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Risk matrix for delay causes in building construction projects in KSA

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ABSTRACT

Time performance of a project is usually a particularly important consideration for the construction parties. Often, the most troublesome construction disputes involve delay and failure to complete the work within the specified time frame. This study aims at identifying the risk matrix for delay causes in building construction projects in Saudi Arabia from contractors' viewpoint. A questionnaire survey was undertaken of 35 contractors working on construction projects in Saudi Arabia. 20 delay causes were identified through literature review. The study concluded that the top delay causes in building projects from contractors' perspective are: Bid award for the lowest price, fluctuation of prices of materials, frequent changes in design, payments delay, poor labor productivity, rework, and lack of adequate manpower.

1. Introduction

The construction industry is at or near the top in the annual rate of business failures and resulting liabilities compared to other industries (Chapman, 2001). This is because it is a risky business with too many uncertainties that management has to deal with (Enshassi and Abu Mosa, 2008). The management of risks is a central issue in the planning and management of any venture. The process of taking a project from initial investment into use is a complex process (Enshassi and Abu Mosa, 2008). Alhallaq (2003) stated that many types of risk can be identified in the construction contracts; that may be:

- Physical works
- Delay and disputes
- Direction and supervision
- Damage and injury to persons and property
- External factors
- Payment
- Law and arbitration

Cost, time, and quality are primary measures of a project's success. This is true, especially for public projects in developing countries, because public construction projects in these countries are executed with limited financial resources (Nega, 2008). Many of investigated literatures on construction projects suggested that the common criteria for project success are generally considered to be cost, time and quality (Frimpong et al., 2003; Nega, 2008; Alhallaq, 2003; Enshassi et al., 2010). Reina and Angelo (2002) state that the problem of cost overruns is critical and needs to be studied more to alleviate this issue in the future. They also point out that cost overruns are a major problem in both developing and developed countries. According to Faridi and El-Sayegh (2006), construction delay is considered to be one of the most recurring problems in the construction industry and it has an adverse impact on project success in terms of time, cost, quality and safety. In Saudi Arabia, there are no previous studies that investigated time delay in building construction projects but the general observations indicate that time overrun is a common phenomenon in building projects. Therefore, this study aims at identifying the risk matrix for delay causes in building construction projects in Saudi Arabia from contractors' viewpoint.

2. Literature review

Many studies were conducted to examine the delay causes in construction projects. Al-Momani (2000) investigated causes of delay in 130 public building projects constructed in Jordan during the period of 1990-1997. He presented regression models of the relationship between actual and planned project duration for different types of building facilities. He concluded that the main causes of delay are related to designer, user changes, weather, site conditions, late deliveries, economic conditions and increase in quantity.

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Mahamid et al. (2011) conducted a study to identify and rank the delay causes in road construction projects in the West Bank in Palestine. Contractors indicated that the top five delay causes are: segmentation of the West Bank and limited movement between areas, political situation, progress payments delay by owner, delays in decision making by owner, and low productivity of labors. While the contractors indicated that the top five affecting causes are: political situation, segmentation of the West Bank and limited movement between areas, awarding project to lowest bid price, shortage in equipment and ineffective scheduling of project by contractor. Koushki et al. (2005) conducted a study in Kuwait to study the causes of time and cost overrun in construction projects. A person-interview survey of 450 randomly selected private residential project owners and developers have been done. They concluded that the main causes of delays are changing orders, owners' financial constraints, and owners' lack of experience. Odeh and Battaineh (2002) found that contractors and contractors agreed that owner interference, inadequate contractor experience, financing and payments, labor productivity, slow decision making, improper planning, and incompetence of subcontractors are the most important causes of construction delay in Saudi Arabia.

