Risk examination in the Arabian Gulf Region construction industry from international firms' insights

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Abstract: Risk is an ever-present event on any construction project. International projects are more challenging than domestic projects as they experience a wider range of risks. With the growing amount of construction in the Arabian Gulf Region (AGR) and many more international firms attempting into new international markets, limited research exists to identify and evaluate the impact of risks on projects in this area. This paper provides an overview of the risk associated with international projects. Seventy-four risks encountered in the AGR were identified and their impact on cost and schedule performance metrics was evaluated. Projects for which cost and schedule were both impacted were identified and the correlation between cost and schedule was compared. Some factors were found to have significantly higher impact on cost or schedule. An international risk assessment tool (IRAT) was developed to help multinational firms enhance their visual ability to pre-emptively identify, address, and mitigate risks.

Keywords: AGR; Arabian Gulf Region; international construction; multinational firms; risks; assessment tool.


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1 Introduction

The risk is “a consideration in the process of a construction project whose variation results in uncertainty in the final cost, duration and quality of the project” (Kartam and Kartam, 2001). Moreover, some authors refer to construction risk as a measure of the probability of occurrence and impact of not achieving a defined project goal (Kerzner, 2009). No matter how risks are defined in the construction industry, it is always beneficial to identify and control them through the life cycle of any construction project to minimise their adverse influence on the success of projects.

Several authors have investigated risks specific to the international construction market including socio-cultural, economic, political, regulatory restrictions, contractual arrangements, and foreign exchange risks to name a few (Baloi and Price, 2003; Chua et al., 2003; Chan and Tse, 2003; Ashley and Bonner, 1987). From the Middle East and North African (MENA) projects perspective, numerous studies focused on identifying risks usually encountered by local (as opposed to multinational) construction firms. Tumi et al. (2009), Sweis et al. (2008), El-Razek et al. (2008), El-Sayegh (2008), Assaf and Al-Hejji (2006), Koushki et al. (2005), Mezher and Tawil (1998) and others
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Cited various significant factors that contributed to an increase in the project’s schedule and cost in countries like Saudi Arabia, Kuwait, UAE, Jordan, Lebanon, Egypt, and Libya. All of them concluded that there are several factors [outlined in detail in the following section] grouped into 10 different risk categories, which lead to poor performance in terms of schedule and cost in these countries. However, there are little to no detailed studies in the literature that focus on identifying risks encountered by multinational firms executing construction projects in the AGR. Only one such study was conducted by El-Sayegh (2008) who examined risks encountered by multinational firms in the UAE construction market, and found that they do not differ from those identified above. Given the large number of multinational firms who are interested in executing projects in the AGR, it is imperative to conduct a more comprehensive analysis of the unique characteristics of that region and the resulting risks to multinational firms.

2 Risk identification

The initial task of the research methodology was targeted toward identifying the top risks encountered in AGC construction industry. The identified risks will then be incorporated in the comprehensive survey that will be used in the data collection stage for further evaluation. First, risks factors were identified through an extensive review of literature as follows: international construction markets (Ozorhon et al., 2007, 2008; Dikmen and Birgonul, 2006; Gunhan and Ardit, 2005a, 2005b; Chan and Tse, 2003; Baloi and Price, 2003; Hastak and Shaked, 2000); the Asian construction market (Ling and Poh, 2008; Zou et al., 2007; Sambasivan and Soon, 2007; Alaghbari et al., 2007; Andi, 2006; Chua et al., 2003) and studies on construction risks encountered in specific MENA countries (Tumi et al., 2009; Sweis et al., 2008; El-Razek et al., 2008; El-Sayegh, 2008; Elyamany et al., 2007; Assaf and Al-Hejji, 2006; Zaneldin, 2006; Abdul Rashid and Bakarman, 2005; Koushki et al., 2005; Al-Reshaid et al., 2005; Goda, 1999; Mezher and Tawil, 1998). Second, standardised construction contracts from different perspectives such as design and construction contracts that are currently in use at construction projects in the AGC region were examined and risks on such contracts were identified with the help of employees at multinational companies currently working in the region. Finally, an open-ended questionnaire asked 222 multinational construction companies to list the top five risks they have encountered in the AGR construction industry. The respondents company origin was mostly from the US (59%), their company role was mainly construction management firm (41%) and designer firms (36%), and their projects were predominantly located in the UAE (41%) or Kuwait (36%). Figure 1 shows the open-ended questionnaire respondents’ characteristics. It was concluded from the open-ended questionnaire that insufficient scope definition comes in the first place with regards to the top five risks encountered in AGR (shown in Table 1).

