

Causes of delay in large construction projects

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Abstract

A survey on time performance of different types of construction projects in Saudi Arabia was conducted to determine the causes of delay and their importance according to each of the project participants, i.e., the owner, consultant and the contractor. The field survey conducted included 23 contractors, 19 consultants, and 15 owners. Seventy-three causes of delay were identified during the research. 76% of the contractors and 56% of the consultants indicated that average of time overrun is between 10% and 30% of the original duration. The most common cause of delay identified by all the three parties is “change order”. Surveys concluded that 70% of projects experienced time overrun and found that 45 out of 76 projects considered were delayed.

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1. Introduction

In construction, delay could be defined as the time over-run either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project. It is a project slipping over its planned schedule and is considered as common problem in construction projects. To the owner, delay means loss of revenue through lack of production facilities and rent-able space or a dependence on present facilities. In some cases, to the contractor, delay means higher overhead costs because of longer work period, higher material costs through inflation, and due to labor cost increases.

Completing projects on time is an indicator of efficiency, but the construction process is subject to many variables and unpredictable factors, which result from many sources. These sources include the performance of parties, resources availability, environmental conditions, involvement of other parties, and contractual relations. However, it is rarely happen that a project is completed within the specified time.

2. Objectives of the study

The main objectives of this study include the following:

- To identify the causes of delays in construction in Eastern Province of Saudi Arabia.
- To test the importance of the causes of delay between each two groups of parties.
- To study the differences in perceptions of the three major parties in any constructions, namely, owners, contractors and consultants.

3. Literature review

Many articles and studies conducted on causes of delay in construction projects, both locally and internationally have been reviewed. Surveys conducted by Assaf et al. [4] outlined 56 main causes of delay in large construction projects. Delay factors are assembled into nine major groups with different levels of importance to different parties. Al-Ghaffly [2] discussed the delay in public water and sewage projects. Sixty causes were identified and classified. Al-Ghaffly [2] concluded the following: the delay occurred

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frequently in medium and large size projects, and considered severe in small projects. There are many important causes of delay related to owner involvement, contractor performance, and the early planning and design of the project. Important causes are financial problems, changes in the design and scope, delay in making decisions and approvals by owner, difficulties in obtaining work permit, and coordination and communication problems.

Chan and Kumaraswamy [5] conducted a survey to evaluate the relative importance of 83 potential delay factors in Hong Kong construction projects and found five principal factors: poor risk management and supervision, unforeseen site conditions, slow decision making, client-initiated variations, and work variations.

Kaming et al. [6] studied influencing factors on 31 high-rise projects in Indonesia and found out that cost overruns occur more frequently and are more severe problem than time overruns. They pointed out that the major factors influencing cost overrun are material cost increase due to inflation, inaccurate material estimation and degree of complexity. While in time overrun, the most important factors causing delays are design changes, poor labor productivity, inadequate planning, and resource shortages.

Kumaraswamy and Chan [7] studied the causes of construction delays in Hong Kong. They found that there was a difference in perceptions as to causes of delays by different groups of participants in building and civil engineering works. They suggested that biases of different industry groups might direct blame for delays to other groups.

Noulmanee et al. [9] investigated causes of delays in highway construction in Thailand and concluded that delays can be caused by all parties involved in projects; however, main causes come from inadequacy of sub-contractors, organization that lacks of sufficient resources, incomplete and unclear drawings and deficiencies between consultants and contractors. The study suggested that delay can be minimized by discussions that lead to understanding.

Al-Momani [3] investigated causes of delay in 130 public projects in Jordan. The main causes of delay were related to designer, user changes, weather, site conditions, late deliveries, economic conditions and increase in quantity. The study suggested that special attention to factors will help industry practitioners in minimizing contract disputes. Delays have strong relationship with failure and ineffective performance of contractors.

