



## An Evaluation of the Causes of Time Overruns in Oil and Gas Megaprojects: Sultanate of Oman Perspective

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### Abstract

Construction projects have been suffering from a slippage on an agreed and planned complete date which causes undesirable results. This paper reviews around Asian countries that shed light on the most important delay factors exist. Moreover, comparison of such oil and gas mega construction projects is investigated. Past researchers categorized the delay factors into different groups, some four and six group while others reached up to nine groups. Such studies were done on private and commercial buildings, infrastructure, and oil and gas projects. Most of the done studies picked up the delay causes for their questionnaires from a collection of literature reviews and local experts to fit geographical location and type of project. "Important index" has been used for most of those studies to analyze the data found. Material management has been found more vital in this industry. There is a real necessity to have more research studies in some countries like Oman to have success in delivering projects.

**Keywords:** Project; Construction Delay Factors; Causes of Delay; Time Overrun

### 1. Introduction

Effective construction management is imperative because the quality of a project relies on it and the fact that most of project plan and cost are spent during the construction phase. Comparing to engineering phase either feed or detailed designs, construction phase takes much longer time. Likewise, around 90% of the project budget is consumed in the phase of construction (Garold Oberlender, 2000. p. 258).

Delay in the construction phase in a project has been defined as "the time overrun either beyond completion date specified in a contract or beyond the date that parties agreed on for a delivery of a project" according to Assaf and Al-Hejji (2005).

Delay in projects could start either in early stages or later ones, and the former, the researcher believes, is worse. The reason is that delays would be cascaded from one stage to another (identify, assess, define, select, execute, and operate) and it would be difficult to recover. Salama et al., 2008, study shows that there is high correlation between a delay that takes place in FEED and the execution phase.

The most overruns on time and cost usually occur in execution phase (Elawi et al., 2015) (Salama et al., 2008), (Hadikusumo, 2014), and (Chan and Kumaraswamy, 1997).

A study conducted in Saudi Arabia revealing that 70% of construction projects suffered from an overrun in Schedule (Assaf and Al-Hejji, 2005). In more specific city, only 61% of Mecca projects were completed on time (Elawi et al.). Sometimes the delay reaches 90% like in MARA projects in Malaysia (Memon et al., 2011).

According to the International Energy Agency, 2006, the average delay in oil and gas (O and G) projects ranges from 5% to 20% (Salama et al.); however, it is been found that the average of delay in

some Iranian petrochemical plants was around 63% of the planned (Naimi et al., 2008) and only four projects have been completed on time out of 34 projects and that is huge.

In terms of budget, it has been found that average of cost overrun is 18% among 200 projects studied in O and G business (Rui et al., 2016).

Although it has been mentioned construction projects are all similar, the assumption is that the main causes of time overrun in O and G projects are different from the rest (Salama et al.). Moreover, it has been found that in execution phase, the time slippage occurs more than other phases of the project (Salama et al.) and the construction phase out of the execution phase is the main concern in a project cycle (Hadikusumo, 2014).

Furthermore, according to independent project analysis (IPA), 2011, 78% of O and G projects especially the upstream one suffered either from time or cost overrun (EY report in 2014, EYGM limited), and in the same report, it reveals that Middle East region has a more delay percentage than the mentioned above percentage.

## 2. Literature Review

Megaprojects definition has been various in previous researches, however, the word “mega” when taken solely, it represents six figures. Thus, it has been based on the investment value of a project (Emam et al., 2015).

Historically, big projects have been called megaprojects due to its high value and at that time million was the highest, especially in pre-second war era. Later, projects started to cost more and more till reached nine figures which technically should be called “Giga Projects.” However, this word “Giga” never been picked up and used to, therefore, the term megaprojects have been used commonly even if they cost is more than a thousand million. According to Merriam-Webster Dictionary, 1<sup>st</sup> time the term megaproject used was in 1976. The word mega alone started to mean “Very Large” in 1982 mega (Flyvbjerg, 2014).

According to Flyvbjerg, 2014, megaprojects are referred to those projects that cost billions of the US and the ones that cost <1 billion are called major projects.

Other authors such as Fiori and Kovaka (2005) state that definition of megaprojects formally does not exist.

### 2.1. Definition of megaproject in O and G

Similar to megaproject in general industry, the definition is based on how much the project costs. Within the limited articles in O and G megaprojects, two articles from Canada, Chanmeka et al., 2012, and Jergeas, 2008, there is a high degree of agreement on the definition of megaprojects, between \$500 million and 1 billion. Moreover, projects more than 1 billion would still be called megaprojects.

Within Oman O and G projects, there is a reference with leading company of calling projects with a budget of more than \$200 million a large project and between 50 and 200 a medium one. In contrast with paper published by AlKiyumi, 2017, one of the public projects examined was around 200 million but called a megaproject.

