

Research Article

Risk Matrix for Delay Causes in Construction Projects in Saudi Arabia

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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 in the specified time frame. Many variables have an impact upon construction delay in Saudi Arabia. This study aims at identifying the risk matrix for delay causes in construction projects in Saudi Arabia from consultants' viewpoint. A questionnaire survey was undertaken of 51 consultants working on construction projects in the Northern Province of Saudi Arabia. Thirty five delay causes were identified through literature review. The study concluded that the top delay causes in construction projects in Saudi Arabia from consultants' perspective are: bid award for lowest price, changes in material types and specifications during construction, contract management, duration of contract period, fluctuation of prices of materials, frequent changes in design, improper planning, inflationary pressure, lack of adequate manpower, long period between design and time of implementation, payments delay, poor labor productivity and rework.

Keywords: Construction, consultants, contributors, delays, risk map

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 construction process is subjected to the influence of highly changing variables and unpredictable causes, such as: resources availability, environmental conditions, financial problems, political conditions, poor productivity and contractual relations. As a consequence of these causes, the construction of projects may face problems, which could cause delay in the project completion time. Delay can be simply defines as the time overrun either beyond the completion date specified in the contract, or beyond the date that the parties (Mahamid *et al.*, 2012).

Saudi Arabia has experienced a construction boom during the past three decades, attracting construction professionals from all over the world. According to the Saudi Ministry of Planning, the construction industry contributed between 30 to 40% of the non-oil productive sectors at the end of each National Development Plan from 1980 to 2000 (Cordsman, 2000). However, project delay is considered to be one of the most serious and frequent problems in the Saudi Arabian construction industry (Faridi and Al-Sayegh, 2006). Assaf and Al-Hejji (2006) found that only 30%

of construction projects in Saudi Arabia were completed within the scheduled completion dates and that the average time overrun was between 10 and 30%. Therefore, it is very necessary to identify the main contributors to delays in construction projects in Saudi Arabia in order to control them and to overcome this critical problem. This study presents the findings of a survey aims at identifying the risk map for delay causes in construction projects in Saudi Arabia from the consultants' perspective. It is hoped that these findings will guide efforts to enhance the performance of the construction industry in Saudi Arabia and other developing countries.

LITERATURE REVIEW

Many studies were conducted to examine the delay causes in construction projects. Mahamid *et al.* (2012) 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 consultants 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 equipments and

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ineffective scheduling of project by contractor. Al-Khalil and Al-Ghafly (1999) investigated three components of delay in the construction of water and sewage works in Saudi Arabia. The components are: the frequency of delayed projects, the extent of delay and the responsibility for delay. The results showed that a high proportion of projects were subject to delay. The frequency of delayed projects seems to be associated with the contractor classification grade. They also found that the project owners and consultants assigned the major responsibility for delay to the contractors while contractors believed that the owner is mostly responsible. Odeh and Battaineh (2002) found that contractors and consultants 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 Jordan. Alghbari *et al.* (2007) examined the delay causes in construction projects in Malaysia. The results of the analysis showed that from a total of 31 variables examined, the major causes causing delay in construction projects financial cause, coordination problems and materials problems.

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. 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. 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.

Al-Zarooni and Abdou (2000) conducted a survey to investigate variations in UAE public projects' estimates. They found that the variations (positive or negative) between feasibility and contract cost, ranging

between -28.5 and +36%. They stated that these variations could be explained knowing that feasibility estimates in the government agencies are usually budgeted using a Single Unit Estimating (cost per square foot) basis, regardless of the nature of projects and their associated risks or the construction complexity of each building type. Al-Najjar (2008) 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, equipments and tool shortage on site and owner delay in freeing the contractor financial payments. Asnaashari *et al.* (2009) presented the result of an investigation into the main causes 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.

RESEARCH METHODOLOGY

Thirty five 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 consultants 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.