Ubaid [10] discussed the performance of contractors as one of the major causes of delay. Thirteen (13) major measures were considered. These measures are related to contractor resources and capabilities. Al-Barak [1] discussed the main causes of failure in Construction industry in Saudi Arabia by surveying 68 contractors and about 34 different causes of failure. The study concluded that lack of experience, poor estimation practices, bad decisions in regulating company's policy, and national slump in the economy are the severe factors.

4. Research methodology

The research methodology contained: Seventy-three (73) causes of delay were identified through literature review and discussion with some parties involved in construction industry. A questionnaire was developed in order to evaluate the frequency of occurrence, severity and importance of the identified causes. Contractors information was collected from Chamber of Commerce and from the lists of contractors from literature. Also, information about consultants and design engineers were collected from lists of consultants found in literature, as well as from Building & Engineering Consultation Directory published by Engineering Committee in the Ministry of Commerce of Saudi Arabia [8].

Data were gathered through a survey, analyzed by using frequency, severity and importance indices, taking in view owners, contractors and consultants. Agreement on the ranking of the importance of the causes of delay between each two groups of parties was also tested. Recommendations for minimizing delay in construction projects were emphasized in view of the results of the study.

5. Questionnaire design

Data were gathered through a questionnaire. The questionnaire is divided into two main parts. Part I is related to general information for both the company and respondent. Both contractors and consultants were further requested to answer questions pertaining to their experience in the construction industry and their opinions about the percentage average time delay in projects they experienced. Part II includes the list of the identified causes of delay in construction project. These causes are classified into nine (9) groups according to the sources of delay: Factors related to project, owner, contractor, consultant, design-team, materials, equipment, manpower (labor), and external factors.

For each cause/factor two questions were asked: What is the frequency of occurrence for this cause? And what is the degree of severity of this cause on project delay? Both frequency of occurrence and severity were categorized on a four-point scale. Frequency of occurrence is categorized as follows: always, often, sometimes and rarely (on 4 to 1 point scale). Similarly, degree of severity was categorized as follows: extreme, great, moderate and little (on 4 to 1 point scale).

6. Data analysis approach

The collected data were analyzed through the following statistical techniques and indices:

Frequency index: A formula is used to rank causes of delay based on frequency of occurrence as identified by the participants

$$\text{Frequency Index (F.I.) (\%)} = \sum a(n/N) * 100/4 \quad (1)$$

where a is the constant expressing weighting given to each response (ranges from 1 for rarely up to 4 for always), n is the frequency of the responses, and N is total number of responses.

Severity index: A formula is used to rank causes of delay based on severity as indicated by the participants.

$$\text{Severity Index (S.I.) (\%)} = \sum a(n/N) * 100/4 \quad (2)$$

where a is the constant expressing weighting given to each response (ranges from I for little up to 4 for severe), n is the frequency of the responses, and N is total number of responses.

Importance index: The importance index of each cause is calculated as a function of both frequency and severity indices, as follows:

$$\begin{aligned} \text{Importance Index (IMP.I.) (\%)} \\ = [\text{F.I. (\%)} * \text{S.I. (\%)}] / 100 \end{aligned} \quad (3)$$

7. Spearman's rank correlation

Spearman's rank correlation is a non-parametric test. Non-parametric tests are also referred to as distribution-free tests. These tests have the obvious advantage of not requiring the assumption of normality or the assumption of homogeneity of variance. They compare medians rather than means and, as a result, if the data have one or two outliers, their influence is negated. In this research the Spearman's Correlation is used. Correlation is a relationship measure among different parties or factors and the strength and direction of the relationship. In this research it is used to show the degree of agreement between the different parties. The correlation coefficient varies between +1 and -1, where +1 implies a perfect positive relationship (agreement), while -1 results from a perfect negative relationship (disagreement). It might be said then that sample estimates of correlation close to unity in magnitude imply good correlation, while values near zero indicate little or no correlation. The Spearman's rank correlation coefficient r is used to measure and compare the association between the rankings of two parties for a single cause of delay, while ignoring the ranking of the third party. And it is calculated by the following formula:

$$r_s = 1 - [(6 \sum d^2) / (n^3 - n)] \quad (4)$$

where r is the Spearman rank correlation coefficient between two parties, d is the difference between ranks assigned to variables for each cause, and n is the number of pairs of rank.