For this paper, the researcher is to use megaprojects term that is aligned with Oman, leading oil company, larger than \$200 million.

### 2.2. General features of megaprojects

Looking at the trend of the past decade, megaprojects in all industries have been increasing and that would not stop. In general, megaprojects are complex and risky, consume high level of investment, and take longer period of time. Stakeholders in those projects are diverse and include both public and private sectors. Moreover, megaprojects have a strong effect on millions of human beings (Flyvbjerg, 2014).

In terms of overruns, Flyvbjerg has evidence that nine out of 10 megaprojects are to experience time overrun and the same number to experience cost overrun, so there is high tendency of slippage in these targets than smaller projects (Frimpong et al., 2002) (Heerkens, 2002).

Jia et al., 2011, argued although megaprojects with their challenges have been recognized a long time ago and still over budgeting and delays are still associated with them. He states that this is not in line with profit maximization theory. Moreover, disputes are results of these overruns can be prolonged even after the megaproject is completed (Motaleb and Kishk 2010) (Motaleb and Kishk 2013).

### 2.3. Features of megaprojects in O and G

O and G megaprojects have similar features to other type of industries with perhaps additional uniqueness. O and G megaproject's sites are more likely to be constructed on harsh extreme conditions and isolated areas, and often, there is more lack of competent resources for project delivery. Furthermore, construction phase in these projects starts even before the design is completed (Chanmeka et al., 2012). In addition, interfaces in mega O and G projects are huge and cannot be underestimated. The risks are even greater in those projects and must be sometimes managed by a higher level of authority than the project team (Jergeas, 2008). The last feature but not the least in mega O and G projects is the technology. It has reached a high level of advancement, and sometimes, such technology has not been tested yet (Morrow, 2011).

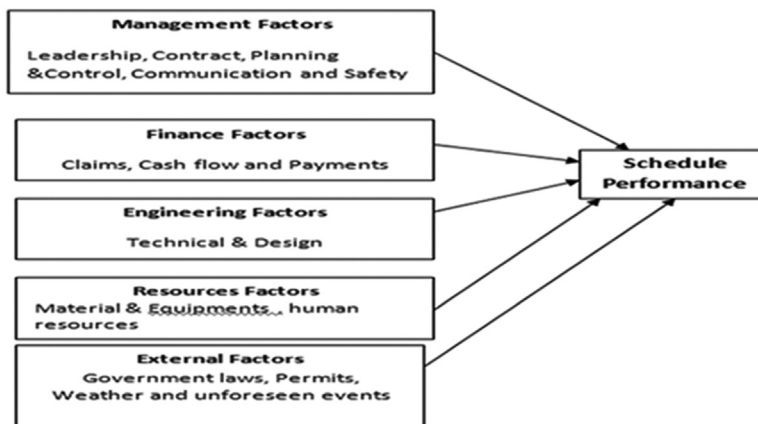
Assaf and Al-Hejji have gone for nine categories that included project, design, materials, equipment, labors, and external.

Looking in depth at the causes, one could see that they are different from one country to another, and even they are different in the same country, and Emam et al. (2015) have confirmed such in their critical review paper. Alnuaimi and Almohsin have done their studies in two periods and clearly the findings were different. One reason concluded that it is because those studies were not done in the same type. However, one common cause found to be the change of orders. These are modifications in design in the construction phase and variations in general. Although Assaf and Al-Hejji have not ranked the causes found in overall regardless of stakeholder (owners, contractor, and consultant), they found that "change orders by owners" are the common cause between all parties. Those significant causes are perceived differently from different stakeholders (Kalkani and Malek, 2016) (Le-Hoai et al., 2008).

## 3. Research Methodology

Figure shows the framework proposed by the author for the factors that affect schedule performance in O and G projects. It could be seen that it is not based on stakeholders; it is based on areas of concern. In O and G project, especially mega ones, engineering, procurement, and construction works are done by a main contractor, although there is good number of cases where EP phase is done by one contractor and construction is by another. Nevertheless, the stakeholder term "consultants" (wherein, other types of construction are one of the main) in O and G megaprojects are diminishing.

### 3.1. Conceptual framework



#### 4. Findings and Analysis

There is a real necessity to analyze the O and G project performance, one for the cliché that says time means money and second, there have been limited studies.

About 64% of O and G megaprojects facing cost overrun and 73% in schedule in the world, where Middle East is the worst region in that department: 87% proportion of projects suffer from time overrun and 89% in cost (EY report in 2014).

The number of literature reviews in time and cost overrun investigation in O and G projects has been very few compared to the normal construction industries.

There have been as few as two articles found on schedule performance in O and G industry in Iran one on gas pipeline projects and the second is on petrochemical plants. Despite the fact that those articles were 5 years apart and different projects in the O and G field, the most vital factor in project delay of the two studies is the material delivery.

