CAUSES OF DELAY ON INFRASTRUCTURE PROJECTS IN QATAR

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The construction industry is of high importance to the economy of most countries. However, it is notorious for projects overrunning time and cost. A plethora of research has been conducted to define causes of delay in completing construction projects. These studies employed a wide variety of analytical methods to statistically conclude the most precise ranking of causes of delay. Moreover, the delays for construction projects differ from one country to another and even between types of project within the same geographic location. The aim of this study is examining factors contributing to delays of infrastructure projects in Qatar.. A comprehensive quantitative literature review was carried out on neighbouring Gulf countries. The causes of delays are identified from literature and used in exploratory interviews with industry experts in Qatar to investigate the relevance of each cause. A survey questionnaire was prepared and was subject to pilot interviews prior to issuing it to practitioners, including clients, consultants, and contractors. Results shows that over 80% of infrastructure projects suffers from delay with an average delay of 25% and the top factors were: long response times from utility agencies; major changes in design during construction; ineffective planning and scheduling; ineffective control of progress, and; changes in the scope of projects. Construction projects need to adopt planning and scheduling methods that deal with its dynamic and changing nature to create robust programmes with buffers to deal with uncertainties.

Keywords: construction planning, delay causes, infrastructure.

INTRODUCTION

Construction projects are notorious for overrunning time and budget. The percentage of delayed projects reported in Assaf and Al-Hejji's (2006) study exceeded 70% in Saudi Arabia and 60% in UK (Davis *et al*. 2014). Extensive research efforts to identify the reasons and causes of delays were conducted in different countries, and the findings were reported in several studies. Emam *et al*. (2014) argued that causes of delay vary from one geographical location to another. These variations are due to bespoke location factors such as availability of resource, efficiency of public authorities, and local regulations. The delay causes in countries with high populations might be the unavailability of trained personnel (Doloi *et al*. 2012). Meanwhile, in countries with low populations, usually availability of labourers is the dominant resource related reason. Consequently, the treatment of causes of delays shall be dealt with on an individual case basis.

Construction activities are currently booming in Gulf Cooperation Council (GCC) countries in general and Qatar in particular. Qatar construction activities are expected to considerably increase in the coming years, due to the award of the World Cup 2022. The government of Qatar has announced plans to spend 205 billion US dollars on

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infrastructure projects over the next five years. The planned investments in infrastructure include highways, railways, underground metro, and tunnelling projects.

The lead author is a practitioner working in a major infrastructure project in Qatar where cost and schedule overruns are often observed in construction operations and the motivation for the research is to avoid this wastage in future. This study focus is on infrastructure projects with repetitive serial activities i.e. projects with repeating activities geographically such as pipelines, highways, roadways, tunnels, and railway projects (Hegazy and Wassef 2001). The main objectives are: (1) identify, assess, and rank the reasons for delays in infrastructure construction projects in Qatar; (2) suggest solutions to mitigate the impact of the identified causes; (3) conduct a comparative study with other GCC countries on causes of delay, and (4) propose future research efforts required to mitigate or eliminate the impacts of the causes of delays.

LITERATURE REVIEW

A quantitative systematic literature review was chosen to ensure comprehensive coverage of earlier studies published in relation to causes of delays in construction projects within the GCC countries. Identified papers resulted from the search were subject to filtering for their validity for inclusion. In the papers found to be valid, their references and citations were used to determine availability of any further literature that did not appear by applying search criteria. It was found that there are 28 published studies on causes of delay topic. These results were filtered for their relevance to the current causes of delay. In addition, citing and referenced publications were reviewed for relevance. The final number of relevant was 18 papers.

The summary in Table 1 shows that Saudi Arabia is the most studied GCC country for identifying causes of delay followed by UAE in the second place with a total of seven and five publications respectively. Qatar had a single study of the causes of delay. The recognised studies were categorised by type of projects that were investigated. This classification gives granularity and demonstrates differences between projects nature in relation to factors causing delays. In order to identify literature gaps, a quantitative matrix of publications was developed. The matrix maps publications to types of projects and country under consideration.

