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Research Article

An Analysis of Causes and Effects of Delays in Construction Projects in Libyan Oil Industry

Libya Petrol Endüstrisinde Gerçekleştirilen İnşaat Projelerinde Gecikme Nedenleri ve Sonuçlarının Analizi

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Abstract

Performance of a project is usually measured in three dimensions: time, budget, and quality. Since these parameters are interdependent, delay often means also budget overrun and quality problem. Hence, identification of delay factors before execution of project is of paramount importance. The purpose of this research is to assess causes and effects of delays in construction projects conducted in Libyan oil industry where security issues, deregulated market, vulnerable legal framework are challenges waiting in front of construction sector in the country. To identify the most essential factors, a survey is conducted among clients, consultants and contractors involved in projects in Libya. Findings reveal that the top three delay factors are: security factor, shortage in material, and construction method. On the other hand, cost overrun, time overrun, disputes, total abandonment, and arbitration are the main effects of delays.

Keywords: Construction projects in Libyan oil industry, Delay causes, Effects of delay, Project management

Öz

Bir projenin performansı genelde üç boyutta ölçülür: süre, bütçe ve kalite. Bu üç boyut birbirinden bağımsız olmadığı için, genellikle projede bir gecikme aynı zamanda bütçenin aşılmasını ve kalite problemlerini de birlikte getirir. Bu nedenle gecikmeye neden olan faktörlerin projeye başlanmadan önce belirlenmesi son derece önemlidir. Bu araştırmanın amacı, güvenlik, düzensiz piyasa ve kırılgan hukuk sistemi gibi zorluklarla yüzleşen Libya petrol endüstrisinde gerçekleştirilen inşaat projelerinin gecikme neden ve sonuçlarını değerlendirmektir. Bu amaçla Libyada petrol sektöründeki aktif proje sahipleri, yükleniciler ve danışmanlar ile bir anket çalışması yapılmıştır. Anket sonuçlarına göre en önemli üç gecikme faktörü; güvenlik faktörü, malzeme/ham madde yetersizliği ve kullanılan inşaa metodu olarak tespit edilmiştir. Bunun yanında gecikmelerin sebeb olduğu sonuçlar, maliyet artışları, süre aşımları, ihtilaf, projeden çekilme ve hakeme başvurma şeklinde sıralanmaktadır.

Anahtar Kelimeler: Libya petrol endüstrisinde inşaat projeleri, Gecikme sebepleri, Gecikme sonuçları, Proje yönetimi

1. Introduction

Realizing an effective time management is a common challenge for various types of projects (Baghdadi and Kishk 2015, Lehtinen et al. 2014, Patanakul 2014). A project is considered as successful when it is completed on time, within budget, in accordance with specifications (Aziz 2013). In practice, these three dimensions are strongly interdependent and correlated. The failure to achieve targeted time, budget and specified quality results with several negative consequences including extra penalty claims by client, loss of goodwill, and even losing the contract (Sambasivan and Soon 2007, Sepasgozar et al. 2015).

Big construction projects in oil industry are especially subject to delays as many players should work in harmony to deliver the project on time. Libyan recovery is focused not only on civilian infrastructure but also on oil industry; many contracts were awarded for raising more storage capacity as the international demand on Libyan oil increases again. This caused many projects to be delayed and not being delivered within the budget agreed upon. Libyan oil reserves, estimated at 48.36 billion barrels (4%), are the largest in Africa and among the largest in the World (OPEC 2015).

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As Libya struggles to recover from the conflict in 2011 with two different governing powers, international oil companies are partially resuming operations in the country. However, Libyan oil industry has to face new challenges such as security issues, deregulated market, vulnerable legal framework and lack of central governing power. In such a business environment, a neat project management framework is of paramount importance for a quick recovery. This framework will serve avoiding delays in projects, identifying the delay factors, as well as the possible consequences of delays.

Through this study, reasons for delays in construction projects in Libyan oil industry and their effects will be discussed and explained. To identify major causes, following the same approach by Sambasivan and Soon (2007), we categorize them to eight main categories. Consequently, major effects of delays will be discussed.

This study fills a gap in the field as it is the first study, to our knowledge, conducted on construction projects on oil exploration, storage tanks, and pipelines in Libyan oil industry. Secondly, this study follows a *cause and effect* approach and focuses also possible effects of delays. Thirdly, this work is one of the rare studies on construction project undertaken after the turmoil that the country experiencing since 2011.

