RISK ANALYSIS FOR THE MAJOR FACTORS AFFECTING THE CONSTRUCTION INDUSTRY IN JORDAN

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1. INTRODUCTION

Many risks are associated with construction. The effect of any of these risks can be expressed in terms for monetary loss, property damage, personal injury or a combination. It is important to identify each risk, and find its appropriate solution. Some risks cannot be controlled, such as those due to political factors or the fluctuating exchange rates¹. In very large projects new risks emerge, adding more consideration to the project size. The liabilities need to be shared in order to encourage the proper implementation, and prompt the managers' attitude towards risk, so managers can take risk into account when selecting projects⁵.

Risk can be defined as the possibility of loss, injury, disadvantage, or destruction. This definition may cover all types of risks such as technical, cost, and schedule risks. There is also the consideration that acquisition risks such as health, safety, weather, insurance, finance, environment, and policies, are part of and often mingled with other venues of risks⁶. In general, risk management is a practice with processes and methods for managing risks in a project⁶. One of the more useful constructs of risk management is that a risk as a possibility consists of a likelihood and of consequences. This definition is derived from the elementary mathematical concept of expectation of an event. Expectation for some event is defined as the product of its probability of occurrence and its value if it occurs. The probability of occurrence depends on the managers' attitude towards risk, so managers can take risk into account when selecting projects⁵.

Risk assessment is an important task if decision-makers are provided with a reasonable method of assessing the potential gains and losses associated with any particular course of action. The risks may be unacceptable, in which case the course of action can either be rejected or a method can be found by which the risks are improved. On the other hand, the risks may be acceptable and the course of action can be pursued with or without any further improvement in the risks. When a method is devised to assess the probability and potential severity of perceived risks,
the assessment can be compared with others for alternative courses of action. Cost-benefit analysis is the usual method, but it is difficult, if not impossible, to place monetary values on all factors such as human lives and happiness.

There are many obstacles that delay smooth decision-making such as: complexity, uncertainty, and multidimensionality are examples of these obstacles. The decision maker, controlled by the decision situation, has the authority and the responsibility to act in choosing the right course of action. Construction managers with differing business experiences, education, and personal motivation can evaluate differently the identical project data. Some contractors, for example, may accept low profit margins and high risk rate in exchange for personal satisfaction and public recognition associated with prestige projects, such as high rise buildings, high-arch bridges, or enclosed stadiums.

Construction companies in Jordan are classified into five classes according to the Ministry of Public Works and Contracting Association depending on budget, assets and employees. The highest three classes are qualified to undertake all the project depending on the company classification and the project size, hence are the focus of this research. This study addressed the risks that occur in the upper three classes Jordanian construction companies. After evaluating the major risks affecting projects, contractors who play a major role in speeding or delaying the project progress were interviewed to evaluate, investigate, and analyse risks affecting the project and propose appropriate solutions.

2. METHODOLOGY

The methodology was carried out in the following order:
- Data surveying and piloting,
- Evaluating related problems using risk management definition,
- Dividing risks into five major categories,
- Questioning risks,
- Analysing risks using SPSS software,
- Ranking risks after general discussion,
- Investigating appropriate solutions,
- Issuing an internet model to present all results achieved in this study, and
- Presenting conclusions.

3. DATA SURVEY

Construction companies in Jordan are classified into five classes according to the Ministry of Public Works and Contracting Association depending on budget, assets and employees. The highest three classes undertake most of the projects and are the focus of this research.

Two different questionnaires were conducted to collect relevant data concerning major risk factors affecting the construction industry in Jordan (See Appendix I and II). The first questionnaire was divided into five major categories. These were: administrative, financial, resources, manpower, and technical. Numerous questions, over seventy in total, were adopted for each category to present full description of the major risks influencing project behavior.

The first questionnaire was sent to all companies of the first class, second class, and third class. This represented a 100% sample size. Table 1 show the total number of companies and those who responded.

<table>
<thead>
<tr>
<th>Class Type</th>
<th>Number Sent</th>
<th>Number Replied</th>
<th>Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Class</td>
<td>49</td>
<td>37</td>
<td>75.5 %</td>
</tr>
<tr>
<td>Second Class</td>
<td>50</td>
<td>40</td>
<td>80.0 %</td>
</tr>
<tr>
<td>Third Class</td>
<td>104</td>
<td>92</td>
<td>88.5 %</td>
</tr>
</tbody>
</table>

This questionnaire was designed to analyse the risks that may face the contracting companies in the construction industry. Risks proposed in this questionnaire were chosen after long discussions and meetings with those involved in the construction area, project management, and statistical analysis. Each question was given four choices depending on the importance degree of the risk. Grade 4 indicates that the risk is very important and decreasing value indicates that the risk is less important. The minimum grade for each risk is 1 and it indicates that the risk is not important at all.

