations, such as the Arabian Gulf, and others further away, such as in America. The aim in reviewing all these studies was to focus on those risks that could be associated with aviation construction projects in Saudi Arabia.

The studies conducted in Saudi Arabia, included a study by [8] in 2015 in which fifty-one consultants were interviewed. This revealed that thirty-three risks occurred that impacted construction projects in the Northern Province of the country. The most significant risks resulted from awarding the contract to the lowest bidder, changing the material types and specifications during construction, contract management, duration of contract period, and fluctuations in material prices. The authors used statistical analysis to confirm that there was agreement among the respondents' answers concerning the significance of the risks. In 2014, Ikediashi *et al*. [9] identified thirty risks that had affected infrastructure projects in the city of Jeddah. Again, statistical agreement was reached among the respondents regarding those risks that had the greatest significance. These included poor risk management planning, budget overruns, poor communication between parties, project schedule delays and poor estimation practices.

Al-Kharash and Skitmore [10] studied 112 risks inherent to public construction projects. The three categories of

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respondents in the study, namely clients, contractors and consultants, disagreed regarding the most significant risks. However, all three categories did agree that labour shortage was among the most important risks. Another study by [11] focussed on thirty-one risks from sixty-three risks identified in a literature review relating to public construction projects in Saudi Arabia. The authors found that poor tendering systems; delays in sub-contractors' work; poor qualifications, skills and experience of contractor's technical staff; poor planning and scheduling of the project by the contractor; and payment delays by the owner were the risks that had the highest impact and the greatest likelihood of occurrence. Similarly, Assaf and Al-Hejji [12] studied a number of large construction projects to investigate the risks that affected those projects. From this, seventy-three risks were identified and classified, according to their sources, into nine groups. The sources include project, owner, contractor, consultant, design, material, equipment, labour and external factors.

Arain *et al*. [13] identified forty-eight risks in a number of construction projects that were caused by inconsistencies between design and construction. The authors found that the involvement of the consultant as a designer, the communication gap between the contractor and the designer, insufficient detail in the working drawings, lack of coordination between parties and lack of personnel in the design firms were among the top risks. In 1999, [14] conducted a study to investigate the risks associated with public utility projects in the country. The findings identified sixty risks believed to affect these projects. The authors statistically calculated the following five risks to be among the most significant: cash flow problems faced by the contractor, difficulties by the contractor in financing the project, difficulties in obtaining work permits, the tendering system (where the lowest is chosen) and payment delays. However, disagreements among the participants, and particularly between clients and contractors, resulted in blaming and possibly affected identification of the risks.

A study by [15] identified seventy-three risks associated with large construction projects across the country. This study is considered one of the first to focus on risks in the context of Saudi construction and it is frequently cited in the literature. These authors found that the financial group of risks affect construction projects most significantly in the country. Furthermore, the contractors blamed the consultants for delaying approvals and payments and for changes made to the design. However, no statistical test was conducted to determine differences among the views of the various groups.

Three studies have investigated risks inherent to the construction industry in three other Arabian Gulf countries, namely, United Arab Emirates (UAE), Oman, and Kuwait. A large study was conducted in 2008 in the UAE by [16]. This study identified forty-two risks related to construction projects and classified these into two major groups according to their sources, namely internal risks and external risks. The study survey included a range of construction practitioners in the UAE, including owners, designers, contractors and consultants. From the results, the most significant risks causing time delays and cost overruns were inflation, tight schedules by owners, poor performance by subcontractors, delays of material supply by suppliers and design changes by owners. Alnuaimi and MOHSIN [17] investigated the risks inherent to construction projects in Oman during two different periods, namely 2007/8 and 2009/10. The study did not specify the method used for collecting data from participants, who represented the clients and consultants. It also failed to include the contractors' views about the risks faced, which would have enhanced the study and made the results more comprehensive. In Kuwait, Kartam and Kartam [1] interviewed thirty-one contractors who had been involved in the country's construction industry for a long time, and identified twenty-six risks associated with construction projects in Kuwait. Here, financial failure, payment delays, labour, materials and equipment availability, defective design and coordination with subcontractors were the most important risks according to the respondents.