Naimi et al., 2008, explained that those materials are not easy to find in the local market and the delivery of those take much longer than other industries items. Besides, the local government had passed a law to have at least 51% of the items must be purchased from the inside. Whereas Fallahnejad (2013) states that, root cause behind such is the global sanction on Iran (at that time at least).

Another cause of project delay in O and G projects in Iran which found in the top three of two articles is the unfeasible project duration set by the client.

Fallahnejad's input on this is recent urgency from the owner to get to the gas from the reservoir, which their competitor (Qatar) has already benefited from. From Fallahnejad point view and finding the reason behind it, the main contractor will do everything to get the construction contract, to be awarded to them, even if the schedule is not realistic.

Fallahnejad findings are more balanced, valid, and unbiased due to the fact that response rate from all stakeholders including the contractors and still this (unfeasible project duration) particular factor is the second important cause found in the results.

Fallahnejad and Naimi et al. both used questionnaires distributed to different parties involved in a project. The response rate is relatively small.

Another finding the researcher observed in Naimi et al. outcomes, the subcontractor problems were of the important factors shown in their graph; however, it has not been disused at all.

In comparison with Salama et al. (UAE), the most important factors are very similar as well (material and competent team members).

In the paper of Naimi et al. (where projects suffered delays by around 63% against the planned period), it has been investigated that consequences of delays as follows: Major dispute or penalty. The author states although there is high percentage of time overrun in the studied projects only about third of those delayed project cases ended up with penalized fees. It has been argued that such is due to incompetence of project team from the client and that this is the situation of the culture.

Hadikusumo, 2014, has conducted a study case on schedule performance in some selected projects. Key personnel from project management were interviewed into investigate the root cause of schedule delays. The study not only covers the "execute" phase of project but also the initial phase. Nevertheless, Hadikusumo, 2014, found that the heavyweight causes occur during construction phase, although early on project phase delay could lead to delays in execution phase of the project (Doloi et al., 2011).

The projects that have been analyzed were all missed their deadline by as much as 3.5 (years) in one of the projects.

##### Management factors

Slow decision-making by owners

Safety

Poor site management and supervision (contractor)

Management of subcontractor

Accidents during construction - labor injuries - (contractor) infectious disease

(Contd...)

Poor understanding of the scope of work during tendering (contractor)	Inadequate application of safety rules and regulations by contractor
Inappropriate construction methods implemented	Communication
Conflicts among joint owners of the project (for joint venture projects)	Poor communication and coordination by contractor with other parties
Contract	Poor communication between site management and labor force
Ineffective “delay penalties” or “incentives for early delivery”	Lack of communication between designers and contractors
Selection of the lowest bidder for construction contractor	Lack of communication between client and project team
Unrealistic contract durations imposed by client	Inadequate coordination among designers from different disciplines
Unsuitable contract type	Poor interaction with vendors in the engineering and procurement stages
Contract strategy (EPC; EP+C; E+P+C)	Project Planning and control
Complications and delay in the tendering process	Ineffective planning and scheduling by the main contractor
Mistakes and discrepancies in contract documents	Poor management of contractor’s schedule
Poorly defined or vague scope of work (contracts)	Poor monitoring and control
Poor definition of payment milestones/ distribution of cash flow	Inadequate quality assurance control
Poor definition of interfaces resulting in scope creep	

Engineering factors	Resources factors
Rework due 10 errors by contractor or subcontractor	Materials and equipment: Delay in start of purchasing long-lead items Contractor poor procurement management’s
The use of state of art technology and model in construction: Lite 3D model	Delay in manufacturing long-lead items
Inconsistence of technical specifications	Quality and productivity of materials
Client interfaces	Shortage in material and equipment
Clients’ change orders - large quantities of extra work	Slow delivery of materials
Major changes in design during construction	Low ability of contractor to provide imported material
Insufficient data collection and survey before design	Non-adherence of material specifications - provided by client - to drawings
Imperfect data transmission to vendors for long-lead items	Construction plant and equipment breakdowns
Lack of operation procedure	Poor inspection and testing of equipment and material at supplier site

(Contd...)

Mistakes and discrepancies in design documents	Human resources
Lack of involvement of operations and maintenance staff in the design phase	Lack of ownership in the project (design contractor)
Reengineering of different units caused by poor basic design package	Lack of leadership qualities in managers
Delay in preparation and approval of drawings during construction work	Frequent change of client managers
Low engineering completed before construction start	Labor problems - personal conflicts - strikes
Late in reviewing and approving design documents by owner	Low labor productivity
Finance factors	Low of morale and motivation of the workforce
	Inadequate main contractor experience
	High turnover of skilled staff
Variations and claims	Lack of experts in commissioning
Finance and payments of completed work by client to main contractor	Low experience of contractor in planning and controlling
Payment to subcontractor	Lack of experience in inspection
Contractor's poor cash flow management	Shortage of experienced skilled workforce and qualified engineers

In this study, the local contractor performs much worse than the external one, and of most, the root causes of the delays are coming from them while the owner is accountable for two causes only (Omorieg, 2006).