Data collection and analysis: Fifty-one consultants working on public 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), 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

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)

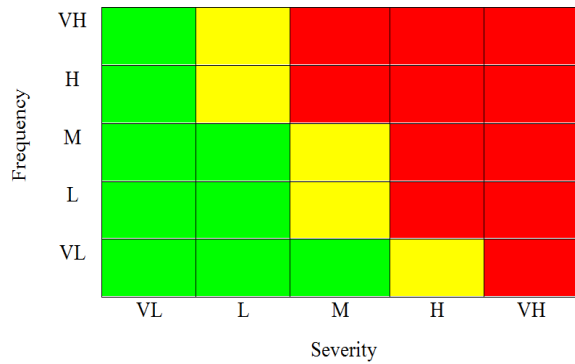


Fig. 1: The risk map

frequency levels are identified using Table 1. Finally, the zone of each variable in the risk map was identified using Fig. 1 (Mahamid, 2011).

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.

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.

RESULTS AND DISCUSSION

Participants: The target populations in this study are the total number of construction consultants in the Northern Province of Saudi Arabia. Simple random sampling was used to select the participants from the available list.

The questionnaire was sent out to a total of 60 consultants asking their perception in ranking the identified 35 causes in terms of severity and frequency

Table 2: Risk map for delay causes from consultants perspective

Cause	S.I	Level	F.I	Level	Cause zone
Additional work	45.00	M	49.57	M	Yellow
Bid award for lowest price	64.35	H	51.30	M	Red
Changes in material types and specifications during construction	56.67	M	60.87	H	Red
Contract management	74.61	H	64.35	H	Red
Contractual procedure	43.33	M	39.13	L	Yellow
Disputes on site	49.17	M	44.35	M	Yellow
Duration of contract period	59.17	M	61.74	H	Red
Economic instability	41.67	M	57.39	M	Yellow
Effects of weather	44.17	M	40.87	M	Yellow
Fluctuation of prices of materials	77.48	H	61.74	H	Red
Frequent changes in design	66.09	H	58.26	M	Red
Government policies	39.17	L	47.83	M	Green
High interest rates by bankers	40.83	M	40.00	M	Yellow
Improper planning	83.22	VH	63.48	H	Red
Inadequate production of raw materials by the country	56.67	M	48.70	M	Yellow
Inflationary pressure	81.30	VH	56.52	M	Red
Lack of adequate manpower	73.65	H	57.39	M	Red
Lack of contractor experience	54.17	M	49.57	M	Yellow
Lack of coordination between design and contractors	55.83	M	55.65	M	Yellow
Late design work	60.00	M	46.96	M	Yellow
Level of competitors	50.00	M	53.04	M	Yellow
Long period between design and time of implementation	65.22	H	59.13	M	Red
Manipulation of suppliers	51.67	M	46.96	M	Yellow
Mistakes in design	54.17	M	58.26	M	Yellow
Number of competitors	48.33	M	49.57	M	Yellow
Number of projects going at the same time	50.83	M	50.43	M	Yellow
Payments delay	75.57	H	60.87	H	Red
Poor financial control on site	55.83	M	52.17	M	Yellow
Poor labor productivity	76.52	H	61.74	H	Red
Poor relationship between managers and labors	55.00	M	56.52	M	Yellow
Poor resource management	46.67	M	47.83	M	Yellow
Project location	40.00	M	50.43	M	Yellow
Rework	63.48	H	55.65	M	Red
Social and cultural impacts	34.17	L	30.43	L	Green
Unreasonable project time frame	58.33	M	50.43	M	Yellow