Similar studies, conducted in the Middle East, Asia, Africa, Europe and America, were also included in the review. From all the studies reviewed, the authors of the current study identified fifty-four risks, classified into three groups, external, internal and acts of God, which could be associated with aviation construction projects in Saudi Arabia. These risks were identified from the literature and from interviews with a number of project managers working for the General Authority of Civil Aviation (GACA).

Hence, the objective of this paper is to assess the importance of these fifty-four risks identified by the authors as being associated with aviation construction projects in Saudi Arabia, and to take into account the probability of the occurrence and the impact of each risk. The paper will also compare the results generated with the results of similar studies conducted in different contexts, yet with its greatest focus on the Saudi Arabian context.

III. Methodology

After identifying fifty-four risks from the literature described above, a questionnaire was designed to analyse these risks. The questionnaire aimed to discover the importance of these identified risks by calculating the potential impact and the probability of occurrence of each risk. The questionnaire consisted of two main parts. The first part aimed to obtain information about the respondents, including their experience, roles and positions. The second part of the questionnaire dealt with the analysis of risks by asking three questions about each risk. These included the existence of the risk in GACA projects, the degree of probability of such an occurrence, and the potential impact of the risk. The study deployed a five-point Likert scale and asked the respondents to select the degree of impact and the probability of occurrence of each risk, where 1 = very low, 2 = low, 3 = medium, 4 = high and 5 = very high.

The questionnaire was distributed to ninety-five respondents grouped into three categories, clients, contractors and consultants. Since the authors decided to choose respondents who had dealt with GACA projects, especially the contractors and consultants, a non-probability sample was chosen. This approach is recommended when the researcher intends to select respondents based on certain criteria [18].

Of the ninety-five questionnaires distributed, fifty-four useable questionnaires were returned and analysed as summarised in Table I below.

TABLE I: THE QUESTIONNAIRE RESPONDENTS

Category	Client	Contractor	Consultant	Total
Distributed questionnaires	45	25	25	95
Returned questionnaires	34	17	19	70
Usable questionnaires	29	12	13	54

The analysis of the results generated from the questionnaires was undertaken as follows:

A. Significance of Risks

The data analysis was carried out using Microsoft Excel. As suggested by [7], the risk importance (RI) was calculated by multiplying the probability of occurrence of risk (P) by the negative impact (I) of the risk, as shown in the following equation:

$$RI = P \times I$$

B. Significant Differences among Respondents

The one way ANOVA test was employed in this study as it tests the statistical difference among groups of respondents when there are three or more groups [19]. This test works by testing the null hypothesis against the results of the three identified groups of respondents. All respondents were asked the same questions, namely they had to rank the impact and probability of the occurrence of each risk according to a five-point Likert-scale. The null hypothesis was formulated as follows:

H0: There is no significant difference among the three groups of respondents (client, contractor, and consultant).

With risks that are found to have a statistical difference, a different test is suggested, namely the Bonferroni correction [20]. This is based on a series of t-tests carried out between two groups to determine where the significant difference exists.

IV. RESULTS AND DISCUSSION

This section deals with the results from analysing the questionnaires, and discusses these results against the results from similar studies. The section is in two parts, covering the two parts of the questionnaire: first, the general information about the respondents and second, the importance of the risks.

A. General Information about Respondents

Out of the fifty-four usable questionnaires, the number of respondents who represented GACA (as the client) was twenty-nine; there were twelve contractors and thirteen consultants. The client respondent category was further divided into two subcategories according to roles. Here project managers represented 24% of the overall respondents and project engineers 28%. Table II, below, summarises the results from the first section of the questionnaire, and includes the role, experience and educational background of the respondents.