“Poor communication, inadequate control procedures, and ineffective planning and scheduling” are the top three causes in the construction phase found by Hadikusumo and the contractor is the accountable party. Moreover, the author analyzed the studied data in the design phase and concluded that three of five highest ranked delay causes were the responsibilities of the main contractor yet again.

The researcher finds the above paper with research approach to be not comprehensive, there were only three projects studied and a quantitative methodology is highly recommended as other authors explained.

Furthermore, the contractor perception was not included in this study and that does not give a holistic picture of the subject (Alamri and Amoudi, 2017).

Unlike Hadikusumo, besides the interviews, questionnaires have been developed in Salama et al. research. The questionnaires sent to 100 practitioners to rank the time delay causes. The interviews were conducted to understand issues of O and G projects in Abu Dhabi, UAE, and to finalize the questionnaires.

Salama et al. found that only 38% of projects in O and G met the schedule target and those delays mostly took place in “execution” phase just like Hadikusumo findings (Al-Rashid, Kartam, 2004).

Other findings that are similar to Hadikusumo et al. research are the main source of the causes, contractor is the blame, although the contractor was not part of the survey and that could cause biased results. Feed phase of the project is a key indicator of schedule performance and that is mentioned in Hadikusumo results as well.

Most of the top important causes have to do with materials, starting from procurement process till the delivery. The authors explain in O and G sector most materials are unique and not available in local market; therefore, they take time to reach construction site. Moreover, before ordering such items, information are to be exchanged between the contractors and vendors to get the right and specified materials. Such process will affect the duration of material delivery.

Chanmeka et al. assessed and quantified project data gathered by the authors and construction industry institute, through Alberta benchmarking system. This system consists of 19 companies varies

from owners to contractors. 37 projects were analyzed of 78 and majority from the input of the owners (28). Chamneka et al. utilized Pearson's correlation along with regression analysis. The analysis has extended not only on time, cost, and performance but also other project performance pillars such as safety, change, and productivity. These paper findings show that if there are less drawings produced while construction has been already started that there is high chance the project performance time and cost will be greatly affected. In other words, early phase of the project like the front end one, it is very vital to improve the schedule performance. This is line with researches of Salama et al., Hadikusumo, and Jergas.

In addition, it has been found that the productivity of the workforce is not a primary factor of time and cost overrun. Also, the wrong estimate of work force at the peak of the construction phase will lead to time and cost overrun.

Other association Chamanka et al. found is that prefabrication and the use "offsite modules" are in proportional with schedule performance. Furthermore, it is found planning for start-up which takes place at the end of commissioning and is essential to the project planned schedule to be met.

After going through the literature review of the above, it is safe to say that top causes of O and G are somewhat different from other industries and that is in line with Salama findings. Material management is very vital in O and G business as could be seen. Long-lead items in this industry are in large number and thus procurement process must start early. Furthermore, specification of such materials must be done by competent personnel to avoid receiving the wrong ones and that results in repeating the ordering process which consequently delays the project (Ruqaishi and Bashir 2014).

In addition, there is significant accountability on the main contractor (the executor of the project) more than other stakeholders for the main delay causes. Management, supervision, communication, and material delivery are found by the examined papers (Albogamy et al., 2012).

## 5. Recommendation and Conclusion

This paper surveyed many researches across Asia on the factors affecting schedule performance for project delivery. These projects are from different types of industries. It has been found that those high ranked factors are quite different from one country to another and from one industry to another. In different types of construction (other than O and G), change of orders by the client is the most common delay factor in the mentioned region. In O and G megaprojects, materials management is more important due to the large number and the complexity of long-lead items which needs to be purchase ordered early to avoid time overrun.

In addition, contractor-related causes are more evident in this industry and need to be managed properly. Some of the studies did not include a main stakeholder which hurt the credibility of the findings. Furthermore, some found important causes of delay have not been discussed in details, which could serve the project management team better.

Some countries need more empirical studies to highlight key time overrun factors which enable the industry experts to place recommendations in place, for example, Oman. It has been mentioned that there is only one article in O and G projects in Oman, in which authors highly recommended the need to have another study in verify their findings.

Moreover, since Oman economy is depended on O and G, the megaprojects delivery within time and cost is even more crucial, especially the oil production is much lower than most of GCC countries with higher OPEX according to the report: Oman 2013.

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