The rest of this study is organized as follows. Related works on causes of project delays is summarized in the second section. The third section summarizes the methodology where the details of the survey and data analysis are given. The forth section is devoted to the results and discussions where some prescriptions for reducing delays are also presented. Lastly, we conclude the work with some remarks on the results of the study.

2. Related Work

Chan and Kumaraswamy (1997) identified 83 delay factors effecting construction projects in Hong Kong and conducted a survey. The results indicate that the top cause of delays is poor site management and supervision.

A similar study was done by Kaming et al. (1997) in Indonesia. They stated that design changes, poor labor productivity, and inadequate planning are main delay factors. Another study focused on factors effecting project schedule in groundwater projects in Ghana. The results revealed that poor contractor management, monthly payment difficulties from agencies, material procurement are the main causes (Frimpong et al. 2003).

Public projects in Jordan were investigated with the aim of aiding construction managers in evaluation of projects. The study showed that poor design and negligence of the owner, change orders, weather condition are the main causes of delays in considered projects (Al-Momani 2000). Project delays in Jordanian construction sector were also studied by Odeh and Battaineh (2002) and Sweis et al. (2008).

Another comprehensive work was conducted on project delays in Saudi Arabia (Assaf and Al-Hejji 2006). The most common cause indicated by the respondents was change orders by owner during construction. A similar study conducted on industrial projects in Saudi Arabia pointed out lack of experience in the business field, war, poor project management are among the top delay factors (Assaf et al. 2015).

Unlike the other studies above, the studies by Sambasivan and Soon (2007) and Kikwasi (2013) were focusing both on causes and effects of delays (Sun & Meng 2009) on construction projects in Malaysia and Tanzania respectively. From the perspectives of three parties involved in a project, they found that contractor's improper planning, contractor's poor site management, inadequate contractor experience are most important factors.

A study on pipeline projects in Australia was conducted where design changes, design errors, poor communication are among the mostly stated factors (Orangi et al. 2011). Reporting the experience in Indian projects, lack of commitment, inefficient site management, poor site coordination, are the top three causes of delays (Doloi et al. 2012).

The construction projects in Egypt were studied in two works (Aziz 2013, Marzouk and El-Rasas 2014). The former study identified ninety-nine (99) factors of delay and the most frequent three delay causes were stated as; delay in progress payments, different tactics patterns for bribes, shortage of equipment. On the other hand, finance and payments of completed work by owner, variation orders/ changes of scope by owner during construction, and effects of subsurface conditions were the most important delay factors (Marzouk & El-Rasas 2014).

The field studies done on this topic were mostly undertaken in the Middle Eastern countries. We believe this is due to the fact that this region has been hosting remarkable number of big-scale construction projects during the last two decades. Also, other similar studies we reported here are conducted in fast developing regions. Looking from "causes"

and "effects" perspective, most studies focused on delay causes (Aziz 2013, Doloi et al. 2012, Orangi et al. 2011) whereas only three works took a glance at the effect side (Mukuka et al. 2015, Kikwasi 2013, Sambasivan and Soon 2007). Mostly, building projects (Marzouk and El-Rasas 2014, Aziz 2013, Orangi et al. 2011, Baghdadi and Kishk 2015) were subject to the study while few works focused on other types of constructions projects, such as pipelines (Orangi et al. 2011, Fallahnejad 2013), industrial (Assaf et al. 2015), and groundwater projects (Frimpong et al. 2003).

3. Material and Methods

To collect data, online and paper-based questionnaires were used. The survey designed for this research consisted of three sections and was timed to take approximately 20 minutes to complete. First section was devoted for demographics while the second part focused on causes of construction delays. The delay factors included in the survey are mostly identified in accordance with Odeh and Battaineh (2002) where 28 factors were listed. Additional to these factors, we asked opinion of the practitioners whether these are inclusive enough. Based on their suggestions, we added four more factors deemed by experts from the field as highly relevant to Libyan construction sector. The respondents were asked to indicate their perception on relative importance of 32 construction delay factors divided into eight major classes consisting following factors:

- **Client related factors:** Lack of finance and payments of completed work, owner interferences, slow decision making and unrealistic contract duration imposed by owners.
- **Contractor related factors:** Delays caused by subcontractor, site management, improper construction methods, improper planning, mistakes during construction stage, and inadequate contractor's experience.
- **Consultant related factors:** Contract management, preparation and approval of drawings, quality assurance and waiting time for approval of test and inspection.
- **Material related factors:** Shortages in material, quality and availability of material as well as on time material delivery.
- **Labor and equipment related factors:** Low labor productivity, lack of appropriate skills, equipment availability and inadequate equipment.
- **Contract related factors:** Change orders, and mistakes or discrepancies in contract document.
- **Contract relationship related factors:** Inappropriate overall organizational structure linking to the project, lack of communication between the parties, and major disputes and negotiations are not well addressed.
- **External factors:** Weather condition, regulatory changes, problem with neighbors, unforeseen site condition and security factor.

At the end of second part of the questionnaire, an open-ended question on respondents' recommendations to improve the performance of Libyan Oil construction industry was given. The implications of the open-ended questions were used creating prescriptions for three groups involved in projects. The third part of the questionnaire focused on the effects of construction delays. Inspired by Sambasivan and Soon (2007), the five possible effects of delays we questioned were: time overrun, cost overrun, dispute, arbitration, total abandonment. A five-point Likert scale ranging from 1 (not important) to 5 (extremely important) was adopted for evaluation of causes and effects of project delay.

3.1. Population Sampling

The participants taking the survey were sampled with convenience and snowball sampling. As the name implies, the participants are identified through referral networks and professional relations. This method is usually preferred if possible response rate is very low when the sample is selected randomly and the size of the entire population is small (Sambasivan and Soon 2007). The questionnaires were distributed through friends working in Libyan oil industry as project developers, consultants, and clients, as well as managers in public institutions. Friends in turn distributed to their networks. With this sampling method, we were able to obtain a large number of completed questionnaires quickly.

3.2. Data Collection

The survey was conducted over a five-week period. To comply with ethical concerns, the respondents were not asked to include any personal information such as names, addresses, phone numbers etc.

Initially, one hundred and twenty potential respondents were targeted at all levels in the organizations within the oil industry in Libya. Out of all questionnaires, ninety sets were fully completed and eligible for analysis. Out of forty potential respondents at various public departments of Libya, 27 sets of questionnaires were collected whereas 53 contractors returned a fully completed questionnaire.

Additional ten samples were taken from consultants and used for analysis.

3.3. Data Analysis

Relative importance index (Kometa et al. 1994) measure is used to determine the relative importance of the various causes and effects of delays. The five-point scale ranged from 1 to 5 was adopted and transformed to relative importance indices (RII) for each factor as follows:

$$RII = \frac{\sum_{i=1}^{N} W_i}{A * N} \quad (1)$$

where W_i is the weighting given to each delay factor, A is the highest weight (5 in this case), and N is the total number of respondents. The RII value had a range from 0 to 1, where the higher the value of RII, the more important was the cause or delays (Sambasivan and Soon 2007). The same ranking approach is employed for effects of delays.

4. Results and Discussion

4.1. Demographic Analysis

The demographic characteristics of the respondents; age, gender, duration of experience, types of contractor, types of sector, occupational level, types of organization, are given in Table 2. As seen from the table, contractors, clients and consultants were involved in the study. Looking to the occupational level of the respondents, beside various high level project management staff, mainly project managers and site engineers with mid- and long term experience took part in the survey.

4.2. Causes of Construction Delay

Based on the responses to the survey, the relative importance index (RII), is computed for each cause to identify the most significant ones. Then, RII values are used to rank delay factors in construction projects in Libyan oil industry. Table 2 summarizes the obtained RII and ranking values of each delay cause grouped into eight different categories.

Based on the RII values, the most important cause of construction delays related to clients is unrealistic contract duration and requirement imposed (RII=0.583) whereas the most important causes of contractor related cause is construction method (RII= 0.706). Based on the ranking of the third group of delay factors, the mostly stated cause of consultant related factors is contractor management with a RII of 0.533. Considering the material related causes,

Table 1. Demographic results of the survey.

