# ANALYSING CONSTRUCTION DELAY FACTORS: A CASE STUDY OF BUILDING CONSTRUCTION PROJECT IN LIBYA

**Shebob, A.[1], Dawood, N. and Xu, Q.**

*School of Science and Engineering (SSE), Teesside University, Middlesbrough, TS1 3BA UK.*

Delays are one of the biggest problems facing by the construction industry. The delays in construction projects have significant financial and social impact to all parties involved in the projects. The aim of the paper is to analyse the impact of delay in Libyan construction projects by identifying and ranking the delay factors. A comprehensive literature was conducted to build up the general knowledge required to identify the potential delay factors in different countries. A semi structured questionnaire was designed using literature and distributed to construction companies that were selected randomly. The delay factors were ranked using the frequency of occurrence and severity scale. The survey result exposed that the construction projects in the developing countries suffer more delay than the developed countries. The critical delay factors found in Libyan construction projects were low skills of manpower, changes in the scope of the project, slowness in giving instruction, poor qualification of consultant and delay in delivering site project to contractor. Statistical experiments including, Paired Samples T-Test, was run to test the significance of the survey data and found that the result was significant. A case study of Libyan building project was analysed to identify the possible project delay and the sensitivity of each delay factor using @ risk simulation program. The case study result found that the project might be delayed by 97 to 103 days for one block in comparison to the planned duration. The results will guide the construction manager to take necessary measures to reduce the impact on construction project. The outcome of this study provides a methodology for identifying the delay factors and analysing the impact on construction projects.

Keywords: construction delay, delay analysis, questionnaire, statistical tests, simulation model.

## INTRODUCTION

Construction delay is a major problem facing by the construction industry. In most construction projects, there are delays and their impact level varies from project to project ranging from a few days to years. It is generally understood that the construction delay is the most critical factors affecting to deliver the project in time, within budget, and expected quality. It can be found rarely that a project was completed within the specified time. According to Mansfield (1994), it was found that timely completing of construction project was a signal of project efficiency; however, construction processes depend up on several variables and unpredictable factors that occur from various sources, including performance of involved party, availability of resources, site conditions and contractual conditions.

[1] A.Shebob@tees.ac.uk

Shebob, A, Dawood, N and Xu, Q (2011) Analysing construction delay factors: A case study of building construction project in Libya *In:* Egbu, C. and Lou, E.C.W. (Eds.) *Procs 27th Annual ARCOM Conference*, 5-7 September 2011, Bristol, UK, Association of Researchers in Construction Management, 1005-1012.

Understanding the causes of construction delay may help to find out the main causes and their significance in order to minimise and avoid the impact of delays in construction projects. This study focuses on analysing the impact of delays in Libyan construction project. This paper includes a case study to identify the possible delay and the sensitivity of each critical delay factor using @ risk simulation model. The findings from case study is expected to assist construction manager in taking necessary measures particularly the critical delay factors to reduce the impact on construction project. The remainder of the paper contents literature review, questionnaire design and distribution, statistical data analysis with SPSS and a case study of a building project in Libya.

## LITERATURE REVIEW

There are several research studies were conducted in identifying the delay factors in construction projects and their impact in cost and time in different countries. Wa'el and Mohd (2007) identified that the major causes and the types of delays in Malaysia construction industry. They found poor conditional weather, shortage of materials and lack of equipment in local market were found as external factors in construction delay. This research also highlighted that questionnaire survey is one of the most cost effective ways to collect and analyse a large number of responses from various involved parties in order to achieve better statistically analysis of the data.

Zaneldin (2006) investigated the variation and claims in construction projects in Dubai and Abu Dhabi in the United Arab Emirates using 124 claims related to can be little more specific the range of the projects or typical project. He concluded that 1) a reasonable time should be allowed for the design team in order to reduce clear and complete contract documents with no or minimum errors and discrepancies; 2) efficient quality control techniques and mechanisms need to be established to minimise errors, mismatches, and discrepancies in the contact documents; 3) special contracting provisions and practices need to add in contract document and a strategy needs to introduce to deal with tighter scheduling requirements. Alaghbari (2005) found several causes of delay in Saudi construction projects and they are drawing preparation, approval of design, payment delay, changes in design, slow cash flow, design errors, labour shortage. The filed survey in his research on the delay in construction projects in Saudi Arabia included examined 23 contractors, 19 consultants, and 15 owners. Al-Moumani (2000) conducted a qualitative analysis of construction delays by examining the records of 130 public building projects constructed in Jordan during the period 1990-1997 where the frequencies analysis method was used to identify the main causes of delay from the survey records. The result of the analysis exposed that the main causes of delay in construction projects were relate to designers user, changes weather, site conditions, late deliveries, economic conditions and increase in quantities.