TABLE II: THE QUESTIONNAIRE RESPONDENTS

Category	Respondents number	Percentage
Role		
Client –Project Manager		24 %
Client – Project Engineer		28 %
Designer		13 %
Contractor		22 %
Consultant		11 %
		100 %
Years of Experience		
Less than 5 years	11	
5-15 years	28	
16 to 25 years	10	
More than 25 years	5	
Educational Background		
Architecture		33 %
Civil Engineering		31 %
Mechanical Engineering		15 %
Electrical Engineering		17 %
Other		4 %

B. Importance of Risks

The fifty-four identified risks were assessed in relation to their importance in GACA projects. The probability (P) and impact (I) were calculated, multiplied and ranked in order to determine the importance (RI) of each risk associated with GACA projects. This ranking was according to the opinions of the three groups of respondents as shown in Table III.

The results presented in Table III are the results of multiplying the mean scores of each risk's probability of occurrence by its impact, divided by 5, because a scale of 1-5 (Likert) has been used in the questionnaire to assess the probability of occurrence and impact of each risk (with 1 the lowest and 5 the highest score).

Table III also shows three levels of risk—internal, external and acts of God—and 11 classifications, including client-, designer-, contractor-, subcontractor-, and consultant-related risks at the internal level. The external level includes political, social, financial, and environmental risks. Natural phenomena and weather issues are included in the category acts of God. A similar study by [16] looked at the risks inherent in the UAE construction industry. This study also used the source of the risks to identify risk levels and classification. However, the difference between the classification introduced by that study and the one by the study is that, the authors of this study introduced a new level of risks, which is Acts of God. A study by [21] investigating the risks in construction projects in Egypt also used the concept of risk levels.

After conducting a descriptive analysis, which included the mean values, standard deviations and ranking, ten risks were found to be the most important according to the opinions of the respondents. The authors assumed that for a risk to be significantly important it needed to have a mean value score equal to or greater than 3, because this number is almost equivalent to the medium score on the Likert1–5 scale used in the questionnaire. Table IV summarises those ten risks and the level and category of risk where each risk belongs.

