INVESTIGATING THE CAUSES OF DELAY WITHIN OIL AND GAS PROJECTS IN THE U.A.E.

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The soaring Oil prices are expected to reflect on the impact of delays within Oil and Gas projects in monetary terms due to the revenues forgone. This study aims at investigating the main causes of delays within Oil and Gas projects in UAE. Reviewing the literature on Oil and Gas projects, there were few studies found to be concerned with this problem. The literature indicates some similarities shared with construction projects. However, the factors identified in the literature as causes of delays in construction projects might not apply to Oil and Gas projects due to the differences between the two industries. Therefore, the literature review concluded that more research is needed on this area. The research method comprised interviews with experts for the purpose of identifying the most important factors leading to time overruns. A questionnaire based on the outcome of the interviews together with the relevant factors mentioned in the construction literature was sent to a sample of 100 practitioners to elect the most important factors that cause delays. Besides listing the most important factors as identified by the sample surveyed, the study concluded that contrary to the prevalent belief amongst most practitioners regarding the insignificance of the impact of delays within the (FEED) phase on the overall duration of the project, the data analysis indicated a strong correlation between delays within the FEED phase and the total delay at the end of the project. The study recommends that delays in the FEED phase should set an early warning and a call for immediate remedial actions to hedge against an overall delay, most likely to occur.

Keywords: causes of delays, EPC projects, oil and gas projects.

INTRODUCTION

The continual growth in the world population and economies led to rapid increase in energy demand especially in developing countries. Major part of this energy is supplied by Oil and Gas that accounted for 55.5% of energy consumption in 2004 and it is expected that the demand will increase by 58.2% in 2030 (IEA, 2006).The United Arab Emirates has 8% of oil reserve in the world and has the fifth largest reserve of natural gas in the world. Abu Dhabi has more than 90% of the hydrocarbon resources in the UAE (IEA, 2005).

Typically among the main aims of Oil and Gas projects is to expand the supply and replace existing facilities. Oil and Gas projects are complex and multi-discipline (Conroy and Soltan, 1997), requiring relatively a long time and a huge capital investment (Dey, 1999; Moreau and Back, 2000). They can be divided into three phases: Conceptual design phase, Front-End Engineering and Design (FEED) phase, and the Engineering, Procurement and Construction (EPC) phase. The purpose of the conceptual phase is to identify and select the project that best fit the business requirements, to develop the Statement of Requirements (SOR) for the FEED, to

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estimate the budgeted cost, and to produce the project charter. In the FEED phase, the functional requirements defined in the conceptual design are translated to front-end engineering design and technical specifications. Also, the scope of work for EPC is defined and the EPC cost is estimated. Finally, in the EPC phase, an external contractor is selected to develop the detailed design, procure the required equipments and material, construct the facility as defined in FEED and handout it for operations (Rashid, 2006).

Meeting the time constraint is usually listed among the key success criteria. However, it is quite common that Oil and Gas projects are subject to delay in the completion date and this delay ranges from 5 to 20% of the project duration. It is expected that the slippage will increase in the future due to shortage in material, equipment and experienced personnel (IEA, 2006). Project delay can be defined as the time overrun either beyond the completion date specified in a contract, or beyond the date that the parties agreed upon for the delivery of a project. Delay in projects typically leads to loss of revenue to the owner due to deferral of production and results in higher cost to the contractor due to fixed costs in addition to the inflation effect manifested in the increasing prices of material and other factors (Assaf and Al-Hejji, 2006).

The main objectives of this study are:

- identifying and prioritizing main causes of delays in the EPC phase in Abu Dhabi,
- Investigating whether delays in the conceptual and / or FEED phases could be used as an early warning of possible delays in EPC.

LITERATURE REVIEW

There is a clear gap in literature addressing the causes of delays in oil and gas projects. However, according to Mohamed and Price (2005), there is a considerable similarity between the oil and gas projects and construction projects. Hence, the relevant literature discussing the causes of delay in the construction projects was reviewed together with the literature on Oil and Gas projects with the prime aim to produce a list of factors that can be surveyed among Oil and Gas project teams.

In construction, it was deduced that the most important causes of delay vary from one country to another, and are different among various groups: owners, contractors, and consultants group. Assaf and Al-Hejji (2006) found that awarding projects to the lowest bidder is the highest frequent cause of delay from both owners' and consultants' perceptions. Also other causes were mentioned such as: delay in progress payments and ineffective planning and scheduling by contractor; poor site management and supervision by contractor; shortage of labour and difficulties in financing by contractor. All three groups (owners, consultants and contractors) agreed on a common factor that is introducing change orders by owner during construction. Sweis et al (2007) identified the top three factors behind project delay as: financial difficulty by the contractor; too many change orders by the owner and poor planning and scheduling by the contractor. Sambasivan and Soon (2007) listed the factors that have most impact on time overrun as: contractor’s improper planning; contractor’s poor site management; inadequate contractor experience; client’s finance and delay in payment for completed work.