Age			Types of Sector		
	Frequency	%		Frequency	%
Less than 20	0	0.00	Gathering	6	6.67
20 – 29	14	15.56	Processing/Refining	4	4.44
30 – 39	33	36.67	Transportation	14	15.56
40 – 49	37	41.11	Storage	54	60.00
50 and above	6	6.67	Technological Applications	12	13.33
Gender			**Occupational Level**		
Male	66	73.33	Managing Director	7	7.78
Female	24	26.67	Director	8	8.89
Duration of Experience in years			Project Manager	20	22.22
Less than two years	16	17.78	Site Engineer	24	26.67
2 - 5 years	20	22.22	Technician	13	14.44
6 - 10 years	30	33.33	Financial Manager	15	16.67
More than 10 years	24	26.67	Other	3	3.33
Types of Contractor			**Types of Organization**		
Public/Government	27	30.00	Client	27	30.00
Private	60	66.67	Consultant	10	11.11
Regulatory authority	3	3.33	Contractor	53	58.89

most of the respondents highlight shortage in material (RII= 0.750). The mostly stated cause of delay related to labor and equipment is equipment availability (RII= 0.706). Based on obtained ranking, the most vital factor related to contract is mistakes and discrepancies in contract document (RII= 0.656) whereas inappropriate overall organizational structure linking to the project (RII= 0.622) is ranked as first among the factors we questioned in contract relationships related category. Lastly, considering the external causes, security factor gets the highest priority among five factors we considered, RII=0.783. Fig. 1 depicts the RII values obtained where the highest ranked factor in each category is highlighted.

4.3. Effects of Construction Delay

The primary data collected from the third part of the questionnaire is analyzed and RII values are calculated as in Eq. 1. Based on the RII values we obtained, the important effects of construction delays perceived by all three parties: (1) cost overrun (RII= 0.6178), (2) time overrun (RII= 0.5956), (3) dispute (RII= 0.5689), (4) total abandonment (RII= 0.5600), (5) arbitration (RII= 0.5333). The results of the third part of the survey are depicted in Figure 2.

4.4. Discussion of Results

This section discusses the implications obtained by analyzing survey results. Some of the points we raise here are country specific while some may be observed in various studies done on the same topic in different locations and can be generalized as tips for good project management practice.

4.4.1. Comments on Causes of Delays

According to the survey, the eight most important causes of delays in each category perceived by respondents in Libya were identified and discussed briefly.

Security Factor (RII = 0.783): Considering the fact that this survey was conducted right after the civil unrest in Libya, security factor is acknowledged by the respondents as the most crucial factor affecting the project timeline. In the meantime, chaotic environment in the country has become more severe. Thus, we may assume security is still a vital factor for project success.