8. Research findings and results

8.1. General characteristics of respondents

Respondents included 23 contractors, 19 consultants and 15 owners out of 66, 51 and 27 distributed question-

naires, respectively. The contractors surveyed are categorized as grade 2 or above. They have an average of experience of about 23 years, while, participated consultants have an average of about 21 years of experience. Simple random sampling was used to select the participants from an available list.

About 76% of the participating contractors specified indicated that the average time overrun for the projects they have experienced is between 10% and 30% of the original project duration. About 56% of the participated consultants specified the same percentage. About 25% of the consultants indicated 30–50% time overrun compared to the original specified duration. Neither consultants nor contractors indicated any time delay of greater than 100% of the original contract duration.

This study covers both private and public projects and has been chosen to be just or almost completed. Owners who have experience with more than one project are surveyed. The participated owners included government departments. Saudi Aramco, Saudi Electricity Company, Eastern Branch, Girls College, Al-Yaum daily newspaper, and others.

8.2. Ranking of delay causes

The three ranking indices explained earlier were used to rank delay causes from viewpoints of the three parties (owners, contractors and consultants). Table 1 shows a list of causes of delay categorized into the mentioned nine groups.

8.3. Frequency of delay causes

The most frequent causes of delay according to owners, consultants and contractors are shown in Table 2. From owner's point of view, the most frequent causes of delay are related to both contractor and labors. Results indicate that owners are realizing that awarding of projects to the lowest bidder is one of the highest frequent factors of delay. Inputs of the contractors indicate that the most frequent causes of delay are related to the owners. Consultants, like owners, assign awarding the lowest bidder as the most frequent factor of delay. This is due to that most of owners award the lowest bidder to execute their projects. Generally, the lowest bidders are unqualified contractors with shortage in resources and low capabilities, which lead to low performance and which cause delay in completion of the work.

8.4. Severity of delay causes

The most severe causes of delay, indicated by all parties separately, will be highlighted. Owners point out most of the severe causes of delay to contractor and labors. Inputs of owners underline that delay of progress payment by the owner is one of the most severe causes of delay. The most severe causes of delay as seen by the owners are as follows:

Table 1
List of causes of delay categorized into nine groups

No.	Causes of delay	Group
1	Original contract duration is too short	Project
2	Legal disputes b/w various parts	Project
3	Inadequate definition of substantial completion	Project
4	Ineffective delay penalties	Project
5	Type of construction contract (Turnkey, construction only,,)	Project
6	Type of project bidding and award (negotiation, lowest bidder,,)	Project
7	Delay in progress payments by owner	Owner
8	Delay to furnish and deliver the site to the contractor by the owner	Owner
9	Change orders by owner during construction	Owner
10	Late in revising and approving design documents by owner	Owner
11	Delay in approving shop drawings and sample materials	Owner
12	Poor communication and coordination by owner and other parties	Owner
13	Slowness in decision making process by owner	Owner
14	Conflicts between joint-ownership of the project	Owner
15	Unavailability of incentives for contractor for finishing ahead of schedule	Owner
16	Suspension of work by owner	Owner
17	Difficulties in financing project by contractor	Contractor
18	Conflicts in sub-contractors schedule in execution of project	Contractor
19	Rework due to errors during construction	Contractor
20	Conflicts b/w contractor and other parties (consultant and owner)	Contractor
21	Poor site management and supervision by contractor	Contractor
22	Poor communication and coordination by contractor with other parties	Contractor
23	Ineffective planning and scheduling of project by contractor	Contractor
24	Improper construction methods implemented by contractor	Contractor
25	Delays in sub-contractors work	Contractor
26	Inadequate contractor's work	Contractor
27	Frequent change of sub-contractors because of their inefficient work	Contractor
28	Poor qualification of the contractor's technical staff	Contractor
29	Delay in site mobilization	Contractor
30	Delay in performing inspection and testing by consultant	Consultant
31	Delay in approving major changes in the scope of work by consultant	Consultant
32	Inflexibility (rigidity) of consultant	Consultant
33	Poor communication/coordination between consultant and other parties	Consultant
34	Late in reviewing and approving design documents by consultant	Consultant
35	Conflicts between consultant and design engineer	Consultant
36	Inadequate experience of consultant	Consultant
37	Mistakes and discrepancies in design documents	Design
38	Delays in producing design documents	Design
39	Unclear and inadequate details in drawings	Design
40	Complexity of project design	Design
41	Insufficient data collection and survey before design	Design
42	Misunderstanding of owner's requirements by design engineer	Design
43	Inadequate design-team experience	Design
44	Un-use of advanced engineering design software	Design
45	Shortage of construction materials in market	Materials
46	Changes in material types and specifications during construction	Materials
47	Delay in material delivery	Materials
48	Damage of sorted material while they are needed urgently	Materials
49	Delay in manufacturing special building materials	Materials
50	Late procurement of materials	Materials
51	Late in selection of finishing materials due to availability of many types in market	Materials
52	Equipment breakdowns	Equipment
53	Shortage of equipment	Equipment
54	Low level of equipment-operator's skill	Equipment
55	Low productivity and efficiency of equipment	Equipment
56	Lack of high-technology mechanical equipment	Equipment
57	Shortage of labors	Labors
58	Unqualified workforce	Labors

Table 1 (continued)

No.	Causes of delay	Group
59	Nationality of labors	Labors
60	Low productivity level of labors	Labors
61	Personal conflicts among labors	Labors
62	Effects of subsurface conditions (e.g., soil, high water table, etc.)	External
63	Delay in obtaining permits from municipality	External
64	Hot weather effect on construction activities	External
65	Rain effect on construction activities	External
66	Unavailability of utilities in site (such as, water, electricity, telephone, etc.)	External
67	Effect of social and cultural factors	External
68	Traffic control and restriction at job site	External
69	Accident during construction	External
70	Differing site (ground) conditions	External
71	Changes in government regulations and laws	External
72	Delay in providing services from utilities (such as water, electricity)	External
73	Delay in performing final inspection and certification by a third party	External

Table 2

Frequency of delay causes

S. no.	Owners	Contractors	Consultants
1	Type of project bidding and award	Delay in progress payments by owner	Type of project bidding and award
2	Shortage of labors	Suspension of work by owner	Change orders by owner during construction
3	Ineffective planning and scheduling of project by contractor	Late in reviewing and approving design documents by owner	Shortage of labors
4	Low productivity level of labors	Change orders by owner during construction	Ineffective planning and scheduling of project by contractor
5	Unqualified work force	Late procurement of materials	Delay in progress payments by owner
6	Change orders by owner during construction	Mistakes and discrepancies in design documents	Low productivity level of labors
7	Hot weather effect on construction activities	Delays in producing design documents	Unavailability of incentives for contractor to finish ahead of schedule
8	Type of construction contract (turnkey, construction only)	Difficulties in financing project by contractor	Ineffective delay penalties
9	Poor site management and supervision by contractor	Late in reviewing and approving design documents by consultant	Hot weather effect on construction activities
10	Conflicts encountered with sub-contractors' schedule in project execution	Slowness in decision-making process by owner	Poor qualification of the contractors technical staff

- Shortage of labors.
- Unqualified work force.
- Inadequate contractor's experience.
- Difficulties in financing project by contractor.
- Ineffective planning and scheduling of project by contractor.
- Low productivity level of labors.
- Rework due to errors during construction.
- Delay in progress payments by owner.
- Original contract duration is too short.

Similar to owners, consultants indicate that the most severe causes of delay are related to contractors. Following are the most severe causes of delay as seen by the consultants:

- Difficulties in financing project by contractor.
- Inadequate contractor's experience.
- Shortage of labors.
- Delay in progress payments by owner.