Table 1: Mapping Types of Studied Projects by Country

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE	Total
Buildings	-	2	-	1	1	-	4
Construction	-	-	1	-	4	3	8
Oil and Gas	-	-	1	-	1	1	3
Pipeline	-	-	-	-	1	-	1
Road	1	-	-	-	-	-	1
Infrastructure	-	-	-	-	-	1	1
Total	1	2	2	1	7	5	18

Saudi Arabia is ranked first amongst GCC countries in the number and diversity of causes of delay studies and only particularly considered pipeline projects. Seven papers focusing on causes of delay in Saudi Arabia were found in the literature. The studies breakdown shows one publication for building (Assaf *et al*. 1995), one for oil and gas, and one for pipeline (Al-Khalil and Al-Ghafly 1999) projects. Meanwhile, general construction was the most frequently studied with four papers (Assaf and Al-

Hejji 2006; Al-Kharashi and Skitmore 2009; Albogamy *et al*. 2012; Mahamid 2013). These studies have variations that are discussed in this section. Assaf and Al-Hejji (2006) investigated causes of delay for large construction projects in Saudi Arabia. Al-Kharashi and Skitmore (2009) study was inclusive of different project scales and was not specific to geographic areas within the kingdom. Albogamy *et al*. (2012) criticised the previous studies for not considering variation due to geographical location and conducted specific research on five Saudi cities. Mahamid (2013) narrowed his study on investigating the perspective of owners on the causes of delay.

The United Arab Emirates (UAE) is ranked as second in frequencies of studies and was the only country with a particular study on delays on infrastructure projects. The five identified studies are categorised as one for infrastructure and one for oil and gas projects, whilst the remaining three studies are related to delays on general construction project. Salama *et al*. (2008) considered reasons for delay in the oil and gas industry within the UAE. Halloum and Bajracharya (2012) focused their research on the causes of delay in infrastructure projects in Abu Dhabi, the capital of UAE. Over 90% of infrastructure projects in the study had time overruns using multiple linear regression. Three studies investigated general reasons for the delay in construction projects (Faridi and El-Sayegh 2006; Motaleb and Kishk 2010; Ren *et al*. 2008). The first study of construction delay causes within UAE was conducted by Faridi and El-Sayegh (2006). Their study considered practitioners from consultants and contractors groups with no participants from owner organisations. Motaleb and Kishk (2010) argued that reasons for delays are changing over time; they conducted a survey, and compared results with the earlier study of Faridi and El-Sayegh (2006) and significant differences were identified.

The cases of Kuwait and Qatar had studies related to building projects. Two studies were carried out with a focus on Kuwait building projects (Al-Tabtabai 2002; Koushki *et al*. 2005). Al- Tabtabai (2002) examined reasons for delays in building projects through surveying practitioners from contractors, consultants and government organisations. On the other hand, Koushki *et al*. (2005) explored the causes of delay in private residential rather than government projects as an earlier study by Al-Tabtabai (2002). Results from both studies show different reasons for project delays which implies that type of owner organisations may influence time over-run causes. Jurf and Beheiry (2010) considered primary delay contributors to private residential compound projects in Qatar. The study focused on compounds built between 2000 and 2005 by private developers. Consequently, the study did not consider different building projects as high-rise, mixed-use and commercial.

Searching Oman resulted in two studies of time over-run; one of them is specific to causes oil and gas (Ruqaishi and Hamdi 2013) while the other is general construction projects (Alnuaimi and Mohsin 2013). Ruqaishi and Hamdi (2013) attempted to identify reasons for oil and gas project delays. They surveyed 59 project managers from different stakeholders. The results show a good level of agreement between stakeholders. They also debated that findings are likely applicable to other GCC countries; which contradicts other studies. Alnuaimi and Mohsin (2013) considered general construction project time over-run reasons. They reported over 40% of surveyed projects were completed with delays.

Bahrain is the only GCC country with research specific to road projects. Hasan *et al*. (2014) conducted a survey containing 47 causes of delay identified from the literature and administered through industry practitioners. The study concluded that major

reasons for delays are improper planning and inexperienced manpower. While one major cause related to owners is delay in decision-making. A detailed systematic quantitative literature review can be found in Emam *et al*. (2014).

The literature review resulted in a list of potential contributors of causes for delays in construction projects within neighbouring countries to Qatar. The identified causes were used to form the basis of this study after validation. There were several factors influence causes of delays thus; project parameters i.e. size and type, client organisation type, contract arrangement, and time of study Emam *et al*. (2014).