Challenges in Oil and Gas Projects

Reviewing literature about the characteristics and challenges in EPC, the major Oil and Gas projects tend to be huge in size, complex and apply various advanced technology (Dey, 1999). The developed product in the EPC phase is unique and comprises a large number of interconnected subsystems and components that need huge human effort and large capital investment (Yeo and Ning, 2002). Completeness of scope definition is critical for the success of detailed design, construction, and start-up (Dumont *et al.,* 1997). Therefore, poorly defined scope can result in considerable changes, and the project may be exposed to cost and time overrun besides disputes among involved organizations (Dumont *et al.,* 1997). Generally, industrial projects of adequate scope definition have better time and cost performance by 13.2% and 23.1% than projects of inadequate scope performance (Construction Industry Institute, 1996).

Typically, the design of Oil and Gas Projects is complex, multi-disciplinary and is developed progressively through the project life cycle (Rashed, 2006). In the engineering and construction projects, the work is fragmented among different organizations (Yeo and Ning, 2002) and the design activities are highly inter-dependent. Thus, intensive communication and effective coordination is imperative to achieve an accurate design. Dey (1999) emphasised the need for an integrated information system in order to improve project performance.

The relatively long duration that most Oil and Gas projects require imposes some challenges that may affect the time performance within Oil and Gas projects such as: unpredictable time duration of some activities like negotiation and obtaining approval from authorities; the high uncertainty of on-time delivery of long-lead equipment from international suppliers; incomplete information due to phase overlapping between engineering, procurement and construction; frequent changes mainly due to external factors; and high uncertainty in the planning due to lack of involvement of suppliers in the planning and design of long-lead equipment (Yeo and Ning 2002).

Generally, procurement and logistics play an important role in major projects where efficient performance in this area significantly improve the cost and schedule performance (Willoughby, 2005). The procurement activities include sourcing, purchasing, contracting and on-site material management (Yeo and Ning, 2002). Dey (1999) identified the main factors that may affect time and cost performance within Oil and Gas project as: improper selection of contract type; awarding contract to lowest price contractor among technically accepted contractors and poor contract administration. The importance of procurement in EPC phase is due to the significant proportion of the material and equipments costs to the total cost.

Yeo and Ning (2002) suggested the application of new strategies such as partnering in the procurement of EPC projects. The argument is that the new approach helps to streamline the project procurement process, remove non-value added activities, enable efficient information flows among organizations, involve suppliers in the planning and design stage for higher accuracy. This approach requires careful pre-qualifying of suppliers; selection of reliable suppliers; developing strategic contracts; and linking organizations through networked information systems.

METHODOLOGY

The research was conducted on two stages: a set of semi-structured interviews followed by a survey. The purpose of the interviews was to obtain an in depth understanding of the characteristics and challenges in oil and gas projects in Abu

Dhabi and to develop the questionnaire for the survey. The purpose of the questionnaire was to determine the attributes of delays and to identify and prioritise the major causes of delays from the practitioner's point of view.

A total of 8 practitioners were invited for interviews. All interviewees are experts with a significant number of years in the Oil and Gas projects ranging from 15 to 40 years of experience in different areas such as: project management, engineering, procurement, information system, and quality assurance and control of projects.

During interviews, the EPC phase was identified as the most significant phase with regard to the project overall delay. In addition, a complete list of causes of delays was developed. A complete list of causes of delays is shown in table (1).

Sampling for the Survey

In the second stage, a survey was conducted to collect the data using self-administered questionnaire. The selected sample for the survey included project managers, project engineers and coordinators working in oil and gas projects in client companies, and project managers from project management consultant (PMC) companies.

A sample of 100 practitioners was randomly selected from an email address list of employees working in projects in Oil and Gas companies in Abu Dhabi. The questionnaire was distributed through email to the sample. Follow up has been done via email and by phone. A total of 37 respondents replied. The number of unreachable subjects was 8 who replied as out of office. Saunders et al (1997) recommend that for mail surveys:
response rate = total no of responses / (sample size – ineligible – unreachable) >30%

In this survey, the response rate = 37 / (100 – 8) = 40%

Data Collection

The questionnaire involved two parts other than the personal information of the respondent. Part one was asking about the frequency of delays in projects and the frequency of delays in each phase. The purpose of this section is to obtain the significance of delay, in terms of its frequency, according to respondent perspective, and whether there is a correlation between delays in different phases of the project. In part two of the questionnaire, a list the possible causes of delays in the EPC phase were presented and the respondents were requested to rate each cause according to their relative importance as a significant cause. A five-point Likert scale was used to obtain the relative importance of each factor, 1 being not important and 5 as extremely important. Factors were ranked according the average weights of importance (Chan and Kumaraswamy, 1997; Odeh and Battaineh, 2002; Frimpong *et al.,* 2003 and Sambasivan and Soon (2007). The causes of delay are grouped into 9 categories as client related factors, contactor related factors, PMC, FEED Engineering, communication, manpower, contract, material and equipment, and external related factors. The categorization provides a structure for cause identification and a balanced list of causes (Assaf and Al-Hejji, 2006, Chan and Kumaraswamy, 1997).