Ahmed et al. (2003) conducted a study to identify the major causes of delays in building construction in the Florida construction industry. A questionnaire survey targeted at contractors in the State of Florida has been used as the tools to carry out this study. They concluded that the top 10 severe factors are: building permits approval, change order, changes in drawings, incomplete documents, inspections, changes in specifications, decision during development stage, shop drawings approval, design development, and changes in laws. Le-Hoai et al. (2008) studied the causes of delay in building and industrial construction projects in Vietnam. They did a questionnaire survey to identify the causes of time and cost overruns by interviewing 87 Vietnamese construction experts. 21 causes of delay and cost overruns were identified. They concluded that the top ten affecting factors are: poor project management, poor site management and supervision, financial difficulties of owner, financial difficulties of contractor, design changes, unforeseen site conditions, slow payment of completed works, inaccurate estimates, shortages of materials, and mistakes in design. Kaliba et al. (2009) studied the schedule delays in road construction projects in Zambia, they concluded that the most affecting factors are: delayed payments, financial processes and difficulties on the part of contractors and clients, contract modification, problems in national economy, materials procurement, changes in drawings, staffing problems, equipment unavailability, poor supervision, construction mistakes, poor coordination on site, changes in specifications and labor disputes and strikes. Sambasivan and Soon (2007) concluded that the ten most important causes of delays in Malaysian construction industry are: contractor's improper planning, contractor's poor site management, inadequate contractor experience, inadequate client's finance and payments for completed work, incompetence of subcontractors, shortage in material, labor supply, equipment availability and failure, lack of communication between parties, and mistakes during the construction stage. They also found that the six main effects of delay are: time overrun, cost overrun, disputes, arbitration, litigation, and total abandonment.

Frimpong et al. (2003) conducted a survey to identify and evaluate the relative importance of significant causes contributing to delay and cost overruns in Ghana groundwater construction projects. A questionnaire with 26 causes was designed. The questionnaire was directed towards three groups in both public and private organizations: owners of the groundwater projects, consulting offices, and contractors working in the groundwater works. The result of the study revealed the main causes of delay and cost overruns in construction of groundwater projects are: monthly payment difficulties from agencies; poor contractor management; material procurement; poor technical performance, and escalation of material prices. Enshassi et al. (2010) concluded that the top affecting causes that cause time overrun in building construction projects in Gaza Strip as perceived by contractors are: strikes, Israeli attacks and border closures, lack of materials in markets, shortage of construction materials at site, delay of material delivery to site, cash problem during construction, poor site management, poor economic conditions (currency, inflation rate, etc.), shortage of equipment at site, equipment and tool shortage on site, and owner delay in freeing the contractor financial payments.

Alaghbari et al. (2007) examined the factors that cause delay in construction projects in Malaysia. The results of the analysis show that from a total of 31 variables examined, separated into four categories by responsibility (who is responsible for the delay source), the major factors causing delay in construction projects are factors due to the contractor, followed by factors due to the consultant, factors due to the owner, and finally external factors. The main finding of the study is that the financial factor is the most influencing factor in causing delay in construction projects in Malaysia. Coordination problems are considered the second important factor causing delay in construction projects, followed by materials problems. Asnaashari et al. (2009) presented the result of an investigation into the main factors which cause construction delay in Iran. Eleven in-depth interviews are conducted with construction managers and practitioners associated with the Iranian construction industry. The results reveal that most construction projects in Iran are subject to delay. Cash constraints, shortage of resources, high inflation rate, delay in payments, and disputes

in the supply chain are the top causes of delay in the Iranian construction industry.

3. Research method

20 delay causes in construction projects were defined through a detailed literature review. The causes were tabulated into a questionnaire form. Then the draft questionnaire was discussed with three experts in construction industry to evaluate the content of the questionnaire. Modifications and changes have been done. The questionnaire is divided into two main parts. Part I is related to general information for the company. The surveyed contractors were requested to answer questions pertaining to their experience in public construction. Part II includes the list of the identified delay causes in public construction projects.

4. Data collection and analysis

35 contractors working on building construction projects were successfully questioned. The questionnaire gave each respondent an opportunity to identify variables that they perceived as likely to contribute to delays by responding on a scale from 5 (very important) to 1 (not important). Participants then rated the frequency of occurrence for each variable on project that they have experiences on an ordinal scale: very high (5), high (4), and medium (3), low (2), or very low (1). For each variable, the mean value of the respondents' importance rating was named the *severity index*. Secondly, the mean value from respondents' frequency rating was named the *frequency index*. Accordingly the severity and frequency levels are identified using Table 1. Finally, the zone of each variable in the risk map was identified using Fig. 1 (Mahamid, 2011).