After the first questionnaire was analysed, a second questionnaire addressing the highest ranked risks in each category was sent again to the companies to suggest proposed solutions. This aimed at obtaining feasible solutions for the risks addressed in the first questionnaire.

4. DATA ANALYSIS

In order to quantitatively demonstrate the relative importance of the risks to the construction industry, a weighing approach was adopted. The risk with higher contribution rank was assigned the largest score, while risk with the lowest contribution was given the smallest score. As risks have been ranked in four grades, four weights were applied. For the purpose of simplicity, the four grades in the contribution rank were also used as four weights to indicate the importance of the contribution between risks. Final score of each risk is equal to the summation of the grades times the number of the contractors who assigned the grade. The results were tabulated for each company class individually.

To investigate the relationships between the company classes and problems that may occur, SPSS Software was used to analyse scores obtained from the first questionnaire. Table 2 discusses the descriptive statistics for the respondent answers of all company
classes, their means and standard deviations. The first class companies’ grand mean was (3.2932) which is between fairly important and important. The largest mean in this category was for the respondent answers in the administrative problems (3.3884) with a standard deviation (0.3397), while the smallest mean was for the resources aspects (3.1662) with a standard deviation (0.4124). The grand mean for the respondent answers in the second class companies was (3.2880) which is between fairly important and important. The largest mean in this category was for the respondents’ answers in the financial problems (3.3639) with a standard deviation (0.3900), while the smallest mean was for the manpower problems (3.3068) with a standard deviation (0.5648). As for the third class companies’ grand mean was (2.9843) which is between somewhat important and fairly important. The largest mean in this category was for the respondent answers in the technical problems (3.1196) with a standard deviation (0.4009), while the smallest mean was for the administrative problems (2.8470) with a standard deviation (0.4202).

5. HYPOTHESIS INVESTIGATION

The analysis of variance (ANOVA) was adopted to investigate the strength of two major hypotheses depending on problem categories and company classifications.

### Table 2. Means and standard deviations for the respondent answers.

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative</td>
<td>3.3884</td>
<td>0.3397</td>
<td>3.1692</td>
<td>0.4225</td>
<td>2.8470</td>
<td>0.4202</td>
</tr>
<tr>
<td>Financial</td>
<td>3.2528</td>
<td>0.3448</td>
<td>3.3639</td>
<td>0.3900</td>
<td>2.9809</td>
<td>0.3676</td>
</tr>
<tr>
<td>Resources</td>
<td>3.1662</td>
<td>0.4124</td>
<td>3.2571</td>
<td>0.4833</td>
<td>2.8564</td>
<td>0.4392</td>
</tr>
<tr>
<td>Manpower</td>
<td>3.2998</td>
<td>0.3723</td>
<td>3.3068</td>
<td>0.5648</td>
<td>3.1176</td>
<td>0.4333</td>
</tr>
<tr>
<td>Technical</td>
<td>3.3587</td>
<td>0.3514</td>
<td>3.3432</td>
<td>0.4751</td>
<td>3.1196</td>
<td>0.4009</td>
</tr>
</tbody>
</table>

### Table 3. ANOVA results for the differences in the mean value of all aspects.

<table>
<thead>
<tr>
<th>Category</th>
<th>Analysis</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative</td>
<td>Between Groups</td>
<td>5366.618</td>
<td>2</td>
<td>2683.309</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>16988.385</td>
<td>166</td>
<td>102.340</td>
<td>26.220</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>22355.003</td>
<td>168</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td>Between Groups</td>
<td>2995.166</td>
<td>2</td>
<td>1497.583</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>14066.456</td>
<td>166</td>
<td>84.738</td>
<td>17.673</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>17061.622</td>
<td>168</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resources</td>
<td>Between Groups</td>
<td>3439.532</td>
<td>2</td>
<td>1719.766</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>20492.663</td>
<td>166</td>
<td>102.340</td>
<td>13.931</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>23932.196</td>
<td>168</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manpower</td>
<td>Between Groups</td>
<td>905.345</td>
<td>2</td>
<td>452.673</td>
<td></td>
<td>0.033</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>21571.182</td>
<td>166</td>
<td>129.947</td>
<td>3.484</td>
<td>0.033</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>22476.527</td>
<td>168</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical</td>
<td>Between Groups</td>
<td>1401.883</td>
<td>2</td>
<td>700.942</td>
<td></td>
<td>0.002</td>
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<tr>
<td></td>
<td>Within Groups</td>
<td>17421.103</td>
<td>166</td>
<td>104.946</td>
<td>6.679</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>18822.986</td>
<td>168</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.1. First Major Hypothesis