TABLE III: THE IMPORTANCE OF RISK IDENTIFIED

	Number of Respondents	Impact	Rank	Probability of occurrence	Rank	Importance	Rank
1- Internal Level							
A) Client related							
Payment Delays	44	3.91	13	3.75	7	2.97	11
Setting tight schedule by client	36	3.78	20	3.83	3	2.93	13
Inappropriate intervention by client	38	3.68	27	3.66	15	2.81	18
Design changes by client	47	4.11	6	3.89	2	3.34	2
Inadequate scope	26	3.69	25	3.5	22	2.63	26
Site access delays	35	3.63	34	3.4	28	2.51	33
Contract breaching by client	20	3.6	39	3.3	34	2.48	35
Client financial failure	13	3.46	46	2.58	52	1.88	53
Lack of experience of client	23	3.61	37	3.74	8	2.83	17
Obtaining / issuing required approval	41	3.9	15	3.73	9	3	10
Issue of sustainability	19	3	54	2.79	50	1.89	52
Inadequacy of requirements	22	3.41	48	3.23	39	2.34	41
Poor coordination	36	3.64	31	3.39	30	2.56	30
Changing demands	39	3.69	25	3.67	12	2.88	15
B) Designer related							
Design errors	43	4.02	8	3.67	12	3.01	9
Incomplete design	26	4.12	5	3.65	16	3.08	6
Design constructability	13	4.31	2	3.69	11	3.17	5
Poor quality of design	26	3.85	16	3.81	4	3.02	8
Project type Know-how skills	21	4.05	7	3.81	4	3.21	4
C) Contractor related							
Poor quality of construction	37	3.92	12	3.59	18	2.94	12
Lack of experience of contractor	34	3.82	18	3.5	22	2.76	22
Contractor financial failure	28	3.68	27	3.29	36	2.54	32
Contractor low or poor work productivity	35	3.63	34	3.4	28	2.55	31
Errors during construction	43	3.81	19	3.44	26	2.73	23
Accidents and safety	36	3.44	47	3.25	38	2.34	41
Quality and control assurance	33	3.36	50	3.27	37	2.34	41
Contractor breaching by contractor	26	3.35	51	3.23	39	2.30	44
Project type Know-how skills	28	3.96	10	3.57	19	2.84	16
Inadequate risk management plan	31	3.77	21	3.52	21	2.78	21
D) Subcontractor related							
Subcontractor poor work productivity	39	3.74	22	3.49	25	2.68	24
Subcontractor breaching contract	29	3.52	44	3.21	42	2.38	38
Subcontractor financial failure	28	3.57	41	3.11	45	2.29	45
Material availability	36	3.61	37	3.22	41	2.41	37
Material quality	35	3.65	30	3.11	45	2.27	46
Project type Know-how skills	26	3.54	43	3.35	32	2.38	38
E) Consultant related							
Lack of experience of consultant	36	3.83	17	3.53	20	2.81	18
Inadequacy of specifications	36	3.64	31	3.36	31	2.58	28
Quality assurance	35	3.6	39	3.43	27	2.57	29
Project type Know-how skills	28	3.64	31	3.71	10	2.81	18
2- External level							
A) Political							
Bureaucratic problems	47	3.74	22	3.77	6	2.92	14
Threats of wars	13	3.62	36	2.77	51	2.20	48
Labour issues	46	4.22	4	3.91	1	3.39	1
Corruption	42	4.24	3	3.67	12	3.24	3
Changes of law	29	3.97	9	3.62	17	3.05	7
B) Social							
Crime's rate	9	3.56	42	2.22	54	1.67	54
Cultural differences	23	3.04	53	3.17	44	2.11	49
C) Financial							
Inflation	19	3.47	45	3.21	42	2.36	40
Currency fluctuation	16	3.31	52	2.88	49	2.04	51
D) Natural							
Poor site conditions	32	3.66	29	3.5	22	2.63	26
Pollution	20	3.4	49	2.9	48	2.06	50
3- Acts of God							
A) Natural Phenomena							
Earthquakes	12	4.33	1	2.42	53	2.22	47
Fires	26	3.96	10	3.35	32	2.67	25
Floods	33	3.91	13	3.09	47	2.46	36
B) Weather Issues							
Severe weather conditions	30	3.7	24	3.3	34	2.49	34

TABLE IV: THE TEN MAJOR RISKS IDENTIFIED BY RESPONDENTS

Category	Mean	Rank	Level	Category
Labour issues	3.39	1	External	Political
Design changes by client	3.34	2	Internal	Client related
Corruption	3.24	3	External	Political
Project type know-how skills for designers	3.21	4	Internal	Designer related
Design constructability	3.17	5	Internal	Designer related
Incomplete design	3.08	6	Internal	Designer related
Changes of law	3.05	7	External	Political
Poor quality of design	3.02	8	Internal	Designer related
Design error	3.01	9	Internal	Designer related
Obtaining/ issuing required approval	3.00	10	Internal	Client related

It is evident from the table that seven of the important risks are at the internal level and three at the external level. However, no risks regarded as Acts of God came within the top fifteen most significant risks in GACA projects. Of the ten top risks, five were in the designer related category; three were in the political category and two in the client related category.