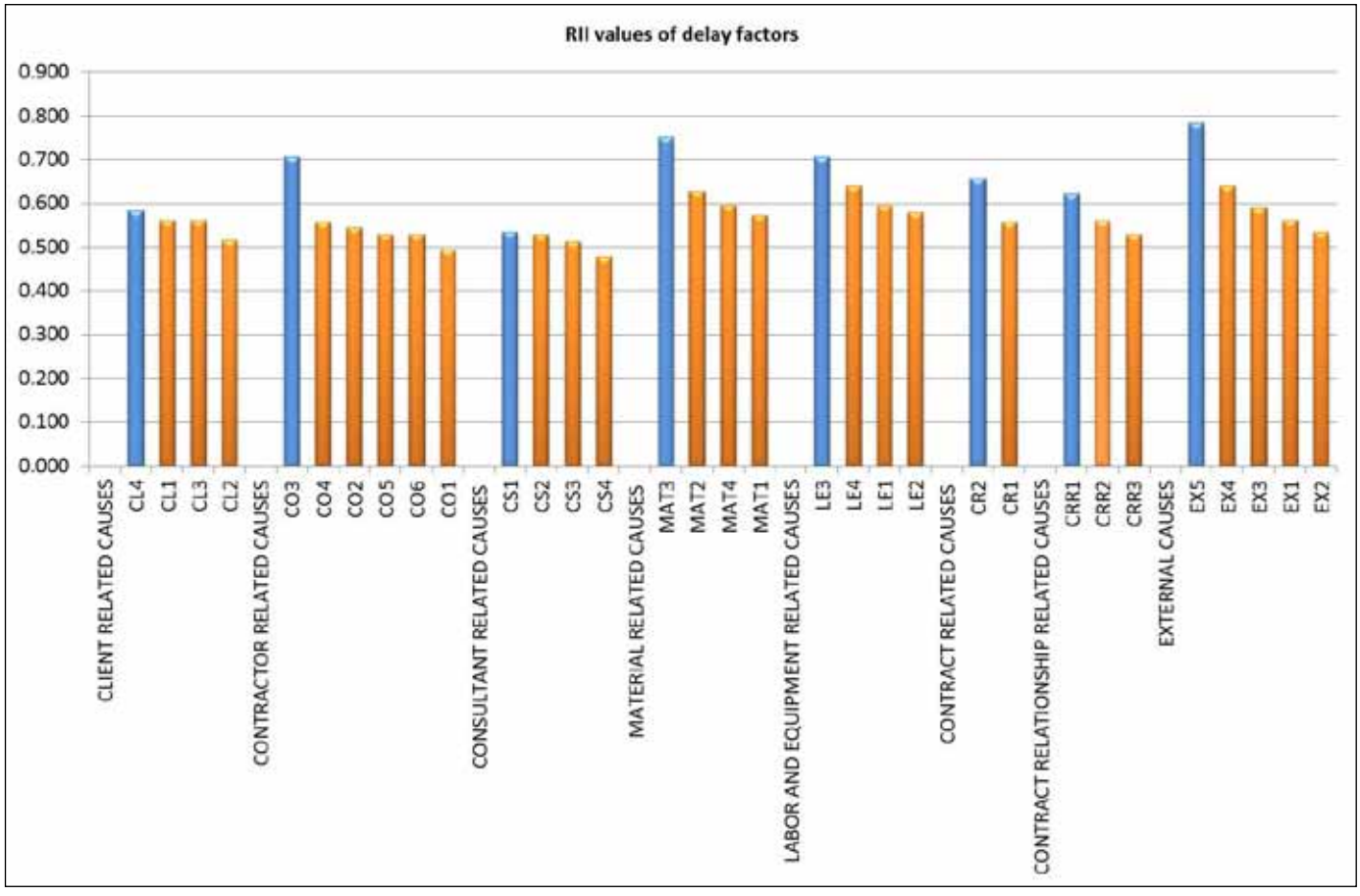

Figure 1: RII values for each delay factor.

Table 2. RII values obtained for delay factors and their ranking.

Client Related Causes	RII	Rank
Lack of Finance and Payments of completed works (CL1)	0.561	16
Owner Interferences (CL2)	0.517	29
Slow decision Making (CL3)	0.561	17
Unrealistic contract duration and requirement imposed (CL4)	0.583	13
Contractor Related Causes		
Subcontractor (CO1)	0.494	31
Site Management (CO2)	0.544	22
Construction Method (CO3)	0.706	3
Improper Planning (CO4)	0.556	20
Mistakes during construction stage (CO5)	0.528	25
Inadequate contractor experience (CO6)	0.528	26
Consultant Related Causes		
Contractor management (CS1)	0.533	23
Preparation and approval of drawings (CS2)	0.528	27
Quality assurance and control (CS3)	0.511	30
Waiting time for approval of tests and inspection (CS4)	0.478	32
Material Related Causes		
Availability of materials (MAT1)	0.572	15
Availability of Quality Materials (MAT2)	0.628	8
Shortage in Material (MAT3)	0.750	2
On time material delivery (MAT4)	0.594	10
Labor And Equipment Categories Causes		
Low labour productivity (LE1)	0.594	11
Lack of appropriate skills (LE2)	0.578	14
Equipment availability (LE3)	0.706	4
Inadequate equipment (LE4)	0.639	6
Contract Related Causes		
Changes orders (CR1)	0.556	21
Mistakes and discrepancies in contract document (CR2)	0.656	5
Contract Relationship Related Causes		
Inappropriate overall ogranizational structure linking to the project (CRR1)	0.622	9
Lack of communication between parties (CRR2)	0.561	18
Major disputes and negotiations (CR3)	0.528	28
External Causes		
Weather Conditions (EX1)	0.561	19
Regulatory changes (EX2)	0.533	24
Problem with neighbors (EX3)	0.589	12
Unforeseen site condition (EX4)	0.639	7
Security factor (EX5)	0.783	1