First major hypothesis adopted in this study was based on the assumption that company problems increases with company classification. A 0.05 Significance Level was used. Relying on the results obtained for each risk category, this major hypothesis was divided into five other sub-major hypotheses. These five hypotheses were in the same sequence, each investigated the strength of the decision making due to the company classification. Hypothesis number (1) is demonstrated next, and the other four hypotheses followed the same procedure.

To test the difference in the mean value for the administrative aspects due to the company classification, the following investigation is carried out. H0: There is no difference in the mean value for the administrative aspects due to the company classification. H1: There is difference in the mean value for the administrative aspects due to the company classification. Table 3 shows ANOVA results for the differences in the mean values of the five categories. Analysis results showed that F value is 26.220, which is greater than the critical value of F0.05 (2.166) which is 3.00, and P value in the table is 0.00 which is smaller than 0.05, hence, reject H0 with 95% confidence interval and conclude that there is a difference in the administration aspects due to company classification.
The same conclusion resulted for the other four hypotheses and all analysis had shown that there is a difference in all categories due to the company classification.

5.2. Second Major Hypothesis
The second major hypothesis investigated the relationship between each category and others. The five categories presented in the questionnaire were intercorelated, hence, ten sub-major hypothesis can be evaluated to test the strength of the relationship between each category and others, Table 4.

Next, an example to test the strength of the relationship between administrative and financial aspects is carried out. H0: there is no correlation between administrative aspects and financial aspects. Ha: there is correlation between administrative aspect and financial aspects. Table 4 shows that the correlation between administration and financial is 0.610 which is quite positive, and since the p value of the relationship between the administration and financial aspects is 0.00, which is smaller than 0.05, hence, reject the null hypothesis with 99% confidence level and accept the alternative one. This means that there is a significant relationship between administrative aspects and financial aspects.

It is important to note that the value of Pearson correlation is considered weak if its absolute value is less than 0.5 and can be considered strong if its absolute value is more than 0.5. Therefore all relationships were considered significant except for those between administrative and manpower, and between resources and technical aspects which have a value of Pearson value less than 0.5 and thus were considered of a weak relationship.

The strongest correlation occurred between the manpower and the technical aspects (0.692), while the weakest correlation occurred between the administrative aspects and the manpower (0.437).

These two results are very logical and indicate the strong relationship between the technical implementation and the quality of the manpower. It also shows that there is little connection between the administration and manpower selection.

6. FINDINGS

According to the first-class companies, two major problems were ranked highest in the administrative category of the questionnaire. These are: the absence of administrative experience in business administration and the contractor’s lack of scientific knowledge. These two problems indicate the importance of having qualified people running the projects. People, who lack sufficient experience academically and administratively, will have negative affect on the development of the project. Second-class Financial support by the owner is an important risk factor. All companies of the three different classes agreed that payments delay is the most important risk factor. Second-class companies always fear the size of the project. Apparently they are able to get into big projects but actually financial funding affects the project’s progress. Duration, financial support and tax payments play the key factors in company performance. Many second-class companies may bid on projects offered for lower company classes depending on the project size and on their success level. companies considered the absence of licensed administrative bureaus for contractors to be the most important risk factor, indicating the importance of having qualified and licensed contractors to run the business. Third-class companies agreed again on the demand of having qualified contractors and administrators.

Table 4. Correlation matrix between all aspects.