Table 1: Levels of severity and frequency

Index value (Scale)	Severity	Frequency
≤ 20%	very low (VL)	very low (VL)
20% - 40%	low (L)	low (L)
40% - 60%	moderate (M)	moderate (M)
60% - 80%	high (H)	high (H)
80% - 100%	very high (VH)	very high (VH)

The risk map includes three zones: red, yellow, and green; such that:

- Green zone**:** risks in this zone are low level, and can be ignored.
- Yellow zone: risks in this zone are of moderate importance, and should be controlled.
- Red zone**:** risks in this zone are of critical importance. These are the top priorities, and close attention should be paid to them.

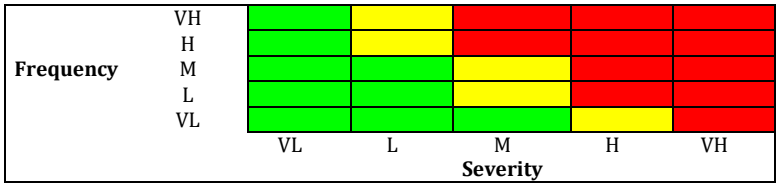

Fig. 1: The risk map

5. Statistical analysis

The statistical analyses for delay causes as assessed by contractors are performed. The tests include the computation of the weighted mean, standard deviation, and coefficient of variation. These tests are used to check the compactness and consistency of the responses.

6. Results and discussion

6.1. Participants

The target populations in this study are the total number of contractors working on building construction projects in Saudi Arabia. Simple random sampling was used to select the participants from the available list.

The questionnaire was sent out to a total of 45 contractors asking their perception in ranking the identified 20 causes in terms of severity and frequency using an ordinal scale. A total of 35 contractors filled the questionnaire. The response rate by contractors is 78%. On average, the respondents have experience of more than 5 years.

6.2. Causes' risk map

Table 2 shows the results of risk map for contributors to delays in building projects in Saudi Arabia from contractors' perspective. It shows that 7 causes are located in the red zone (critical causes), 13 causes are located in the yellow zone (moderate importance), and no any cause in the green zone (low level).

6.3. Top delay causes

Table 3 shows the top contributors to delays in building construction projects in Saudi Arabia from contractors' perspective, they are:

1. Bid award for lowest price: in general, the clients award bids to the lowest bidder to execute their projects. However, the lowest bidders might be low qualified contractors. Consequently, poor performance will occur that will affect the project schedule. This result is in line with Mahamid et al. (2011).
2. Payments delay: Due to the delay of payments by the owner, work progress can be delayed because of inadequate cash flow to support the construction expenses by contractor. This result

is in line with many of the investigated studies (Frimpong et al, 2003; Enshassi et al., 2010; Koushki et al., 2005`; Odeh and Battaineh, 2002; and Mahamid et al., 2011)

3. Poor labor productivity: it increases the actual time for a specific work items to be completed. Consequently, the project delay is resulted. This result is supported by (Mahamid et al., 2011; Odeh and Battaineh, 2002).
4. Rework: redoing things again and again will lead to time overrun. This result is in line with Frimpong et al. (2003).
5. Fluctuation of prices of materials: in general, the fluctuation of material prices will affect the performance in the construction projects, since the contractors, in some cases, may be forced to wait for some time to get the best material prices. This result is in line with some of the investigated studies (Frimpong et al, 2003; Enshassi et al., 2010).
6. Frequent changes in design: this situation interrupts the planned schedule, especially if the changes lead to additional works or rework. This result was pointed out by some of the investigated studies (Al-Momani, 2000; Koushki et al., 2005).
7. Lack of adequate manpower: manpower is one of the most important resources in the construction industry. Their availability and adequacy affect the construction productivity, therefore an adequate manpower should be appointed. This result was not pointed out by any of the investigated studies.