- Delay in material delivery.
- Poor site management and supervision by contractor.
- Ineffective planning and scheduling of project by contractor.
- Type of project bidding and award.
- Poor qualification of the contractor's technical staff.
- Low productivity level of labors.
- Unqualified work force.

8.5. Importance of delay causes

Table 3 shows the most important causes of delay according to the owners, contractors and consultants. The importance index of each cause is calculated as a product of both frequency and severity indices.

Only one cause of delay is common between all parties, which is "change orders by owner during construction". There are many causes which are common between two parties, such as delay in progress payments by owner,

Table 3
Importance of delay causes

S. no.	Owners	Contractors	Consultants
1	Shortage of labors	Delay in progress payments by owner	Type of project bidding and award
2	Unqualified work force	Late in reviewing and approving design documents by owner	Shortage of labors
3	Ineffective planning and scheduling of project by contractor	Change orders by owner during construction	Delay in progress payments by owner
4	Low productivity level of labors	Delays in producing design documents	Ineffective planning and scheduling of project by contractor
5	Hot weather effect on construction activities	Late in reviewing and approving design documents by consultant	Change orders by owner during construction
6	Conflicts encountered with sub-contractors' schedule in project execution	Difficulties in financing project by contractor	Low productivity level of labors
7	Poor site management and supervision by contractor	Mistakes and discrepancies in design documents	Difficulties in financing project by contractor
8	Inadequate contractor's experience	Late procurement of materials	Poor site management and supervision by contractor
9	Effects of subsurface conditions (soil, existing of utilities, high water table, etc)	Inflexibility (rigidity) of consultant	Poor qualification of the contractor's technical staff
10	Change orders by owner during construction	Slowness in decision making process by owner	Delay in material delivery

ineffective planning and scheduling of project by contractor, poor site management and supervision by contractor, shortage of labors and difficulties in financing project by contractor.

All three parties agree that the following delay causes are the least important:

- Changes in government regulations and laws.
- Traffic control and restrictions at job site.
- Effect of social and cultural factors.
- Accidents during construction.

8.6. Ranking of sources (Groups) of delays

The causes are grouped into nine classes. Ranking of these groups associated with frequency of occurrence, degree of severity and importance by owners, contractors and consultants are presented in Tables 4–6, respectively.

Tables 4 and 6 show that owners and consultants specify labor, contractor, and project related causes as sources of

delay. While, contractors indicate that sources of delay in construction projects are owners and consultants. The combined results that are presented in Table 7 show that delay in construction projects is mostly originated by the owner, followed by the contractor. Design, labor and consultant related factors are less importance.

8.7. Importance rank correlation

The Spearman's rank correlation coefficient is used to measure the degree of agreement or disagreement associated with the importance ranking of each two parties while ignoring the ranking of the third party. Eq. (4) is used for this purpose. Results show that there is relatively good agreement between each two groups of parties in ranking delay causes with the highest degree of agreement (about 72.4%) between owners and consultants, while, the lowest degree of agreement is between owners and consultants of about 56.8%. Due to relative agreement between each group of parties in ranking causes, results of this study can be dependable Table 8.

Table 4
Ranking of sources (groups) of delay by owner

Sources (groups) of delay	Freq. of occurrence		Degree of severity		Importance index	
	Index	Rank	Index	Rank	Index	Rank
Labor-related factors	65.75	1	71.28	1	46.87	1
Contractor-related factors	58.16	3	69.34	2	40.33	2
Project-related factors	59.34	2	65.63	3	38.94	3
Owner-related factors	54.97	4	63.89	5	35.12	4
Consultant-related factors	52.94	6	64.9	4	34.36	5
Plan/equipment-related	53	5	62.67	7	33.21	6
Design team-related factors	51.89	7	62.5	8	32.43	7
Materials-related factors	50.25	9	63.83	6	32.07	8
External factors	50.43	8	57.67	9	29.08	9