Additional questions are added at the beginning of the survey seeking information about the respondent such as company type, job title, and number of years of experience within and outside UAE and other countries.

Respondents belonged to 14 different companies. Respondents from client companies were 31, while 6 respondents worked for Project management consultant (PMC)

firms. Project managers formed 32% of the surveyed sample, 38% of respondents were project engineers and 30% of respondents belonged to other job types such as: project coordinator, project cost control engineer, project planning engineer, team leader, and head of performance measurement. Respondents portrayed a wide experience in different phases of projects with an average of 24 years of experience in oil and gas and an average of 11 years of experience in Abu Dhabi. Most respondents had previous experience in other countries.

DATA ANALYSIS AND FINDINGS

Attributes of Project Delays

The purpose of this section is to determine attributes of projects delays. Out of the 37 respondents, only 28 provided complete information in this section of the questionnaire. Accordingly, the analysis in this section is based on 28 respondents only. A majority of 89% of the respondents identified the EPC phase as the most significant phase where delay occurred in most of the cases. The average number of projects per respondent is 11 and the average number of delayed projects per respondent is 6.8. In other words, nearly 62% of projects were delayed. These results indicated that in Oil and Gas Projects in Abu Dhabi, delays are of high probability, thus consistent with the IEA report (2006).

Respondents were requested to assess the impact of delays on the total project cost. The mean was found to be 8.9% with a standard deviation of 8.60. Obviously, the corresponding monetary value would be very high due to the nature of the Oil and Gas projects. This does not include the revenue forgone, though.

The correlation between delays in early phases and delays in EPC

According to the respondent answers in above section, the correlation between the delays in FEED and the delays in both FEED and EPC was found to be 0.7. This indicated a strong correlation between delays in FEED and delays in FEED and EPC together. The correlation does not necessarily imply causality but more likely to indicate an association between the two variables, which means that there are common factors that caused delays in both FEED and EPC such as: poor scope definition; problems in design; poor project management or long time for approval and decision making by the client's representatives.

The above mentioned correlation should entice practitioners to be alert when delays occur during the FEED phase and consider it as an early warning indicating that delays during the EPC phase have a high probability of occurrence. Practitioners as emphasised during the interviews do not seem to be aware of this indirect relationship. Hence, in practice, less attention is given to the schedule performance during earlier phases like the FEED. However, since the EPC was identified by the sample as the most significant phase causing an overall delay in the project finish date, the relatively high correlation between delays in both phases indicates the detrimental effect of any delays occurring during the FEED phase on the overall duration of the project.

Causes of Delays in Oil and Gas Projects

The analysis used the Relative Importance Index (RII) in order to determine the relative importance for each cause of delay (Sambasivan and Soon, 2007).

For each cause of delay, $RII = \sum W / (A * N)$ Where

- W is the weight provided by the each respondent, ranging from 1 to 5
- A = 5 (which is fixed for all calculations and represents the highest possible weight on the Likert scale).
- N is the total number of respondents
- RII is ranging from 0 to 1 (but 0 is not included). The higher value of RII implies the more importance of the factor as a cause of delay.

Based on the calculation of RII, the causes of delay could be ranked in descending order according to their relative importance as shown in Table (1). The calculations have been based on the input of 34 respondents. Three respondents were removed from the calculation of the ratings where two of them have some missing data and the third respondent have most of his ratings as 1 or 2.

According to the sample, the most important five factors that caused delays were:

1. Delay in start of purchasing long-lead items with RII 0.818;
2. Delay in material and equipment delivery with RII 0.794;
3. Lack of experience and knowledge of contractor technical with RII 0.771;
4. Poor project management by contractor with RII 0.765 and
5. Shortage of experienced and qualified engineers' with RII 0.759.

The first and second causes of delays are related to procurement. The third and fourth causes of delays are related to the contractor. The fifth cause is related to shortage of qualified manpower in the market.