<table>
<thead>
<tr>
<th>Category</th>
<th>Ab=analysis</th>
<th>Administrative</th>
<th>Financial</th>
<th>Resources</th>
<th>Manpower</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative</td>
<td>Pearson Correlation</td>
<td>1.000</td>
<td>0.610*</td>
<td>0.617*</td>
<td>0.437*</td>
<td>0.501*</td>
</tr>
<tr>
<td></td>
<td>Significance (2-tailed)</td>
<td>-</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Sample Size (N)</td>
<td>169</td>
<td>169</td>
<td>169</td>
<td>169</td>
<td>169</td>
</tr>
<tr>
<td>Financial</td>
<td>Pearson Correlation</td>
<td>0.612*</td>
<td>1.000</td>
<td>0.635*</td>
<td>0.621*</td>
<td>0.612*</td>
</tr>
<tr>
<td></td>
<td>Significance (2-tailed)</td>
<td>0.000</td>
<td>-</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Sample Size (N)</td>
<td>169</td>
<td>169</td>
<td>169</td>
<td>169</td>
<td>169</td>
</tr>
<tr>
<td>Resources</td>
<td>Pearson Correlation</td>
<td>0.617*</td>
<td>0.635*</td>
<td>1.000</td>
<td>0.544*</td>
<td>0.489*</td>
</tr>
<tr>
<td></td>
<td>Significance (2-tailed)</td>
<td>0.000</td>
<td>0.000</td>
<td>-</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Sample Size (N)</td>
<td>169</td>
<td>169</td>
<td>169</td>
<td>169</td>
<td>169</td>
</tr>
<tr>
<td>Manpower</td>
<td>Pearson Correlation</td>
<td>0.437*</td>
<td>0.621*</td>
<td>0.544*</td>
<td>1.000</td>
<td>0.692*</td>
</tr>
<tr>
<td></td>
<td>Significance (2-tailed)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>-</td>
<td>0.000</td>
</tr>
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<td>169</td>
<td>169</td>
<td>169</td>
<td>169</td>
<td>169</td>
</tr>
<tr>
<td>Technical</td>
<td>Pearson Correlation</td>
<td>0.501*</td>
<td>0.612*</td>
<td>0.489*</td>
<td>0.692*</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Significance (2-tailed)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Sample Size (N)</td>
<td>169</td>
<td>169</td>
<td>169</td>
<td>169</td>
<td>169</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.01 level (2-tailed).
Whenever the company rank drops down, it is more likely that labour cost will influence the project profit. Therefore, companies of less ranks are always more determined at reducing the labour cost to the minimum. Third-class companies are keen on finding lowest cost labourers and materials.

From a technical point of view, the first and second-class companies agreed that the absence of actual supervision and monitoring on behalf of the designer offices is classified as first risk factor. This implies that engineering offices are not providing fully detailed drawings, and therefore more time is consumed on understanding and correcting drawings, leading to less profit. Third-class companies aim at accomplishing the project in the shortest time to achieve a higher profit. All companies agreed on the importance of having accurate tables of quantities in order to reduce the time consumed on correcting these tables.

In all cases, statistical analysis revealed that there is always a difference in the mean values for the five categories due to the company classification. This means that company classification has big influence on the risks that it may face. Results had shown that company problems are increasing with the rising in company classification. Another main hypothesis has been approved, that is there is always a correlation between each risks category and other categories. The correlation is varied between the categories but it was an indication, as was anticipated from the beginning, that each risk is linked to others by one way or another. The strongest correlation occurred between manpower and technical categories, while the weakest correlation occurred between administrative and manpower categories.

7. CONCLUSIONS

Construction companies in Jordan are classified into five categories depending on budget, assets and employees. This study addressed risks that occur in the upper three classes of the Jordanian construction companies since they are qualified to undertake all projects depending on the company classification and the project size.

Most of the problems that occur in the construction industry companies in Jordan are based on financial issues. Therefore, scheduled payments should be specified in a detailed contract in order to facilitate implementation and encourage the contractor to finish the project. One major discovery of this study is the urgent need for establishing new legislations in cooperation with Ministry of Public Works, Engineers’ Association, Contractors’ Association and other interested parties in order to produce new mechanism with new legislations that will protect the rights of all parties. Merging small companies to create larger and stronger companies is for the benefit of all parties, and may reduce intense competition in the market.

Very little data is available for the construction industry; therefore more research is required in corporation with the government and local associations. This study could be classified as a representative sample of other countries in the region with similar conditions as in Jordan.

REFERENCES


APPENDIX I

THE FIRST QUESTIONNAIRE: RISKS AND PROBLEMS FACING THE CONSTRUCTION INDUSTRIAL SECTOR IN JORDAN

Please fill in the value most appropriate against the problem: (1) Not important, (2) Some what important, (3) Fairly important, (4) Important.

First: ADMINISTRATIVE ASPECT
1. Employer’s direct supervision in managing the project
2. Lack of defining Cadre structure in the company
3. Lack of employing computer programs in project management
4. Absence of administrative experience in business administration
5. Overlap in Cadre structure, whether administrative or technical.
6. The contractor’s lack of scientific know-how.
7. Lack of applying all specifications agreed upon between consultant and contractor.
8. Absence of licensed administrative bureaus for contractors.
9. Lack of sufficient administrative Cadre for project management.
10. Absence of qualification courses for administrators.
11. Lack of distinguishing between technical and administrative project aspects.
12. Continuous change in laws, particularly income tax law.
13. Contractor’s rank is based on his company’s capital.