The risk identification task resulted in 74 potential risk factors which have been classified into two categories

- external risks (outside the company’s control) with twenty-seven (27) risks
- internal risks (within the company’s control) forty-seven (47).
Table 1   Top five risks encountered in AGR

<table>
<thead>
<tr>
<th>Risk</th>
<th>Rank</th>
<th>% of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient scope definition</td>
<td>1</td>
<td>45.5%</td>
</tr>
<tr>
<td>Inadequate schedule</td>
<td>2</td>
<td>41%</td>
</tr>
<tr>
<td>Defective design documents</td>
<td>3</td>
<td>36%</td>
</tr>
<tr>
<td>Subcontractors performance</td>
<td>3</td>
<td>36%</td>
</tr>
<tr>
<td>Change orders</td>
<td>4</td>
<td>32%</td>
</tr>
<tr>
<td>Authorities and regulations</td>
<td>4</td>
<td>32%</td>
</tr>
<tr>
<td>Unforeseen site conditions</td>
<td>5</td>
<td>18%</td>
</tr>
</tbody>
</table>

Each of the two categories was further subcategorised to five (5) for external risks:

- political
- economic
- legal
- social
- natural.

For internal risks:

- design
- financial
- construction
- management
- maintenance.

The risks classification followed in this study was carefully chosen to ensure that similar behaviour risks are grouped together in a certain category and analysed independently. Figure 2 outlines in detail the 74 factors that lead to cost overruns and schedule delays in the form of a fishbone diagram. There are 27 internal risks (top half) and 47 external (bottom half) risks.
Based on the risks identification task; a comprehensive survey was developed to quantitatively evaluate each risk factor from the perspective of multinational firms working on AGC projects. The participants were requested to rate the seventy-four (74) identified risks’ relative frequency; as well as, impact on project cost and schedule in a six-point rating score. A total of 280 multinational construction firms associated with the AGC construction industry were contacted; resulted in a 43.6% response rate for 122 completed surveys. A listwise deletion was implemented, where any case with missing data was excluded from the analysis resulted in 66.4% (i.e., 81 out of 122) completed surveys. The participants consisted mainly of designer/consultant (56%) and project manager (36%), and were from USA (70%) and UK (24%). Most of the projects used the lump sum as a financial contract type (83%). In most cases, companies were involved during the construction phase (66%). Figure 3 outlines the characteristics of the comprehensive survey and the Venn diagram in Figure 4 illustrates the distribution of the eighty-one (81) projects. The analysis presented in this paper was performed on the fifty-eight (58) impacted projects (intersection in the Venn provided in Figure 4) that experienced both cost overruns and schedule delays.

3 Data analysis

3.1 Risk prioritisation

Once the risk factors were identified, descriptive data analysis was employed to determine the degree of significance of each of these factors both cost-wise and schedule-wise. The significance of each risk factor was calculated in terms of its frequency ($\alpha$) and degree of impact ($\beta$). In the context of this research, the frequency and degree of impact are both defined on a six-level scale (1 = never or no impact, 2 = seldom or negligible,
3 = sometimes or minor, 4 = often or moderate, 5 = usually or significant, and 6 = always or extreme). Risk Significance (RS) can be expressed as a function of both attributes as follows (Shen et al., 2001):

\[ RS = f(\alpha, \beta) \]

Each risk factor resulted in two risk significance scores: one for the cost and the other for schedule. Cost risk significance, denoted as \( RS_c \), is obtained for each project \( i \) by multiplying the frequency of the factor by its impact on cost through the following equation:

\[ RS_{c,i} = \alpha \beta_{c,i} \]

Schedule risk significance, denoted as \( RS_s \), is obtained for each project \( i \) by multiplying the frequency of the factor by its impact on schedule and can be written as follows:

\[ RS_{s,i} = \alpha \beta_{s,i} \]

A risk significance score was obtained for each of the 74 risk factors on each project. An average significance score, also called risk index, RI, was then obtained for each factor by averaging scores from all 58 projects through the following equations: (Shen et al., 2001)

\[ RI_{c,j} = \frac{\sum_{i=1}^{58} RS_{c,i,j}}{58} \quad \text{and} \quad RI_{s,j} = \frac{\sum_{i=1}^{58} RS_{s,i,j}}{58} \]

where \( RI_{c,j} \) is the cost risk index for risk factor \( j \) and \( RI_{s,j} \) is the schedule risk index for risk factor \( j \).