Table 5
Ranking of sources (groups) of delay by contractor

Sources (groups) of delay	Freq. of occurrence		Degree of severity		Importance index	
	Index	Rank	Index	Rank	Index	Rank
Owner-related factors	61.41	1	66.9	1	46.87	1
Consultant-related factors	60.09	2	64.38	2	40.33	2
Design team-related factors	56.52	3	63.64	4	38.94	3
Materials-related factors	52.83	4	64.31	3	35.12	4
Labor-related factors	51.09	5	59.4	6	34.36	5
Contractor-related factors	49.31	6	61.36	5	33.21	6
Project-related factors	48.86	7	54.07	7	32.43	7
External factors	43.96	8	47.99	9	32.07	8
Plan/equipment-related	41.3	9	50	8	29.08	9

Table 6
Ranking of sources (groups) of delay by consultant

Sources (groups) of delay	Freq. of occurrence		Degree of severity		Importance index	
	Index	Rank	Index	Rank	Index	Rank
Contractor-related factors	52.13	4	69.41	1	36.19	1
Labor-related factors	55	2	65.79	2	36.18	2
Project-related factors	57.46	1	62.5	6	35.91	3
Owner-related factors	53.55	3	64.87	3	34.74	4
Design team-related factors	49.17	5	62.91	5	30.94	5
Materials-related factors	46.99	6	64.12	4	30.13	6
Consultant-related factors	42.8	8	57.89	7	24.78	7
Plan/equipment-related	44.74	7	55	8	24.61	8
External factors	41	9	50.87	9	20.82	9

Table 7
Ranking of sources (groups) of delay by all parties (combined)

Sources (groups) of delay	Freq. of occurrence		Degree of severity		Importance index	
	Index	Rank	Index	Rank	Index	Rank
Owner-related factors	61.39	1	71.47	1	43.88	1
Contractor-related factors	56.81	2	67.08	2	38.11	2
Design team-related factors	56.45	5	66.65	3	37.63	3
Labor-related factors	56.51	4	66.58	4	37.62	4
Consultant-related factors	56.53	3	66.49	5	37.59	5
Materials-related factors	49.55	6	62.34	6	30.89	6
External factors	48.9	8	56.6	8	27.68	7
Project-related factors	48.96	7	56.15	9	27.49	8
Plan/equipment-related	48.43	9	56.72	7	27.47	9

Table 8
Spearman rank correlation coefficient

Parties	Spearman rank correlation coefficient	Significance level
Owners and contractors	0.568	0.95
Owners and consultants	0.724	0.95
Contractors and consultants	0.664	0.95

9. Summary and conclusion

The delay in construction projects in Saudi Arabia is discussed in a field survey. It studied frequency, severity and importance of the causes of delay. The importance index of each cause is calculated as a product of both frequency and severity indices of each cause. 73 causes of

delay were identified through research. The identified causes are combined into nine groups. The field survey included 23 contractors, 19 consultants, and 15 owners. Data collected were analyzed by frequency, severity and importance.

76% of the contractors have indicated that average of time overrun is between 10% and 30% of original duration, while about 56% of the consultants specified the same percentage. 25% of the consultants have indicated from 30% to 50% average time overrun. Owners specified that causes of delay are related to contractor and labors. Study indicated that owners and consultants realize that awarding to the lowest bidder is the highest frequent factor of delay, while, contractors considered severe causes of delay are related to owners.

Only one cause of delay is common between all parties, which is “change orders by owner during construction”. Many causes are common between two parties, such as delay in progress payments, ineffective planning and scheduling by contractor, poor site management and supervision by contractor, shortage of labors and difficulties in financing by contractor. All parties agree that the following causes are the least important: changes in government regulations, traffic control and restrictions at site, effect of social and cultural factors and accidents during construction.