Table 3: Top delay causes from consultants' perspective

Cause	S.I	Scale	F.I	Scale	Risk zone
Bid award for lowest price	64.35	H	51.30	M	Red
Changes in material types and specifications during construction	56.67	M	60.87	H	Red
Contract management	74.61	H	64.35	H	Red
Duration of contract period	59.17	M	61.74	H	Red
Fluctuation of prices of materials	77.48	H	61.74	H	Red
Frequent changes in design	66.09	H	58.26	M	Red
Improper planning	83.22	VH	63.48	H	Red
Inflationary pressure	81.30	VH	56.52	M	Red
Lack of adequate manpower	73.65	H	57.39	M	Red
Long period between design and time of implementation	65.22	H	59.13	M	Red
Payments delay	75.57	H	60.87	H	Red
Poor labor productivity	76.52	H	61.74	H	Red
Rework	63.48	H	55.65	M	Red

using an ordinal scale. A total of 51 consultants filled the questionnaire. The response rate by contractors is 85%. On average, the respondents have experience of more than 10 years.

Causes' risk map: Table 2 shows the results of risk map for contributors to delays in construction projects in Saudi Arabia from consultants' perspective. It shows that 13 causes are located in the red zone (critical causes), 20 causes are located in the yellow zone (moderate importance) and 2 causes are located in the green zone (low level).

Top delay causes: Table 3 shows the top contributors to delays in construction projects in Saudi Arabia from consultants' perspective, they are.

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 supported by Mahamid *et al.* (2012) in that award project to the lowest bid price is one of the main delay causes.

Changes in material types and specifications during construction: These changes will interrupt the project planning and schedule because it may lead to rework and redesign in most of the cases. This result is supported by Koushki *et al.* (2005).

Contract management: It is defined as the process of systematically and efficiently managing contract creation, execution and analysis for the purpose of maximizing financial and operational performance and minimizing risk. Many reasons can lead to poor contract management such as staff experience, project size and economical stability. Consequently, delay will occur. This result is in line with Frimpong *et al.* (2003) in that the poor contract management is one of the top delay causes.

Duration of contract period: Most of the construction projects, especially the public projects, in Saudi Arabia have long construction period. During this period, the projects influencing by many of changing factors such

as inflation, fluctuation of prices, availability of materials and staff turnover that may interrupt the planned schedule of the project. This result was not pointed out by any of the investigated studies.

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 was pointed out by some of the investigated studies (Frimpong *et al.*, 2003; Al-Najjar, 2008).

Frequent changes in design: This could happen due to the less involvement of the owners in the early phases of the projects or due to the design mistakes and scope changes. 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).

Improper planning: Planning has a vital role in the success of the construction projects, as proper planning will get resources together to achieve the project objectives within the limited time, cost and quality. This result was concluded by Odeh and Battaineh (2002).

Inflationary pressure: Generally it leads to fluctuation in resources prices that may interrupt the project management and planning process. This result was concluded by some of the investigated studies (Asnaashari *et al.*, 2009; Al-Najjar, 2008).

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.

Long period between design and time of implementation: The owner should try to shorten the period between the design and time of implementation, since during this period many influencing changes could be arise that may interrupt the project schedule.