A report published by the National Audit Office, UK and edited by John Bourn having title "Modernising Construction", exposed that 70% of the construction projects carried out by public departments and agencies were completed late. Moreover, a recent research by Building Cost Information Service (BCIS, UK) found that nearly 40% of all studied construction projects had overrun the contract period (Bourn, 2003). Chan and Kumaraswamy (1997) conducted an industry survey to discover the causes of overruns in Hong Kong construction projects and they found that three major groups of construction participants (owner, contractor, and consultant) were responsible for delay. They also found that the most significant sources of overrun

were site management, unforeseen ground conditions, low of decision-making and necessary variations of work.

Literature review concludes that the causes and effects of delay in construction industry can vary from country to country due to different topographical locations, local environmental regulation and advanced technologies applied in construction projects. It is also found that questionnaire is used widely as a research method to identify the causes and effects of delay in construction projects. In the view of competitive environment and globalisation, it is assumed that a comparative study on the delays between Libya and other countries, particularly UK, is very important and timely needed. Therefore, the paper focuses to identify the delay factors in the construction industry, and rank them according to the frequency of the occurrence. The paper also presents a comparative study of the delays factors between Libyan and UK. The next section discuses the research methodology.

# RESEARCH METHODOLOGY

Previous research studies highlighted that questionnaire survey is one of the most cost effective ways to collect and analyse a large number of responses from various involved parties in order to achieve better statistically analysis of the data (Wa'el and Mohd, 2007). Therefore, the questionnaire survey was selected as a research methodology to collect and analyse the delay factors in construction industries.

## Questionnaire design

A questionnaire was designed using existing questions used in previous study for delay analysis (Assaf and Al-Hejji; 2006; Wa'el and Mohd, 2007). The aim of the survey is to estimate the frequency of occurrence and severity level of delay factors in construction projects. The questionnaire is divided into three parts. Part one is related to general information of the respondent's experience and associated company. Contractors, owner and consultants were requested to answer the questions pertaining to their experience in the construction industry and their opinions about the percentage average time delay in projects they experienced. Part two related to project performance associated with respondents. Part three includes a list of 75 delay factors, which have been identified from literature review related in construction project. These factors are further classified into four (4) categories and eight (8) sub-categories according to the sources of delay.

Delay factors are related to project, owner, contractor, consultant, materials, equipment, manpower (labour), project management and external factors. For each delay factor, two questions were asked: What is the frequency of occurrence for this factor? And what is the degree of severity of this factor on project delay? Both frequency of occurrence and severity were categorized on a four-point scale. Frequency of occurrence is categorized as follows: never, occasionally, frequently and constantly (1 to 4 point scale). Similarly, degree of severity was categorized as follows: No effect, fairly severe, severe and very severe (on 1 to 4 point scale).The questionnaire was designed in two languages: English and Arabic in order to collect the responses from UK and Libya. The survey data was collected through post, email in UK and in person in Libya.

## Survey data collection

A random sampling procedure was employed to select the potential construction companies in UK and Libya. In total 300 surveys were distributed, 175 in the UK, which were sent by post and the rest 125 were distributed in Libya by the researcher in

person amongst the selected companies. Total 39% responses were received from the participated companies whereas response rate in UK was 37.9% and 62.1% in Libya. The details of questionnaire distribution and respective number of responses from both countries are presented in table 1.

**Survey data analysis**

Different sorts of ranking analysis is presented and discussed as part of survey data analysis. In data analysis, importance-based ranks is included in a group ranking, either by the total answers of each professional group (contractors, consultants and owners) or a country group (respondents from Libya and UK respectively). Moreover, three ways are used for ranking all delay factors, subcategories rank, and main categories rank. The analysis and discussion of ranking focuses directly on the importance of delay factors rather than ranking them based on frequency and severity separately, because of the significance values of presenting the rank of delay factors based on frequency and severity separately. For testing the data, a Statistical Package for Social Science (SPSS) was selected as the best available options. The following statistical methods were used to analyse the data and outline the survey results:

*Table 1: Number of respondents*

| Questionnaires | Contractors | | Total | Consultants | | Total | Owners | | Total | G. Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | L | UK | | L | UK | | L | UK | | |
| Distributed | 38 | 68 | 106 | 45 | 57 | 102 | 42 | 50 | 92 | 300 |
| Respondents | 24 | 13 | 37 | 20 | 19 | 39 | 28 | 12 | 40 | 116 |

*L: Libya, UK: United Kingdom*

Frequency index method was selected for the ranking of delay factors considering the frequency of occurrence identified by participants in the questionnaire survey.

$$(\mathrm{F.I.})\ (\%) = \sum_{a=1}^{4} \mathrm{a} \times \left(\frac{\mathrm{n}}{\mathrm{N}}\right) \times \frac{100}{4} \quad \text{..... (1)}$$

Where a is the constant expressing weighting given to each response (ranges from 1 for never up to 4 for constantly), n is the frequency of the responses, and N is total number of responses

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

$$(\mathrm{S.I.})(\%) = \sum_{a=1}^{4} \mathrm{a} \times \left(\frac{\mathrm{n}}{\mathrm{N}}\right) \times \frac{100}{4} \quad \text{..... (2)}$$

Where a is the constant expressing weighting given to each response (ranges from 1 for no effect up to 4 for very severe), n is the frequency of the responses, and N is total number of responses.

Importance Weight: The importance index of each factor is calculated as a function of both frequency and severity indices (Assaf and Al-Hejji, 2006).

$$\mathrm{IW} = \frac{[\mathrm{F.I.}(\%) \times \mathrm{S.I}(\%)]}{100} \quad \text{..... (3)}$$

## RESULTS OF INDUSTRIAL SURVEY

The delays factors were grouped into four categories (contractors, consultant, owners and externals factors) as shown in Table 2. Furthermore, analysing with Average

weight (AW) method for a particular category is practical in determining the average importance weight of the same category. In other words, the contractor performance category includes 35 individual delay factors, while the consultant category includes 10, poor early planning that leads to change in the scope of projects; these problems are occurred quite often in construction projects in Libya than in the UK. The survey result identified that delay impact was related to external factors categories were due to delay in agreement of design drawings and confirmation of tested materials, utility works concerning to public organization, economic crisis such as devaluation of currency and price inflation of materials, and shortage of required equipment.

## STATISTICAL TEST

Statistical test is necessary to analyse and identify the relationship and confidence level of the data validity or verify the correctness between or within groups of survey data Nelson (2004). Different types of statistical tests may be possible to decide more influential delay factors. In this paper, a statistical experiment of Paired Samples T-Test was selected to identify the relationship and confidence level of survey data. The test was performed in three categories: consultant, owners and contractors in Libya and UK. Table (4, 5 and 6) shows the relationship and confidence level of survey data from three categories: consultant, owners and contractors in Libya and UK in terms of frequency and severity scale. The relative importance of each category of the frequency and severity scale of delay factors perceived by the respondents were tested at 95% of confidence level. The P values of frequency and severity scale for all three groups was found less than 0.05 in T-test. Therefore, it is concluded that the survey results are significant. The significance of the result indicates that there is chance of delay in the construction project due to several delay factors identified through the research study. This result concluded that the data collected for the delay factors are significant and correct.

*Table 4: Paired Samples Test between Libya and UK consultants in frequency and severity scale*

| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | LibConsF - UKConsF | 8.04167E0 | 6.54957 | 1.19578E0 | 5.59602E0 | 1.04873E1 | 6.725 | 29 | .000 |
| Pair 2 | LibConsS - UKConsS | 6.36667E0 | 3.19869 | .58400 | 5.17226E0 | 7.56108E0 | 10.902 | 29 | .000 |

*LibConsF: Libyan consultant frequency scale, UKConsF: UK consultant frequency scale.*
*LibCons S: Libyan consultant severity scale, UKConsS: UK consultant severity scale*

*Table 5: Paired Samples Test between Libya and UK Owner in frequency and severity scale*

| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | LibOwnF - UKOwnF | 1.58534E1 | 4.39435 | .81601 | 1.41819E1 | 17.52497 | 19.428 | 28 | .000 |
| Pair 2 | LibOwmS - UKOwnS | 1.61034E1 | 4.02477 | .74738 | 1.45725E1 | 17.63439 | 21.547 | 28 | .000 |

*LibOwnF: Libyan owner frequency scale, UKOwnF: UK owner frequency scale. LibOwnS: Libyan owner severity scale, UKOwnS: UK owner severity scale*