Labour issues were ranked first, as being the risk most important to GACA projects. These problems can be attributed to the Ministry of Labour as it contributes to this issue by applying strict rules that the construction company is forced to comply with involving a decrease in the number of non-Saudi workers. It is widely recognised, and confirmed by studies in different contexts, that this risk is one of the most significant affecting construction projects. In the Saudi Arabian context, this issue has been identified by [10], [12], and [15], among others. It was also identified by [1] in Kuwait and by [22] in Jordan. However, none of these studies ranked it as the most important issue. Design change by the client was ranked as the second most significant risk. This risk appears in the majority of GACA construction projects and has a high level of impact on these projects. This risk was addressed in almost all of the interviews conducted in a 2015 study by [3]. This result was also in alignment with a number of comparable studies in different contexts. For instance, the contractor respondents in a study on large building projects in Saudi Arabia, conducted by [15], ranked this risk among the top three.

Corruption was considered the third most important risk affecting GACA projects. This issue has not been widely discussed in the literature involving Saudi construction projects, with only one study by [9] recognising this risk within the study context. In 2013, Choudhry and Iqbal [23] also identified the issue of corruption and the importance of its effects on Pakistani construction projects, ranking it as one of the top ten most important risks. The paucity of discussion regarding this risk can be attributed to the sensitivity of the subject. Project know-how skills were ranked in fourth place. This risk was added to the list of risks associated with Saudi aviation projects by one of the senior project managers working for the GACA in [3]. This risk is distinctive and has not been identified in the context of the Saudi construction industry before. It differs from the risks relating to design experience in that the designer can be 'a big name' and yet has not dealt with this particular type of project before. Similarly, design constructability (ranked fifth), has not been found among the top risks in the Saudi context before. However, the respondents ranked this risk fifth in terms of its negative impact on the GACA's projects.

Incomplete design was ranked as the sixth most important risk, with a mean value of 3.08. Delay in the start of construction is a typical consequence of the occurrence of this risk. However, the authors did not find this risk identified among the most important risks of any related studies, especially those from Saudi Arabia.

Poor quality of design and design errors were ranked as the eighth and ninth most important risks to GACA projects with mean values of 3.02 and 3.01, respectively. One of the senior project managers interviewed explained that there are a number of reasons for the occurrence of these risks. They are attributed to the designers' lack of compliance with the documented GACA design requirements, and to the lack of experience of some designers. These results do not seem to align well with what is happening in the Saudi Arabian context, possibly because there were only client respondents in the study conducted by [15] on large building projects. These respondents ranked this risk as top among the most important risks. However, contractor and consultant respondents did not consider this to be among the top risks. Obtaining or issuing of required approvals was ranked as the tenth most important risk in GACA projects. This also included the lengthy process of getting approvals issued and the slowness of owners in making decisions, as reported by [15]. Again, this risk has been widely addressed in the literature in a number of contexts. In Saudi Arabia, the respondents in a survey conducted by [14] ranked this risk as the third most important. It was ranked as the second most important risk by contractor respondents in a study conducted by [10].

Three of the 54 risks were found to be the risks of least importance to GACA projects: these were risks that scored less than two in their mean values of importance, and included the issue of sustainability (with a mean value of 1.89), client financial failure (mean value of 1.88), and crime rate (mean value of 1.67).

A further analysis of the categories of risk and the levels of each group are presented in Table V together with the ranking of these groups with respect to their importance to GACA projects according to the respondents.

TABLE V: THE IMPORTANCE OF THE CATEGORIES OF RISKS

Category	Mean	Mean	Rank
Internal	designer related risks	3.27	1
Internal	client related risks	2.91	2
Internal	consultant related risks	2.71	3
Internal	contractor related risks	2.59	4
Acts of God	Natural Phenomenon	2.56	5
Acts of God	Weather Issues	2.49	6
Internal	subcontractor related risks	2.38	7
External	environmental risks	2.37	8
External	political risks	2.36	9
External	financial risks	1.94	10
External	social risks	1.62	11

As shown in Table V, the rank of each category of risks is identified. Five categories of risk are found to be the most important categories of risk to GACA projects as these all scored 2.50 or more. These include:

1) Designer related risks

This category has been ranked as the first and most important group of risks in GACA projects. This result confirms the findings of a study conducted in the context of Saudi Arabia by [13], which listed 45 risks related to design that caused inconsistencies between design and construction. Moreover, these results match the results of similar study conducted in Florida, USA by [27], which found that the design related group of risks is the most significant among six groups of risk.