The resulting cost risk indices and schedule risk indices are then prioritised based on their values to provide a framework for decision making related to risk allocation on projects in the AGR.

Table 2 displays the top 10 most significant and least significant risk factors based on their cost and schedule risk indices.

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>( RI_{c,j} )</th>
<th>Risk factor</th>
<th>( RI_{c,j} )</th>
<th>Risk factor</th>
<th>( RI_{s,j} )</th>
<th>Risk factor</th>
<th>( RI_{s,j} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>MG1</td>
<td>20.10</td>
<td>MG1</td>
<td>18.34</td>
<td>N1</td>
<td>1.64</td>
<td>N1</td>
<td>1.5</td>
</tr>
<tr>
<td>E4</td>
<td>16.09</td>
<td>C12</td>
<td>18.00</td>
<td>C3</td>
<td>3.02</td>
<td>E3</td>
<td>2.98</td>
</tr>
<tr>
<td>F4</td>
<td>15.60</td>
<td>N2</td>
<td>16.98</td>
<td>S2</td>
<td>3.22</td>
<td>S2</td>
<td>3.10</td>
</tr>
<tr>
<td>P1</td>
<td>14.36</td>
<td>P1</td>
<td>15.47</td>
<td>L5</td>
<td>3.89</td>
<td>C2</td>
<td>3.20</td>
</tr>
<tr>
<td>E5</td>
<td>14.28</td>
<td>E5</td>
<td>15.32</td>
<td>N3</td>
<td>3.96</td>
<td>E1</td>
<td>3.46</td>
</tr>
<tr>
<td>MG6</td>
<td>13.91</td>
<td>C4</td>
<td>15.24</td>
<td>S4</td>
<td>4.05</td>
<td>L5</td>
<td>3.47</td>
</tr>
<tr>
<td>N2</td>
<td>13.72</td>
<td>C6</td>
<td>15.05</td>
<td>F7</td>
<td>4.12</td>
<td>F8</td>
<td>3.5</td>
</tr>
<tr>
<td>D3</td>
<td>13.70</td>
<td>C8</td>
<td>14.79</td>
<td>L8</td>
<td>4.22</td>
<td>F7</td>
<td>3.67</td>
</tr>
<tr>
<td>C12</td>
<td>13.41</td>
<td>F4</td>
<td>14.13</td>
<td>F2</td>
<td>4.53</td>
<td>S4</td>
<td>3.71</td>
</tr>
<tr>
<td>P2</td>
<td>13.40</td>
<td>D1</td>
<td>13.77</td>
<td>F6</td>
<td>4.60</td>
<td>E2</td>
<td>4.10</td>
</tr>
</tbody>
</table>
Figure 3 Characteristics of the comprehensive survey

The results presented in this table show that ‘Insufficient definition of scope’ (MG1) had the most influence on cost overruns and schedule delays while ‘Pestilence’ (N1) had the least influence.

3.2 Correlation

After ranking and prioritising the risk factors that highly affect project cost and schedule, it was beneficial to investigate the correlation between the impact of a risk factor on project cost vs. its schedule.
The correlation coefficient measures the strength of the linear relationship between two variables. In this study, the first variable is the impact of a risk factor on project cost and the second variable is the impact of the same risk factor on the project schedule. A positive correlation coefficient indicates that one variable increases with the other and a negative sign indicates that one variable decreases as the other increases. According to Cohen, the strength of the relationship between two variables can be evaluated based on its correlation coefficient as follows: correlation coefficients between 0.1 and 0.29 represent a small association, coefficients between 0.3 and 0.49 represent a medium association, and coefficients of 0.5 and above represent a strong association (Statistics Solutions, 2017). The results of this study show that all 74 correlation coefficients are positive with ‘Latent Design Defect’ (D4) having the highest correlation coefficient (0.98) and ‘Currency Exchange Rate’ (E2) having the lowest correlation coefficient (0.23). Table 3 shows that the majority of the risk factors are strongly correlated with correlation coefficients greater than 0.5.