*Table 6: Paired Samples Test between Libya and UK contractors in frequency and severity scale*

| | | Paired Differences | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 95% Confidence Interval of the Difference | | | | |
| | | Mean | Std. Deviation | Std. Error Mean | Lower | Upper | t | df | Sig. (2-tailed) |
| Pair 1 | LibConF - UKConF | 7.48837E0 | 3.83008 | .58408 | 6.30965E0 | 8.66710 | 12.821 | 42 | .000 |
| Pair 2 | LibConS - UKConS | 9.00581E0 | 3.37907 | .51530 | 7.96589E0 | 1.00457E1 | 17.477 | 42 | .000 |

*LibConF: Libyan contractor frequency scale, UKConF: UK contractor frequency scale. LibConS: Libyan contractor severity scale, UKConS: UK contractor severity scale*

# CASE STUDY

The purpose of this case study is to identify project duration due to delay factors and validate the simulation model results. The case study is one of the largest housing projects underway in the south of Tripoli city in terms of the scale of construction activities. The project comprises the construction of more than 280 housing flats. The project was awarded as a turnkey contract having project value of LD 14,660, 568 m for the design and construction of ten blocks, where each block includes seven floors and each floor contains four flats. A risk simulation model was developed in the research by integrating the critical activities and delay factors identified from industry survey using MS project and @risk simulator. The detailed framework and development methodologies are not included due to space restriction. However, a case study was run using the risk simulator model and results are presented below.

## Case study results and discussion

The distribution of probability for each identified critical delay factors has been determined and plotted between probability and random number using risk simulation model. The probability distribution of each delay factor is assumed for critical activity as triangle (Dawood, 1997). From the output functionality of @ risk, probability of any duration can be selected. After running the @risk program, the expected duration of the building project between minimum and maximum possible duration was identified as shown in figures 1 and 2. The result shows the minimum possible project duration of the building project is 463.50 days, maximum possible duration is 476.54 days and the mean project duration is 469.92 days. It is found that the duration of project more than the planned duration of 373 days that was identified by, Ms Project. Delayed duration = the mean of possible project duration with considering the impacts of the most critical factors vs. planned duration. Mean delayed duration = 469.92 – 373 = 96.92 days. The results are presented in figures 1 and 2.

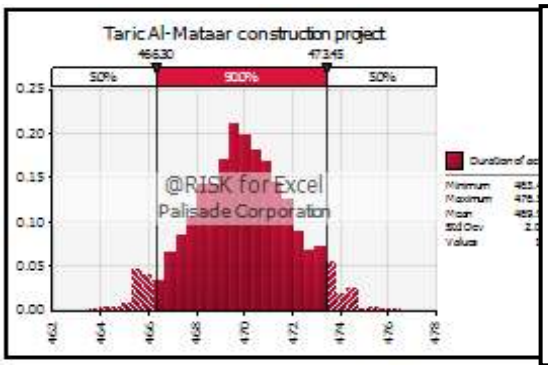


*Figure 1: Distribution of possible project duration*

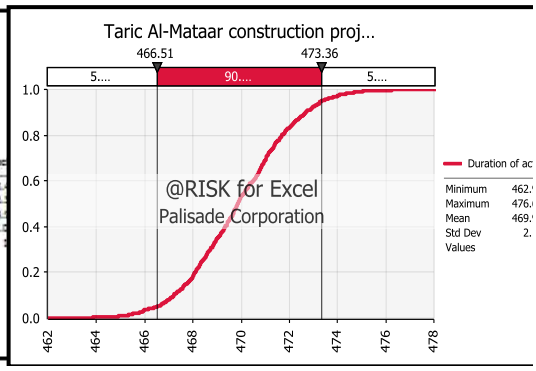


*Figure 2: Distribution of possible project duration*

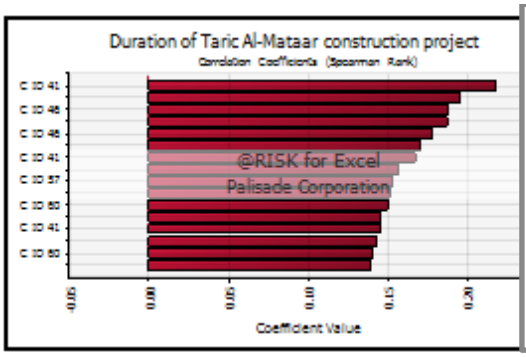


*Figure 3: Cumulative distribution for project duration between delay factors and correlation coefficient*