2) Client related risks

This category was ranked as the second most important category of risks in GACA projects. This result contrasts with some studies in the Saudi Arabian construction context, where contractor related risks are regarded as being of highest importance by the other parties, including the client. This has been recognised by a number of other authors, including [9], [11] and [14]. In contrast, client related risks are considered the most important category of risks in similar studies conducted in different contexts. For instance, in a study conducted by [1] in Kuwait, the client was identified as the major party causing risks in the context; however, the sample chosen for this study involved only contractors. Also, Alnuaimi and MOHSIN [17] recognised that client-related risks are the main source of delay in construction projects in Oman.

3) Consultant related risks

Although none of the risks in this category was highlighted in Table II as being among the top ten risks, this category is ranked as the third most important group of risks in GACA projects. This result could be attributed to the fact in the majority of GACA projects the designer companies are also the consultants. Since the designer related category is ranked first, it indicates that risks generated from the design are important to GACA projects. It is therefore no surprise to see the consultant-related risks category among the top five most important categories.

4) Contractor related risks

This category is ranked fourth among risks in GACA projects. This result shows a clear contrast with similar studies conducted in different contexts. In Saudi Arabia, [9]-[11] and [14] found that contractor related risks were the main category causing delays in various construction projects around the country. Likewise, [26] studied the risks inherent to the Chinese construction industry, and found that contractor related risks, coupled with owner related risks, were the most significant factors causing delays. The same conclusion was drawn by [24] in Turkey, [22] in Jordan and [25] in Iran.

C. Significant Differences between Respondent Groups

The reason for conducting this analysis was to validate statistically the respondents' opinions on the importance of the risks associated with GACA projects. Since the number of groups of participants was three (i.e. more than two), namely, the clients, the contractors and the consultants, the one-way ANOVA test was applied to statistically determine the significant differences between the opinions of the three groups. The results from conducting the one-way ANOVA test for the fifty-four identified risks' F ratio and P-values are presented in Table VI. It should be noted that if the result of the P-value for any risk is <0.05 it means that a there is a statistical difference between the results of the groups of respondents.

TABLE VI: THE IMPORTANCE OF THE CATEGORIES OF RISKS

Risk	F	P-Value
Payment Delays	1.11	0.34
Setting tight schedule by client	0.85	0.43
Inappropriate intervention by client	1.38	0.27
Design changes by client	2.12	0.13
Inadequate scope	0.66	0.53
Site access delays	1.83	0.18
Contract breaching by client	1.42	0.27
Client financial failure	1.22	0.33
Lack of experience of client	5.59	0.01
Obtaining / issuing required approval	0.20	0.82
Issue of sustainability	4.13	0.04
Inadequacy of requirements	1.20	0.32
Poor coordination	2.99	0.06
Changing demands	2.52	0.09
Design errors	1.57	0.22
Incomplete design	1.06	0.36
Design constructability	0.04	1.00
Poor quality of design	2.71	0.09
Project type know-how skills	1.08	0.36
Poor quality of construction	2.86	0.07
Lack of experience of contractor	2.34	0.11
Contractor financial failure	2.18	0.13
Contractor low or poor work productivity	0.14	0.87
Errors during construction	2.66	0.08
Accidents and safety	0.99	0.38
Quality and control assurance	0.80	0.46
Contractor breaching by contractor	3.02	0.07
Project type know-how skills	0.69	0.51
Inadequate risk management plan	0.24	0.79
Subcontractor poor work productivity	1.89	0.16
Subcontractor breaching contract	2.98	0.07
Subcontractor financial failure	2.60	0.09
Material availability	0.94	0.40
Material quality	1.43	0.25
Project type know-how skills	0.43	0.66
Lack of experience of consultant	0.58	0.56
Inadequacy of specifications	2.25	0.12
Quality assurance	0.05	0.95
Project type know-how skills	0.82	0.45
Bureaucratic problems	4.70	0.01
Threats of wars	0.09	0.91
Labour issues	0.81	0.45
Corruption	0.11	0.89
Changes of law	0.46	0.63
Crime rate	0.20	0.82
Cultural differences	1.30	0.30
Inflation	0.09	0.91
Currency fluctuation	0.47	0.64
Poor site conditions	1.31	0.29
Pollution	0.04	0.97
Earthquakes	0.24	0.79
Fires	1.06	0.36
Floods	0.83	0.45
Severe weather conditions	0.35	0.71