Second: FINANCIAL ASPECT
1. The Company obtains large loans
2. Inability to execute the project within specified timetable.
3. The owner lags behind in paying the contractor.
4. The contractor expands his work simultaneously in more than one project.
5. The contractor does not pay worker wages in due time.
6. Incompatibility of work progress (completed work) with cash payments.
7. Weak remitting.
8. Construction prices are low.
10. Absence of laws governing payment process and protecting contractor’s rights.
11. Large number of Construction companies in Jordan.
12. Deterioration of general economic conditions.
13. Specialists in project financial analysis are not employed.
14. Inability to control project financial affairs.
15. Taxes and tax burdens.
16. Absence of price standing strategy in the market.
17. Inexperience when pricing tenders.
18. Absence of clear financing mechanisms.

Third: RESOURCES
1. There is no standing guideline of the numerous resources in Jordan.
2. There are many fake and not original varieties of materials.
3. Monopoly of some material types.
4. The long distance between the project and resources.
5. There is no monitoring for high quality.
6. There are no regular tests for materials used in projects.
7. Absence of basic materials in the project.
8. Scarcity of resources sometimes, especially basic resources.
9. Some materials do not arrive at the assigned site.
10. Agreed-upon technical specifications are not realized.
11. The contractor takes into account the resource of lowest price.
12. Heavy equipment are not maintained periodically.
13. Fluctuating prices of materials.
14. There are no guarantees on imported materials.

Fourth: MANPOWER
1. Absence of trained local manpower.
2. Wages of local manpower are high.
3. Laws of employing foreign manpower are rigid.
4. Absence of training centers for local manpower.
5. The worker does not abide by regular work-hours.
6. Necessary technical skills are not available.
7. Public safety rules are not abided by.
8. Absence of health insurance.
9. Low productive efficiency of the worker.
10. There is no care for workmanship.
11. Instability of Cadre in the companies.

Fifth: TECHNICAL ASPECT
1. Design bureaus are not monitored.
2. There are many design bureaus.
3. Providing special Cadre is not abided by.
4. The designer does not follow up designs and changes made on them.
5. The owner’s meddling with the design.
6. Recurring design errors.
7. Errors in the inventory of quantities.
8. Supervising the project is not abided by.
9. Plans of design are incompatible with execution.
10. Survey processes are not precise.
11. Many modifications on designs are made during execution.

APPENDIX II

THE SECOND QUESTIONNAIRE: RISKS AND PROBLEMS FACING THE CONSTRUCTION INDUSTRIAL SECTOR IN JORDAN

Most problems faced by the Construction Industrial Sector in Jordan are listed below. Please provide your viewpoints and suggestions for the best appropriate solutions for these problems.

ADMINISTRATIVE ASPECT
1. Employer’s direct supervision in project management.
2. Lack of defining Cadre structure in the company.
3. Lack of employing computerized software in project management.
4. Absence of administrative experience in business administration.
5. The contractor’s lack of scientific know-how.
6. Lack of applying all specifications agreed upon by the adviser and contractor.
7. Absence of licensed administrative bureaus for contractors.
8. Lack of sufficient administrative Cadre for project management.
9. Continuous change in laws, particularly income tax law.

FINANCIAL ASPECT
1. Inability to execute the project within specified timetable.
2. The owner lags behind in paying the contractor.
3. The contractor does not pay worker wages in due time.
5. Inability to control project financial affairs.
6. Absence of financial allowances with the contractor when the project tender is invited.

RESOURCES
1. There are many fake and not original varieties of materials.
2. There are no regular tests for materials used in projects.
3. Absence of basic materials in the project.
4. Scarcity of resources sometimes, especially basic resources.
5. Agreed-upon technical specifications are not realized.
6. The contractor takes into account the resource of lowest price.
7. Heavy equipment is not maintained periodically.

MANPOWER
1. Laws of employing foreign manpower are rigid.
2. Necessary technical skills are not available.
3. Low productive efficiency of the worker.
4. There is minimum attention to workmanship.
5. Instability of Cadre in the companies.

TECHNICAL ASPECT
1. Design bureaus are not monitored.
2. Recurring design errors.
3. Errors in the inventory of quantities.
4. Supervising the project is not done properly.
5. Many modifications on designs are made during project’s execution.