RESEARCH METHODOLOGY

The problem to be studied is construction schedule over-runs. The study commences by conducting a comprehensive literature review. In order to ensure full coverage of literature, a quantitative systematic literature methodology was used as proposed by Pickering and Jason (2014). The methodology is based on identifying keywords related to the problem in study and systematically running electronic searches using these keywords. Filtering of results are then carried out to ensure their relevance to the subject; also references and citations are screened to ensure their inclusion. If the screening resulted in additional papers, additional keywords are generated using found papers and search queries and executed again. This process repeats until no further papers related to the topic are found. Upon completing the systematic identification of literature, results are presented in quantitative form such as frequency counts, number of publications in specific location and for different type of projects. This study literature review was for causes of delay in construction projects in Gulf Cooperation Council (GCC) countries. The search was implemented in several databases including EBSCohost, ProQuest, Scopus, and Web-of-Science. Figure 1, shows the process adopted in the literature review.

A two-stage research method approach is adopted in this study. The first stage is based on exploratory interviews with industry practitioners and researchers. The exploratory interviews were semi-structured to discuss with the interviewees the relevance of the compiled list of delays. The interview methodology was selected to gain an in-depth understanding of the delay causes and discovering new alternatives from the interviewees' experience. The interviews included personal discussions with five industry experts representing clients, consultants, and contractors. The identified list of international causes of delays were sent to participants. The sample size of interviews is identified by saturation as a standard practice of qualitative research methods (Guest *et al*. 2006). The saturation is reached when more meetings do not produce new data. These interviews were digitally recorded along with field notes for the analysis. Upon conducting the interviews, the delay causes list was then refined and enhanced taking into account the feedback from the industry practitioners. The second stage involved the design of a questionnaire to be administered in an electronic survey format. The survey questionnaire was piloted among four industry professionals to ensure that the contents and terminology used were clear to other professionals. The survey was distributed to a random sample of 212 construction professionals. The completed qualified responses were 37, representing participants from clients (5), consultants (17) and contractors'(15) organisations. The overall response rate is 17.45%.

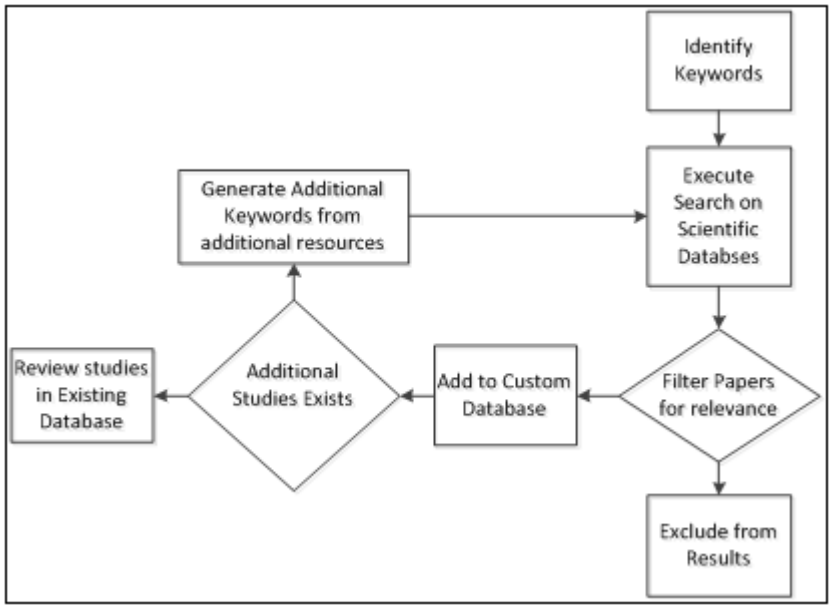

Figure 1: Systematic Search Process Flow (Emam et al. 2014)

The authors acknowledge the low client representation in the sample and therefore no strong inferences are made. The mixed research methodology was employed due to the exploratory nature of the first stage of the study which requires identification of relevant delay causes to Qatar. However, to rank these reasons for delay a quantitative approach is considered more appropriate due to using a sample that will converge to reality. In addition, by using mixed research methods triangulation is achieved by using two methodologies thus; semi-structured interviews and surveys.

Survey Design

The survey was designed in two main parts. The first part collected personal, professional and project information about participants. The collected information provides an understanding of the position of the organisation in relation to the supply chain, the seniority level of participants within organisations, and the experience extent of participants. The project related section collects data on the size of the project, procurement arrangement, contractual agreement, and project type. The second part of the survey targets collecting frequency and severity information from participants about 88 identified causes of delay in Qatar. Factors were clustered into four different groups to corresponding to which party caused the delay i.e. contractors, consultants, clients, and external factors. The frequency is measured in the second part by means of Likert-scale with the possible selections: always coded as 4, often 3, sometimes 3, rarely 1 and never 0. Meanwhile, the severity information is obtained by impact scale with the following choices; very high coded as 4, high 3, moderate 2, low 1, and very low 0.