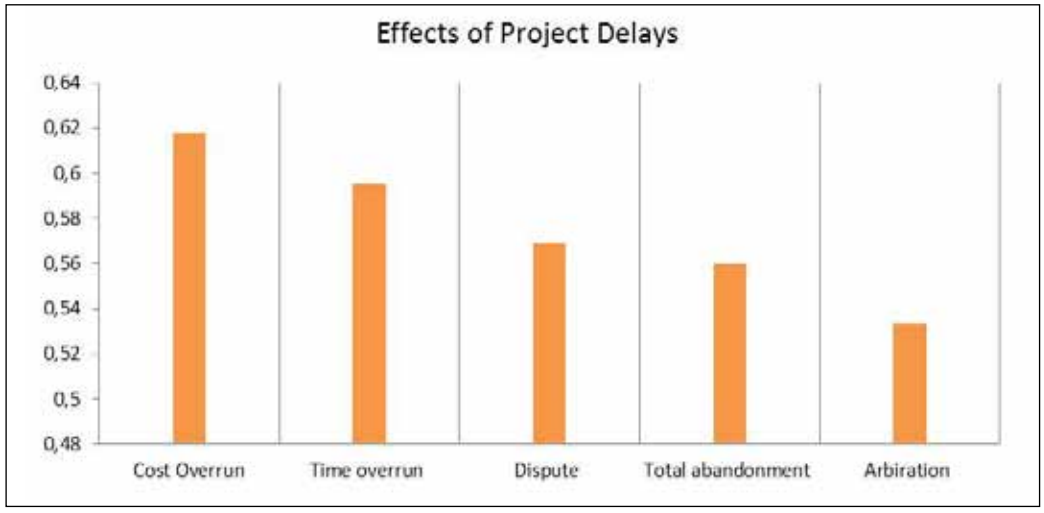

Figure 2: RII rankings of effects of project delays.

Shortages in Material (RII = 0.750): Shortages in basic materials like sand, cement, bricks, and iron can cause major delays in projects. Since Libya is experiencing exhaustive delays on logistic operations, usually demand exceeds the supply and this causes prices to increase and the contractors, as a result, postpone the material purchase.

Equipment availability (RII= 0.7056): Many of the contractors do not own equipment required for the construction work. They rent the equipment when needed. The whole supply chain of material and equipment has been especially weakened after 2011 due to the turmoil being experienced in the whole country and, as a result, in oil industry.

Construction Method (RII= 0.7056): The physical conditions prevailing in construction fields are highly challenging. Thus, contractors sometimes may not be able apply usual construction methods and a contractor with inadequate experience cannot plan and manage the projects properly.

Mistakes and discrepancies in contract document (RII = 0.6556): The contract is not only a document providing legal basis of the project but also a practical project guide giving important solution hints on different scenarios. Considering this, mistakes and discrepancies in contract document may lead severe consequences as the main reference document for resolving disputes and problems between parties is wrong. It is, in general, very hard to make changes in the contract afterwards. Thus, a neat contract also means a well-organized work plan. Improper planning at the initial stages of a project causes delays at several steps.

Inappropriate overall organizational structure linking to the project (RII = 0.6222): This is linked to mistakes and discrepancies in contract document, because a contractor must submit all participants that will participate in the project along with their qualifications so that the client can approve their qualifications and approve according to their criteria for the certain project being conducted.

Unrealistic contract duration and requirement imposed (RII = 0.5833): This arises from security risks of projects in the oil field. This forces the clients to impose tight schedules and sometimes unrealistic contract durations with high standards (requirements). In most cases, unexperienced contractors cannot meet these durations.

Contractor management (RII = 0.5333): As the only aim of the contractor in most cases is to get the project and not focusing much on meeting the requirements, professional approaches of management are often neglected.

4.4.2. Comments on Effects of Delays

Cost overrun: Considering the top delay factors, such as security issues, material shortages, mistakes and discrepancies in the contract, unless they are resolved at a reasonable time, the initial effect of these factors is cost overrun as the contractors tries to avoid time overrun at first instance by allocating more resources.

Time overrun: External factors, client-related and contractor-related factors have impact on the time overrun. Factors such as improper site management by the contractors, inadequate construction method, shortages in raw material and equipment, and delay in the payments cause time overrun.

Disputes: Client-related, contract-related, contract relationship related, and external factors have impact on the disputes.

Factors such as lack of finance and payments of completed works, owner interference, problems with subcontractors, mistakes during construction stage, change orders results with disputes between the various parties.