To draw conclusions about populations and not just samples, a correlation test was performed. This statistical method tests if the correlation truly exists or was detected due to a random sampling error. The null hypothesis tested under this test states that the population correlation is zero while the alternative hypothesis states that the population correlation is different from zero. The Bonferroni correction was used to account for multiple comparisons. The results of this analysis showed that all p-values were significant, thus indicating that cost impact and schedule impact are positively correlated with a non-zero population correlation coefficient.

<table>
<thead>
<tr>
<th>Strong association (65)</th>
<th>Moderate association (5)</th>
<th>Weak association (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D4, D5, L8, C13, MN1, L2, D3, P4, MN4, D6, MG8, MN7, N3, F5, P2, C2, MG5, F4, C8, S1, MG6, MG3, P5, MN3, MG1, L5, N4, L6, MG2, MN5, P1, MG4, S3, P6, D2, C11, D1, C10, L1, C14, L4, C3, L7, C9, C1, P3, MG9, F1, F6, C5, F2, C4, F8, MG11, S4, MG10, L3, C6, MG12, C7, E5, E1, C12, MG7, MN6</td>
<td>N2, MN2, E4, S2, F7</td>
<td>N1, F3, E3, E2</td>
</tr>
</tbody>
</table>
3.3 Factor significance on cost and schedule

The average impact on both cost and schedule were computed for each of the 74 factors. Table 4 shows the factors that had a higher average cost impact and those that had a higher average schedule impact.

**Table 4** Classification of factors based on their higher average impact

<table>
<thead>
<tr>
<th>Higher average cost impact (47)</th>
<th>Higher average schedule impact (27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D5, L8, C13, L2, D3, MN4, MG8, MN7, F5, P2, MG5, F4, S1, MG6, P5, MN3, MG1, L5, N4, MG2, MN5, MG4, L1, C14, L4, C3, L7, P3, F1, F6, F2, F8, MG11, S4, L3, C7, E1, MG7, MN6, MN2, E4, S2, F7, N1, F3, E3, E2</td>
<td>D4, MN1, P4, D6, N3, C2, C8, MG3, L6, P1, S3, P6, D2, C11, D1, C10, C9, C1, MG9, C5, C4, MG10, C6, MG12, E5, C12, N2</td>
</tr>
</tbody>
</table>

By simply comparing averages, 74 factors were found to have a higher impact on cost and 27 factors were found to have a higher impact on schedule.

A statistical test was then conducted to test whether there exists a significant difference between the impact on cost and on schedule for each factor. In other words, a test was needed to check if the average cost impact of the 47 factors is statically higher than their impact on schedule and whether the schedule impact of the 27 factors is statistically higher than their impact on cost. Due to the ordinal nature of the data and the dependency between the samples, the non-parametric Mann Whitney U test was used. This test is used to check whether two samples are derived from the same population using a significance level of 0.05. However, since 74 independent comparisons were performed, the Bonferroni correction was used to counteract the problem of multiple comparisons.

The results showed that while there is no significant difference between the impact of most factors on cost or schedule, seven factors did have significant p-values and their impact was higher on one of the project criteria. These seven factors are reported in Table 5.

4 International risk assessment tool

The culminating effort of this research on the evaluation of AGR risk factors was the international risk assessment tool (IRAT). The IRAT was created using Microsoft Excel 2013, and was designed to be user-friendly and intuitive, quickly allowing multinational firms to assess risks for their projects in the AGR.

With this tool project managers are able to identify potential risks they might encounter on their project and visualise their potential impact by inputting the frequency and expected impact of risk factors. The IRAT is comprised of various tabs including: introduction, description of the 74 risks, risk assessment, risk mapping, and database. The introduction tab introduces the tool and emphasises the importance of risk assessment on international projects. In this tab, the user will provide specific information for the project on which IRAT is being used. A sample of this tab is shown in Figure 5.
Table 5  Factors with higher impact on either cost or schedule and the rationale behind it