Both owners and consultants specify labor and contractor related causes as the severe and important sources of delay, while, contractors indicate that the important sources of delay in construction projects are owners and consultants. The values of the Spearman's rank correlation coefficients show that there is relative good agreement between each two groups of parties in ranking of the importance of delay causes. The highest degree of agreement is 72.4% between owners and consultants, while the lowest is 56.8% between owners and contractors.

10. Recommendations

10.1. General recommendation

The following points can be recommended by all parties in order to minimize and control delays in construction projects:

Owners should give special attention to the following factors:

- Pay progress payment to the contractor on time because it impairs the contractors ability to finance the work.
- Minimize change orders during construction to avoid delays.
- Avoid delay in reviewing and approving of design documents than the anticipated.
- Check for resources and capabilities, before awarding the contract to the lowest bidder.

Contractors should consider the following factors:

- Shortage and low productivity of labor: enough number of labors should be assigned and be motivated to improve productivity.
- Financial and cash flow problems: contractor should manage his financial resources and plan cash flow by utilizing progress payment.
- Planning and scheduling: they are continuing processes during construction and match with the resources and time to develop the work to avoid cost overrun and disputes.
- Site management and supervision: administrative and technical staff should be assigned as soon as project is awarded to make arrangements to achieve completion within specified time with the required quality, and estimated cost.

Consultants should look to the following points:

- Reviewing and approving design documents: any delay caused by the consultant engineer in checking, reviewing and approving the design submittals prior to construction phase, could delay the progress of the work;
- Inflexibility: Consultants should be flexible in evaluating contractor works. Compromising between the cost and high quality should be considered.

Finally; *Architect/design engineer* should focus on the following issues:

- Producing design documents on time: A/E should set a schedule to complete design documents on time, otherwise result in a delay of work completion.
- Mistakes and discrepancies in design documents: They are common reasons for redoing designs and drawings and may take a long time to make necessary corrections.

10.2. Recommendations for future studies

Similar study can be performed in other provinces/cities of Saudi Arabia. Another study can be done for a specific type of construction projects, such as utility projects, highways construction project, dam construction projects, etc. Detail studies can be done to evaluate the involvement and effect of a specific party or resource of construction project to the time overrun in construction projects. A research can be carried out to investigate the effect of financing and cash flow problems on delays in construction projects.

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References

- [1] Al-Barak AA. Causes of contractors' failures in Saudi Arabia. Master thesis, CEM Dept., KFUPM. Dhahran, Saudi Arabia, 1993.
- [2] Al-Ghaffly MA. Delays in the construction of public utility projects in Saudi Arabia. Master thesis, CEM Dept., KFUPM, Dhahran, Saudi Arabia, 1995.
- [3] Al-Momani AH. Construction delay: a quantitative analysis. *International Journal of Project Management* 2000;18(1):51–9.
- [4] Assaf SA, Al-Khalil M, Al-Hazmi M. Causes of delays in large building construction projects. *ASCE J Manage Eng* 1995;11(2): 45–50.
- [5] Chan DW, Kumaraswamy MM. A comparative study of causes of time overruns in Hong Kong construction projects. *Int J Project Manage* 1997;15(1):55–63.
- [6] Kaming P, Olomolaiye P, Holt G, Harris F. Factors influencing construction time and cost overruns on high-rise projects in Indonesia. *Construct Manage Econom* 1997;15:83–94.

- [7] Kumaraswamy M, Chan D. Contributors to construction delay. *Construct Manage Econom* 1998;16(1):17–29.
- [8] Ministry of Commerce, Building & Engineering Consultation Directory, Issue (2000–2001), Published by Engineering Committee in the Ministry of Commerce, Saudi Arabia.
- [9] Noulmanee A, Wachirathamrojn J, Tantichattanont P, Sittivijan P. Internal causes of delays in highway construction projects in Thailand. www.ait.clet.com, July, 1999.
- [10] Ubaid AG. Factors affecting contractor performance. Master thesis, CEM Dept., KFUPM, Dhahran, Saudi Arabia, 1991.