Data Analysis

The statistical survey analysis technique and indices used in this study were severity index, frequency index and importance index as follows:

Frequency and severity indices formulas are used for the purpose of ranking causes of delays based on their frequency as selected by participants

$$(F.I.)(\%) = \sum a\left(\frac{n}{N}\right) * (\frac{100}{4}) \quad (1)$$

$$(\mathrm{S.I.})(\%) = \sum \mathrm{a}\left(\frac{\mathrm{n}}{\mathrm{N}}\right) * (\frac{100}{4}) \quad (2)$$

where 'a' is, the constant expressing weighting given to each response (ranges from 0 to 4), 'n' is the frequency of the responses, and 'N' is total number of responses.

The relative importance index of each individual cause is calculated from the result of multiplying the frequency index (1) and severity index (2) as shown in formula (3).

$$(IMP.I)(\%) = \frac{(F.I.)(\%)*(S.I.)(\%)}{100} \quad (3)$$

Rank Correlation

The Spearman's rank correlation is used to measure the level of agreement or disagreement of each two parties based on the importance index. The used formula Eq. (4) shows the calculation method of the correlation factor.

$$\mathbf{r_s = 1 - \left[6 * \sum \frac{d^2}{(n^3 - n)}\right]} \quad (4)$$

where 'rs' is Spearman's rank correlation coefficient between two parties; 'd' is the difference in rank assigned to variables of each cause; 'n' is the number of ranks

RESULTS AND DISCUSSION

The results obtained from the administered survey were analysed using the relative importance index (RII) method. The importance of each factor is equivalent to the product of its frequency and severity. The method used justifies importance of each factor by expressing its frequency of occurrence and impact in case the factor occurred. The factors are then ranked based on their subsequent RII for overall and for each group. The results showed that 81% of the projects exceeded the planned time with an average overrun of 25% which reinforces the significance of the problem. The top 20 factors that cause delay are listed in table 2. The party that has lead responsibility for delays are also indicted.

Client Related Factors

Amongst the top ten ranked factors, clients contributed with three causes. Two of these are related to delays in decision making. Changes in project scope and slow decision making by clients are the top factors attributable to clients and especially government organisations due to the bureaucratic nature to access public funds and centralised decision-making authority and governance. The last top factor attributable to clients is delay in approvals of samples and drawings. Interviewees stated that often clients agents assigned to projects are reluctant to issue such variations and pass responsibility to senior management. The impact of these factors can be reduced by delegating authorities from higher management down the hierarchy to a certain extent.

Consultants

The consultants had three factors out of 17 identified in the top ten ranks. The delays of design information by consultants as explained by interviewees are attributable to: contractual agreements with designers that do not hold them liable to delays and distributed physical location of personnel that lead to miscommunication and lack of urgency. These delays were also attributable to poor resource planning where consultant organisations do not have sufficient level of staff to cope with the workload.

Table 2: Top 20 Factors Causing Delay

Rank	Delay description	RII %	Party causing delays
1	Long response from utilities agencies	62.4	External
2	Major change of design during construction	60.5	Consultant
3	Ineffective planning and scheduling	59.7	Contractor
4	Ineffective control of progress	59.2	Contractor
5	Changes in the scope of the project	59.1	Client
6	Slow decision making	57.7	Client
7	Delay in issuing the drawings	56.1	Consultant
8	Delay in solving design problems	56.1	Consultant
9	Delay in approving shop drawings and sample materials	55.1	Client
10	Difficulties in obtaining work permits	53.1	External
11	Delay in issuance of change orders	53.0	Client
12	Discrepancies between specifications and drawings prepared	52.1	Consultant
13	Unreasonable project time frame	52.0	Client
14	Shortage of manpower	51.2	Contractor
15	Delay in the settlement of contractor claims	50.8	Client
16	Poor coordination with the stakeholders	50.5	Contractor
16	Poor site management	50.5	Contractor
18	Slow preparation of change orders requests	50.3	Contractor
19	Low productivity of labourers	50.3	Contractor
20	Delay in reviewing and approving contract documents	49.8	Client

Contractor Factors

The factors attributable to contractors that appeared in the top 10 ranks were two out of total of 40 identified. Contractors related factors are linked to ineffective project planning and control. Effective planning for infrastructure projects can be achieved by selecting adequate planning techniques such as linear scheduling for infrastructure projects, optimising project schedules to achieving objectives with consideration of all constraints, and allowing sufficient buffers to absorb uncertainties impact i.e. robust scheduling. Better progress control systems can be achieved by adopting dynamic scheduling methods.