The least important three causes of delays were:

1. Inadequate application of safety rules and regulations by contractor with RII 0.482;
2. Lack of IT use in communication and information management with RII 0.488 and
3. Delay in contractor payment to sub-contractors and suppliers with RII 0.488

The above mentioned indicated that the ranking of causes of delay in oil and gas projects are different from other types of construction projects. For example, the causes related to procurement have been assigned the highest rank. This is due to the special characteristics of the oil and gas projects such as complex engineering design; international procurement; purchasing special equipment that require long lead-time; fragmentation of work and the need to exchange information between suppliers for interrelated subsystems.

Table 1: Ranked causes of delays according to their importance (all respondents)

ID	Causes of Delays	RII	Rank	ID	Causes of Delays	RII	Rank
30	Delay in start of purchasing long-lead items	0.818	1	3	Wrong choice of contractor or project management consultant	0.665	19
29	Delay in material and equipment delivery	0.794	2	17	Insufficient data collection and surveys before design	0.659	20
9	Lack of experience and knowledge of contractor technical staff	0.771	3	32	Shortage of material in Market	0.659	21
8	Poor project management by contractor	0.765	4	28	Poor contract management	0.647	22
24	Shortage of experienced and qualified engineers	0.759	5	2	Ambiguous or incomplete definition of Client requirements	0.647	23
15	Poor project management by PMC	0.729	6	25	Wrong choice of contract type	0.635	24
23	Shortage of skilled labor	0.729	7	27	Ineffective 'delay penalties' or 'incentives for early delivery'	0.629	25
34	Shortage of experienced and competent contractors and suppliers	0.706	8	12	Rework due to errors by contractor or sub-contractor	0.624	26
33	Increased cost due to high inflation during project	0.706	9	13	Poor inspection and testing of equipment and material at supplier site	0.571	27
6	Long time for approval and decision making by shareholder and Client representatives	0.706	10	20	Errors in design	0.553	28
14	Improper selection of sub-contractor or supplier	0.7	11	35	Governmental and political related issues	0.553	29
19	Inadequate coordination among designers from different disciplines	0.688	12	31	Shortage in specialized construction equipment	0.529	30
18	Lack of involvement of operations and maintenance staff in the design phase	0.682	13	26	Major disputes and negotiations	0.529	31
16	Slow response and decision making	0.676	14	1	Inadequate study of market requirements	0.524	32
7	Lack of staff involvement in decision making and problem solving	0.676	15	10	Delay in contractor payment to sub-contractors and suppliers	0.488	33
5	Change orders during EPC by Client	0.671	16	21	Lack of IT use in communication and information management	0.488	34
22	Lack of communication among different parties involved	0.671	17	11	Inadequate application of safety rules and regulations by contractor	0.482	35
4	Long time for tendering and award	0.671	18				

CONCLUSIONS

In Oil and gas projects the project size is large and requires intensive capital investment and long time duration. Due to the current increase in Oil prices, the return on investment is high and the payback period is relatively shorter than before. Accordingly, the on-time completion is a high priority for both clients and contractors. Oil and Gas projects comprise three main phases; the Conceptual phase; the FEED and the EPC.

This study aimed at investigating and prioritising main the causes of delays in oil and gas projects in Abu Dhabi. Based on the outcomes of 8 interviews along with the literature review, a comprehensive list of causes of delays within oil and gas projects was identified and utilised to produce a questionnaire. The questionnaire was distributed by email to 100 practitioners in oil and gas projects in Abu Dhabi and attracted 37 responses. The results indicated that nearly 62% of the projects surveyed witnessed delays.

The EPC was identified by 89% of respondents as the most significant phase that should be closely and strictly controlled in order to prevent time slippage and improve the overall schedule performance of projects. However, the results indicated a strong correlation of 0.7 between delays occurring during the FEED phase and delays in both the FEED and the EPC for the same project. The study therefore, recommends that any delay in the FEED phase should be considered as an early warning and a call for immediate remedial actions to hedge against an overall delay, most likely to occur.

In addition the results indicated that the most significant causes of delay in Oil and Gas project in Abu Dhabi in the EPC phase were: delays in procurement and item delivery; poor selection of contractors in the FEED and EPC phases by laying more emphasis on the bid value rather than on the contractor's competencies; ineffective communication system and shortage in experienced manpower.

LIMITATIONS AND FURTHER DIRECTIONS

The sample surveyed included representatives from the client and PMC companies only as both parties are involved in the three phases on the Oil and Gas projects unlike the contractor who participation is limited to either the FEED or the EPC phases. Therefore, it might be a reasonable assumption that contractors will not be able to provide an accurate holistic view of the project's three phases. This, however, caused the absence of the contractor perception about the causes of delays. Still, the results were crosschecked with results of the interviews and came consistent with the findings of the literature review.

Further studies are currently planned to investigate the contractor's perceptions in detail and to compare it with the findings of this study. Hopefully the forthcoming study would enjoy a larger sample size which is another limitation of this study.

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