Statistical differences between groups were found to occur only with three risks (highlighted in red). This means the P-value of these risks was <5%, as this test was performed with significant P-value 5% (0.05). These three risks are, lack of client experience (P=0.01<a=0.05), the issue of sustainability (P=0.04<a=0.05), and bureaucratic problems (P=0.01<a=0.05). A further test will be used to

locate the differences among the three groups of respondents. However, none of the risks included among the ten most important risks to GACA projects showed a statistical difference between the three groups of respondents.

A post hoc Bonferroni t-test was used to determine where the significant difference exists among the three groups of respondents [20]. The results of the test conducted are presented in Table VII below.

TABLE VII: THE RESULTS OF THE POST HOC TEST

Risk	Comparisons of means values of respondents' groups	P-value	Is P-value < 0.0167?
Lack of experience of client	Client (3.89) Contractor (2.30)	0.019	
	Client (3.89) Consultant (2.47)	0.05	
	Contractor (2.30) Consultant (2.47)	0.71	
Issue of sustainability	Client (2.71) Contractor (1.40)	0.07	
	Client (2.71) Consultant (0.06)	0.04	
	Contractor (1.40) Consultant (0.60)	0.22	
Bureaucratic problems	Client (2.42) Contractor (3.55)	0.011	√
	Client (2.42) consultant (3.25)	0.04	
	Contractor (3.55) Consultant (3.25)	0.50	

Regarding the risk involving lack of experience of the client, a significant difference is shown between the responses of the clients (3.89) and the contractors (2.30), although the P-value (0.01p) is less than 0.167 and therefore does not meet the criteria of the Bonferroni test. Similarly, the issue of sustainability risk failed to meet the criteria test. It is obvious from the mean values scored by the respondents of the two groups that the score for the client group of respondents for this risk is low (2.71) compared to the consultant group (0.60). However, since the respondents from the client group scored this risk of bureaucratic problems lower that respondents from the two other groups did the result of one comparison meet the criteria of the test conducted, it confirms that the statistical difference lies in the client group of respondents.

V. CONCLUSION

The field of aviation construction projects in Saudi Arabia is still in need of further research regarding risk allocation. This study has provided that field with an analysis of the risks believed to impact on these projects. Typical results regarding the ten most important risks to GACA projects do not seem to be in alignment with the Saudi Arabian construction context. Only three of the most important risks identified in this research do appear to match the risks recognised by other research in the Saudi Arabian context. These include labour issues, design changes by the client, and obtaining or issuing required approval. These particular risks are well recognised and are highly ranked in the Saudi context by a number of other authors.

The study makes it clear that risks relating to designers, clients, and consultants are all extremely important. While all these groups play an important role in managing risk, it is worth noting that the roles of designer and consultant are frequently played by the same entity. This trend was confirmed in the course of this study.

Statistical tests revealed that there was no significant difference regarding most risks between various groups of respondents, namely: clients, contractors and consultants. Only three risks showed statistical differences between groups, and these were dealt with by using a post hoc test that locates such differences. These risks include, lack of experience of client, issues of sustainability, and bureaucratic problems.

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