Factors by External parties to Contracts

The nature of infrastructure projects, is that they cover broad geographical locations. This geographical spread consequently leads to interfacing with different stakeholders. One of the most critical interfaces is utility diversions that were identified as the most influential factor in infrastructure project delays. Late responses and approvals from utility agencies leads to delays to construction at an early stage where there are no alternative works to execute. Utility organisations need to improve their operations by enhancing their processes and procedures; then publishing them to customers with clear timeframes to allow contractors to plan works adequately.

Rank Agreement

Validation of the hypothesis that stakeholders perceive factors causing delay similarly, is tested by running a Spearman rank correlation test as conducted in earlier studies such as Moataleb and Kishk (2010). The results of the analysis shown in Table 3 demonstrates a good degree of agreement between clients and both consultants and contractor organisations. However, it appears that consultants and contractors' views on the main contributing factors to delay of infrastructure projects are not significantly similar.

Table 3: Ranking of subgroups by Different Stakeholders

Organisation Pairs	Spearman's Rank Agreement Coefficient	Probability
Client - Consultant	0.568	0.0220
Client - Contractor	0.779	0.0042
Consultant - Contractor	0.389	0.0990

Comparative Study

The earlier study of delay causes in Qatar investigated residential compound projects in the country; nine of the top ten factors were reported in Jurf and Beheiry (2010). In this section, ranks are compared with the only study about Qatar. The comparison shows considerable change in ranks between residential compounds research by Jurf and Beheiry (2010) and findings of this study on infrastructure projects within Qatar. The study was chosen to demonstrate the significant difference between infrastructure and housing projects causes of delay. Also, the lack of studies focusing on infrastructure projects within GCC countries with only one study (Halloum and Bajracharya, 2012) that employed linear regression where the results are not comparable to the findings of this study.

Table 4: Comparing Top ten causes with Previous Study by Jurf and Beheiry (2010)

Description	Rank in this study	Jurf and Beheiry (2010)	Rank Change
Long response from utility agencies	1	23	-22
Major change in design during construction	2	2	0
Ineffective planning and scheduling	3	11	-8
Ineffective control of progress	4	22	-18
Changes in the scope of the project	5	-	-
Slow decision-making	6	30	-24
Delay in issuing the drawings	7	26	-19
Delay in solving design problems	8	7	1
Delay in approving shop drawings and sample materials	9	26	-17
Difficulties in obtaining work permits	10	-	-

CONCLUSION

Examining factors contributing to delays of infrastructure projects in Qatar was the aim of this study. A systematic quantitative literature review method was adopted to ensure full coverage of previous studies and identify gaps in literature. This process

lead to identifying 120 factors that were filtered to 88 relevant to Qatar based on interviews with industry practitioners. The filtered factors were then subject to an online questionnaire where 37 infrastructure professionals from clients, consultants and contractors participated. The results were then analysed to produce ranking for each of the factors. The top ten factors were distributed amongst the stakeholders with two related to contractors, three for consultants, three for clients and two associated with external stakeholders. The top five factors were: long response from utility agencies; major change in design during construction; ineffective planning and scheduling; ineffective control of progress; and changes in the scope of the project. Rank agreement between stakeholders shows good rank agreement between clients and both contractors and consultants. On the contrary, consultants and contractors seem to perceive priorities of various factors differently. The study also compared results with previous research examining causes of delay in residential compounds projects in Qatar and found considerable differences in ranking priority.

Future research can potentially focus on further studies on delay causes in other project types such as buildings, utilities, and oil and gas, to understand causes of delay with more granularity. In addition, general studies of different project types to investigate the significance of differences between them will help to confirm the presented arguments. On the other hand, studies on resolving major causes should be conducted to enhance processes and reduce exposure. For example the problem of planning and scheduling need to be investigated for practical solutions to increase the effectiveness by implementing several techniques for optimising schedule baselines, and subsequent revision of programmes using dynamic scheduling methods. These programming techniques account for buffers to absorb impact of uncertainties, and use rescheduling techniques to adjust programmes to current project status.

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