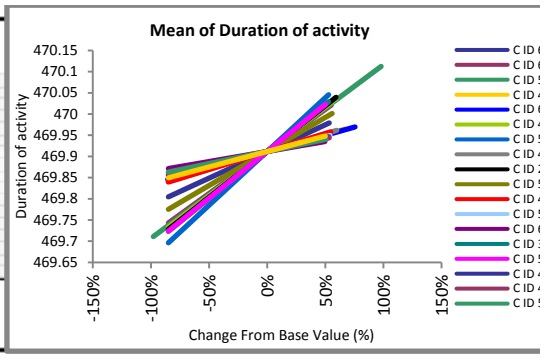


*Figure 4: Advanced sensitivity analysis percentile graph*

### Impacts of delay factors on project duration

A sensitivity analysis and correlation coefficient with different delay factors on project duration were performed. The graphical outputs of the sensitivity analysis and determination of correlation coefficient are presented in (figures 3 and 4). The case study result show that the delayed and slow supervision in making decisions, shortage of required materials, changes in the scope of the project, incomplete design documents, severe weather conditions on the job site, delay in material delivery, financial problems, interference by the owner in the construction operations, delay in the settlement of contractor claims by the owner and rise in the price of material were the most critical delays factors in the project.

## CONCLUSION

The research study found that the critical delays factors are different in UK and Libyan construction projects due to differences in construction methodology and planning techniques used in both countries. This was confirmed by conducting a ranking analysis of data obtained from industry survey. The survey found that low skill workers, rise in price of material, delay in materials delivery and changes in the scope of project were the most critical delay factors in the Libyan construction industry based on contractor point of view. From the views of owners, the most critical delay factors were low skill of manpower, delay in delivering site project to contractor, and modifications (replacement and addition) of new work to the project and changes in material specifications.

Moreover, in the views of consultants, the survey exposed that the critical delay factors in Libyan construction industry were delay in making decisions and slow

supervision, poor planning, slowness in giving instruction and poor qualification of consultant engineer's staff and waiting time for approval of drawings and test samples of materials. The statistical test confirms the significance of the survey data and found that there is a probability of delay in project due to several delay factors. This result also exposed that the assumptions made in this study related to delay factors under different categories are significant and correct.

Finally, the critical delay factors that have high impact were considered for analysis the delay impact on a case study of building project in Libya using risk simulator model. The model result showed that the project might be delay by 97 days from the planned duration after considering the top 24 critical delay factors identified from industry survey. The delay may be more if all identified delay factors are considered. The findings of the case study suggest that delay of construction project is directly related to number of critical delay factors and critical activities considered in the model. Therefore, it is confirmed that the delay analysis model provide a tool to construction manager in order to predict the possible delay of a construction project so that they take preventive measures to minimise these delay and its associated impacts in a project.

## REFERENCES

Alaghbari, W. A. (2005), *Factors affecting construction speed of industrialized building systems in Malaysia*, Master's thesis, University Putra Malaysia, Serdang, Malaysia.

Al-Moumani, H. A. (2000), "Construction Delay: a quantitative analysis", *International Journal of Project Management*, **18,** 51-59.

Assaf, A. and Al-Hejji, S. (2006), "Causes of delays in large building construction projects", *ASCE Journal of Management in Engineering*, **11**(2), 45–50.

Chan, D., and Kumaraswamy, A. (1997), "Survey of time- cost relationships in Hong Kong construction projects", *Building Technology and Management Journal*, **20**, 5472.

Dawood, N. (1997), "Estimating project and activity duration: a risk management approach using network analysis", *Construction management and economics*, **16** (1), 41 – 48.

Bourn, J. (2003), *A report published by the National Audit Office*, UK.

Mansfield, N. R. (1994), "Causes of delay and cost overruns in Nigerian construction project", *International Journal of Project Management*, **12**(4), 254-260.

Nelson, D. (2004), *The Penguin dictionary of statistics*, 2nd Edition, Penguin Books, London, UK.

Wa'el, A. and Mohd, R. (2007), "The significant factors causing delay of building construction projects in Malaysia", *Engineering, Construction and Architectural Management*, **14**(2), 192-206.

Zaneldin, E. K. (2006), "Construction claims in United Arab Emirates: Types, causes, and frequency", *International Journal of Project Management*, **24**, 453– 459.