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>C/S**</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>MG9: Submittals and approvals</td>
<td>S</td>
<td>The cycle of paperwork that started as soon as the construction begins between the contractor and the designer to control the approval and make sure that the contract is strictly followed by the contractor. Can take more time than anticipated and affects the progress of work</td>
</tr>
<tr>
<td>C6: Materials, equipment, or work furnished by other contractors</td>
<td>S</td>
<td>When another contractor is responsible for delivering certain materials or equipment for the project, failure to follow the master schedule precisely has a substantial affect the schedule</td>
</tr>
<tr>
<td>C12: Inadequate schedule</td>
<td>S</td>
<td>If the schedule was not well prepared; having false resources loaded with incorrect relationship were used; this can significantly affect the project schedule</td>
</tr>
<tr>
<td>E4: Price Inflation</td>
<td>C</td>
<td>If the prices for material or equipment escalate during the construction stage, the cost of the project will increase</td>
</tr>
<tr>
<td>E3: Fund Transfer Fees</td>
<td>C</td>
<td>The fund transfer fee should be accounted for in the contractor’s bid price and can, therefore, affect the cost of the project</td>
</tr>
<tr>
<td>E2: Currency Exchange Rate</td>
<td>C</td>
<td>The fluctuation of currency will influence the project cost so the contractor should account for the exchange rate in the total price</td>
</tr>
<tr>
<td>E1: Tax Rate</td>
<td>C</td>
<td>Multinational firms are required to pay income taxes (for example) for their original home countries. USA’s contractors working in the AGR have to add these amounts to their project cost</td>
</tr>
</tbody>
</table>

**Here C indicates an average higher impact on cost and s an average higher impact on schedule.

Figure 5  IRAT – Project information (see online version for colours)

Next, a detailed description of the 74 factors and their categories and sub-categories is outlined in the description tab. The risk assessment tab in IRAT consists of two sections. The first section requires users to input the expected frequency and impact of each of the 74 factors. The second section displays risk assessment information to the user. The IRAT will visually display the severity of each factor and whether cost or schedule is
more impacted. An example of how to use the IRAT and what output to expect is illustrated in Figure 6.

**Figure 6** IRAT output display (see online version for colours)

![IRAT output display](image)

As shown in Figure 6, the colour and the diameter of each circle under the ‘cost’ and ‘schedule’ columns are an indication of the severity of each factor. IRAT will also generate the risk mapping matrix (RMM) to allow a closer examination of the overall severity of risk factors. An example of IRAT RMM is shown in Figure 7.

The cells will contain an indication of the risk factor; P1, for instance, is an abbreviation for War Threat, a political risk. Each of these risks is linked to another sheet for a full description of the designation as shown in Figure 8.

IRAT can also serve as a database for the company to use on the future project. The user can click on the ‘Copy to Database’ button and the information from Figures 5 and 6 will be copied to a separate spreadsheet and saved within the master IRAT spreadsheet. In addition, IRAT has the option to summarise and convert the generated results and RMM into a PDF by clicking the ‘save as PDF’ button.

The ‘Project Information’, ‘Risk’, ‘impact’, ‘Fill Matrix’, ‘Clean Matrix’ buttons – among others are macros written into the IRAT’s MS excel file that run the analysis for the user and show the severity of each risk factor and its impact on either cost or schedule and map those risks into the RMM.

All the results described in this paper can be derived by using this tool. The tool could be also used as a database where multinational firms can store the history of risk assessment on their projects. The project information, project risks’ frequency, impact and severity will be stored and aggregated project after project in a separate sheet to serve as a historical database for the company for future projects. This could also serve as a data collection tool for future researches.
5 Conclusion

As the Arabian Gulf Region (AGR) remains a strategically important area of the world, the construction industry in that area has been experiencing an unexpected boom. The paper attempted to investigate the myriad of risk factors that affect project cost and schedule. Seventy-four factors were identified and grouped into 10 categories. A risk index was then established for each factor where ‘Insufficient definition of scope’ (MG1) was found to have the most influence on cost overruns and schedule delays while ‘Pestilence’ (N1) had the least. A correlation analysis was then performed to show that the impact of a risk factor on cost is positively correlated to its impact on schedule. A statistical test was also performed to check if there was any statistical significance between the impact of each factor on cost and schedule. The results showed that three
factors had a significantly higher impact on schedule and four other factors showed significantly higher impact on cost. Finally, the IRAT tool was developed to summarise the findings of this research in a visual representation that can assist multinational firms in identifying, evaluating, and addressing risk on international projects in the AGR.

References