Total abandonment: In Libya, many projects have been temporarily abandoned during the turmoil since 2011. Obviously, security factors are the main reason to be blamed for this. Furthermore, the security conditions are more severe in rural areas where most construction projects are realized. The political instability in the country means also payment difficulties, poor cash flow, and low determination which are essential factors for big-scale international projects held in Libya. Many of these projects have now become so prohibitive that they have been abandoned permanently.

Arbitration: Mostly, contract-related and contract relationship-related factors lead to disputes. As these disputes become more severe they need to go to arbitration process.

4.5. Prescription to Reduce Delays

Based on the answers given to the open-ended questions by the experts, we shortlisted some key points to reduce delays. The prescriptions were divided into three groups; prescriptions for the clients, prescriptions for the consultants, prescriptions for the contractors.

4.5.1. Prescriptions for the Clients

Selection of right contractors is the first challenge that clients should handle. While selecting the contractors, financial aspects do not have to be the single selection criteria. Sufficient experience, technical and financial capability are usually neglected criterion despite their vital role while executing the project.

The frequent interference by clients and unrealistic requirements of clients are another point neglected by project owner. They should not interfere frequently during the execution since this may require substantial changes and can cause long delays in the project.

Clients should have guaranteed enough financial resources before the execution of project so that payment to the contractors is not delayed which in turn results with large time overruns.

Slow decision making process is a common problem, especially for projects owned by public institutions. Thus, reducing the bureaucracy during all phases of project execution is a must to avoid delays.

4.5.2. Prescription for the Consultants

The design of the contract is highly essential for smooth execution of a project. Contract must prescribe the mechanism to solve disputes, and mechanism to evaluate the risk of delays so that possible risk factors can be foreseen and eliminated accordingly without causing major delays.

Consultants should play a key role in communication between the parties involved.

Consultants should monitor the work closely by making inspections at appropriate times. The inspections should be wisely scheduled so that the mistakes can be prevented before they occur.

4.5.3. Prescriptions for the Contractors

High RII score given to *construction method (CO3)* reveals that contractors should not involve in projects without sufficient expertise.

The construction projects in Libyan oil industry are undertaken by international contractors with many workers from various socio-cultural backgrounds. This international character requires that site-managers should be talented organizers with good communication skills.

A good and detailed work plan should be prepared and shared with the client. This work plan should include not only detailed project steps but also schedules dedicated to procurement of material and equipment, financing, and human resources.

5. Conclusion

Oil industry involves various big-scale construction projects ranging from pipelines to storage tanks as well as refineries. This work investigated the causes and effects of delays in construction projects completed in Libyan oil industry. Since the study was conducted in 2014, after the Libyan revolution while the unrest has not ceased yet, we believe it is a valuable guide to practitioners planning to undertake projects in Libya. For this purpose, a questionnaire was designed and distributed among the three major parties involved in projects (clients, consultants and contractors). We identified main causes of delay and eight most important factors were: (1) security factor, (2) shortages in material, (3) construction method, (4) equipment availability, (5) mistakes and discrepancies in contract document, (6) inadequate equipment, (7) unforeseen site condition, and (8) availability of quality materials. Besides the main delay factors, we questioned the effects of delay where they were

ranked as; (1) cost overrun, (2) time overrun, (3) disputes, (4) arbitration, (5) total abandonment.

As mentioned earlier, the most important delay factor we identified is *security factor* which is a natural consequence of the turmoil the country is going through. High scores for equipment and material availability are also mainly related with this fact. Thus, we should notice that, the conclusions made here are partially country, and sector specific and they should be considered in a temporal context. Another important delay category was material related factors. This fact implies delivering high quality material and equipment on time may drastically reduce length and number of time overruns. Most factors related to contractor are rooted in experience in construction methods used. Beside cost concerns, experience in the field should be recognized as a major selection criterion. Solid legal basis and financially strong clients and contractors are also essential for timely completion of projects in Libyan oil industry.

Considering the results of the survey, this work can be beneficial from practical and theoretical perspectives. The three major parties of a project, clients, contractors and consultants, may refer to the results of this study to identify the most risky factors causing time delay in construction projects. Thus, they can better manage projects and reduce risk of delay by focusing on vital delay factors we highlighted. Additionally, a new theoretical project management framework linking practical project activities with the most essential delay factors can be developed so that the activities bearing high risk can be identified and managed more carefully.

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