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

Cause	Severity			Frequency		
	X'	Sn	C.V (%)	X'	Sn	C.V (%)
Additional work	2.25	1.11	49.43	2.48	1.12	45.31
Bid award for lowest price	3.22	1.00	31.02	2.57	1.12	43.70
Changes in material types and specifications during construction	2.83	0.64	22.52	3.04	1.07	35.00
Contract management	3.73	0.66	17.60	3.22	1.13	35.01
Contractual procedure	2.17	0.69	31.79	1.96	0.71	36.07
Disputes on site	2.46	1.27	51.78	2.22	1.04	47.02
Duration of contract period	2.96	1.04	35.18	3.09	1.24	40.17
Economic instability	2.08	1.03	49.40	2.87	1.25	43.71
Effects of weather	2.21	1.06	48.15	2.04	0.98	47.76
Fluctuation of prices of materials	3.87	0.85	21.83	3.09	1.20	38.96
Frequent changes in design	3.30	1.02	30.86	2.91	1.04	35.72
Government policies	1.96	1.07	54.39	2.39	1.08	45.00
High interest rates by bankers	2.04	0.92	45.05	2.00	0.95	47.67
Improper planning	4.16	0.60	14.41	3.17	1.03	32.43
Inadequate production of raw materials by the country	2.83	0.93	32.76	2.43	1.08	44.35
Inflationary pressure	4.07	0.70	17.29	2.83	1.19	42.21
Lack of adequate manpower	3.68	1.11	30.20	2.87	1.18	41.11
Lack of contractor experience	2.71	1.15	42.61	2.48	1.16	46.91
Lack of coordination between design and contractors	2.79	1.08	38.81	2.78	1.04	37.47
Late design work	3.00	1.01	33.79	2.35	0.83	35.42
Level of competitors	2.50	1.16	46.30	2.65	0.88	33.36
Long period between design and time of implementation	3.26	1.01	30.97	2.96	1.02	34.55
Manipulation of suppliers	2.58	1.29	50.11	2.35	1.11	47.37
Mistakes in design	2.71	1.23	45.43	2.91	1.04	35.72
Number of competitors	2.42	1.16	48.11	2.48	1.08	43.65
Number of projects going at the same time	2.54	0.98	38.64	2.52	0.90	35.61
Payments delay	3.78	1.04	27.44	3.04	1.19	38.98
Poor financial control on site	2.79	1.38	49.39	2.61	1.08	41.25
Poor labor productivity	3.83	0.79	20.65	3.09	1.00	32.27
Poor relationship between managers and labors	2.75	1.25	45.61	2.83	1.15	40.84
Poor resource management	2.33	1.08	46.28	2.39	1.08	45.00
Project location	2.00	0.79	39.64	2.52	1.12	44.53
Rework	3.17	1.07	33.79	2.78	1.35	48.41
Social and cultural impacts	1.71	1.13	33.00	1.52	0.99	45.00
Unreasonable project time frame	2.92	1.15	39.33	2.52	1.16	46.11

This result was not concluded by any of the investigated studies.

Payments delay: Construction works involve high daily expenses and most of the contractors cannot fulfill these expenses when the payments are delayed. 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. The problem is particularly acute for those contractors who are not financially sound. This result is in line with many of the investigated studies (Frimpong *et al.*, 2003; Al-Najjar, 2008; Koushki *et al.*, 2005; Asnaashari *et al.*, 2009; Mahamid *et al.*, 2012; Odeh and Battaineh, 2002; Alghbari *et al.* 2007; Al-Momani, 2000).

Poor labor productivity: It increases the actual time for a specific work items to be completed. Consequently, the project will delay. This result was concluded by many of the investigated studies (Mahamid *et al.*, 2012; Odeh and Battaineh, 2002).

Rework: It can be simply defined by redoing the same activity for more than one time. It can be as a result of many reasons such as poor workmanship, poor material quality, late changes and mistakes in design. Redoing

things again and again will lead to time overrun. This result is in line with Frimpong *et al.* (2003).

Statistical analyses: Table 4 presents the statistical analyses for delay causes as assessed by the surveyed consultants. 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.

CONCLUSION

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 in the specified time frame. Many variables have an impact upon construction delay in Saudi Arabia. A questionnaire survey was undertaken of 51 consultants working on construction projects in the Northern Province of Saudi Arabia. Thirty five delay causes were identified through literature review. The risk map for the considered causes was identified according to their perceived severity and frequencies of occurrence. Three

zones were considered in the risk map: red, yellow and green. The results showed that 13 causes are located in the red zone, 20 causes are located in the yellow zone and 2 causes are located in the green zone of the risk map.

The study concluded that the top delay causes in construction projects in Saudi Arabia from consultants' perspective are: bid award for lowest price, changes in material types and specifications during construction, contract management, duration of contract period, fluctuation of prices of materials, frequent changes in design, improper planning, inflationary pressure, lack of adequate manpower, long period between design and time of implementation, payments delay, poor labor productivity and rework.

The statistical analyses showed 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.

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