Table 2: Risk map for delay causes from contractors perspective

Cause	S.I	Level	F.I	Level	Cause zone
additional work	48.12	M	48.46	M	yellow
bid award for lowest price	67.47	H	50.19	M	red
duration of contract period	58.11	M	60.63	M	yellow
effects of weather	47.29	M	44.76	M	yellow
fluctuation of prices of materials	80.6	VH	50.63	H	red
frequent changes in design	69.21	H	57.15	M	red
improper planning	56.34	M	52.37	M	yellow
inflationary pressure	54.42	M	55.41	M	yellow
lack of adequate manpower	76.77	H	56.28	M	red
lack of contractor experience	57.29	M	48.46	M	yellow
lack of coordination between design and contractors	58.95	M	54.54	M	yellow
late design work	53.12	M	45.85	M	yellow
manipulation of suppliers	54.79	M	45.85	M	yellow
mistakes in design	57.29	M	57.15	M	yellow
number of projects going at the same time	53.95	M	49.32	M	yellow
payments delay	82.13	VH	62.54	H	red
poor labor productivity	80.64	VH	60.63	H	red
poor resource management	49.79	M	46.72	M	yellow
rework	66.6	H	54.54	M	red
unreasonable project time frame	51.45	M	49.32	M	yellow

Table 3: Top delay causes from contractors' perspective

Cause	S.I	Level	F.I	Level	Cause zone
bid award for lowest price	67.47	H	50.19	M	red
fluctuation of prices of materials	80.6	VH	50.63	H	red
frequent changes in design	69.21	H	57.15	M	red
lack of adequate manpower	76.77	H	56.28	M	red
payments delay	82.13	VH	62.54	H	red
poor labor productivity	80.64	VH	60.63	H	red
rework	66.6	H	54.54	M	red

7. Statistical analyses

Table 4 presents the statistical analyses for delay causes as assessed by the surveyed contractors. The table contains the computation of the weighted mean, standard deviation, and coefficient of variation. The results show good data compactness and reasonable values, indicating that there is a good data consistency and agreement between the respondents on the severity and the frequency of the identified causes.

8. Conclusion

This study aims at identifying the risk matrix for delay causes in building construction projects in Saudi Arabia from contractors' viewpoint. A questionnaire survey was undertaken of 35 contractors working on construction projects in Saudi Arabia. 20 delay causes were identified through literature review. The study shows that 7 causes are located in the red zone (critical causes), 13 causes are located in the yellow zone (moderate importance), and no any cause in the green zone (low level).The red causes are: bid award for lowest price, fluctuation of prices of materials, frequent changes in design, lack of adequate manpower, payments delay, poor labor productivity, and rework.

The statistical analyses show that the data has good compactness, indicating that there is a good data consistency and agreement between the respondents on the severity and frequency of occurrence of the identified delay causes.

Table 4: Statistical analyses for delay causes as assessed by contractors

Cause	Severity			Frequency		
	X'	Sn	C.V (%)	X'	Sn	C.V (%)
additional work	2.41	0.98	40.73	2.42	0.68	28.06
bid award for lowest price	3.37	0.87	25.79	2.51	0.73	29.09
duration of contract period	2.91	0.51	17.55	3.03	0.87	28.70
effects of weather	2.36	0.53	22.41	2.24	0.96	42.90
fluctuation of prices of materials	4.03	0.56	13.90	2.53	0.89	35.16
frequent changes in design	3.46	1.14	32.94	2.86	0.93	32.55
improper planning	2.82	0.91	32.30	2.62	0.75	28.64
inflationary pressure	2.72	0.90	33.08	2.77	1.04	37.54
lack of adequate manpower	3.84	0.93	24.23	2.81	0.93	33.05
lack of contractor experience	2.86	0.72	25.14	2.42	0.85	35.08
lack of coordination between design and contractors	2.95	0.89	30.20	2.73	1.00	36.67
late design work	2.66	0.94	35.39	2.29	0.93	40.57
manipulation of suppliers	2.74	0.79	28.84	2.29	0.97	42.31
mistakes in design	2.86	0.47	16.41	2.86	1.20	41.99
number of projects going at the same time	2.70	0.80	29.66	2.47	0.84	34.06
payments delay	4.11	0.57	13.88	3.13	1.01	32.30
poor labor productivity	4.03	0.98	24.31	3.03	0.93	30.68
poor resource management	2.49	1.02	40.97	2.34	0.86	36.82
rework	3.33	0.95	28.53	2.73	1.01	37.04
unreasonable project time frame	2.57	0.97	37.71	2.47	0.95	38.52

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