KICEM Journal of Construction Engineering and Project Management
Online ISSN 2233-9582

www.jcepm.org
http://dx.doi.org/10.6106/JCEPM.2012.2.3.017

Development of a methodology for analysing and quantifying the impact of delay factors affecting construction projects

Abdulhamid Shebob[1], Nashwan Dawood[2], and Raj K. Shah[3]

Received February 20, 2012 / Revised August 8, 2012 / Accepted August 15, 2012

Abstract: Delays are one of the biggest problems facing by the construction industry and they have significant financial and social impact in construction projects. The paper presents a framework of Delay Analysis System (DAS) with the aim of analysing the impact of delay factors in Libyan construction projects. The system has designed by integrating the possible delay factors, critical activities of a project using @ risk simulator. A case study of building project was demonstrated to identify the impact of delays and the sensitivity of delay factor. The case study result showed that the project might be delayed by 97 to 103 days in comparison to the planned duration. The developed DAS is a tool for analysing and identify the impacts of delay factors and assist to construction manager to take necessary measure in reducing the delay impact. The paper provides a methodology for analysing the possible delay impact in a construction project and informing to construction manager in advance of the possible delay factors.

Keywords: construction delay, industry survey, importance weight, critical delay factors, delay analysis system

I. Introduction

Delay factors play a major role in the delivery of a construction project on time, within budget and at the required quality. A report published by General People's Committee PGC (2003) pointed out that 97% of public and private Libyan construction projects suffer delays with a high impact on project cost and time. Mansfield (1994) stated 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.

Understanding the factors of construction delay may help to find out the main factors and their significance in order to minimise and avoid the impact of delays in construction projects. 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, data collection and analysis, @risk simulation and a case study of a building project in Libya.

II. Literature Review

Construction delays are a major problem in the construction industry. Ahmed et al (2003) suggested that delays are key problem that occur in each construction project and the extent of these delays varies from project to project. It is found that certain projects are only a few days late while some projects are delayed by over a month or a year. For construction projects in developing and developed countries, several research studies were carried out to identify the delay factors, and they found a wide range of opinions and factors that delay a project.

Al-Moumani (2000) developed a qualitative analysis of construction delays by examining the records of 130 public building projects in Jordan. The frequencies analysis method was used to rank the main causes of delay from the survey data and revealed that the main causes of delay in construction projects were designer's faults, changes in weather, site conditions, late deliveries, economic conditions and variation in quantities. Similarly, Alaghbri et al (2005) found several causes of delay in Saudi construction projects by analysing the survey data collected from 23 contractors, 19 consultants, and 15 owners. They found that drawing preparation, approval of design, payment delay, changes in design, slow cash flow, design errors, and labour shortage were the key delay factors that affecting the project delay.

Previous research studies (Mansfield et al, 1994; Mezher and Tawil, 1998; Zaneldin, 2006; Assaf et al, 1995; Ogunlana and Promkuntong 1996; Al-Moumani 2000; Frimpong and Oluwoye 2003; Abdelnaser et al 2005) found that the delay factors in construction projects were quite different from project to project and country to country. Morano (2006) highlighted that a large number of techniques are being used in the identification process

[1] PhD Researcher: School of Science and Engineering (SSE), Teesside University, Middlesbrough, TS1 3BA, UK, Tel/Fax: +44 1642 342494, A.Shebob@tees.ac.uk
[2] Professor: School of Science and Engineering (SSE), Teesside University, Middlesbrough, TS1 3BA, UK,
[3] Lecturer: School of Science and Engineering (SSE), Teesside University, Middlesbrough, TS1 3BA, UK

of risks in the construction projects. These techniques are checklists, interviews with individuals or groups, brainstorming, survey and Delphi technique. Abdulaziz et al (1998) found various methods to analyse the impact of delays on construction schedules and these methods are As-planned method, As-built method and modified As-built method. They also found that the outcomes of delay were unpredictable. One method might not be used universally over another in all situations; or one method might prove to be the most desirable from the standpoint of the contractor or the owner (Abdulaziz et al, 1998).

To analyse the impact of delay factors on construction projects, Youngjae et al (2005) developed an effective and logical methodology "Delay Analysis Method Using Delay Section (DAMUDS)" by evaluating the construction delays which adequately accounts for commonly encountered situations. The first inadequacy was the ambiguity in the analysis of the concurrent delay. The other was the inadequacy of consideration of time-shortened activities. The DAMUDS incorporated two new concepts for correcting these inadequacies: the Delay Section (DS) and the Contractor's Float (CF). The developed method included three steps: the first step was a division of the total delayed project duration into multiple time increments of DSs, and the second step was to analyse and evaluate the time increment. The last step was to iterate the analysis of time increment into three steps: updating the baseline schedule, rescheduling the updated baseline schedule, and apportioning the responsibility of the changed project duration. The DAMUDS was widely used as a method of concurrent period of analysis. However, this method did not integrate and simulate the risk probability associated with delay factors and critical work activities of a construction project.

More recently, Jaskowski and Biruk (2011) pointed out that project activities' durations are directly affected by different risk factors independently. Existing risk analysis models, for example, simple analytical and neural networks developed by Kog et al. 1999; Chua et al. 1997; Zayed & Halpin 2005; Shi 1999, AbouRizk et al. 2001; and, Sonmez & Rowings 1998; fuzzy set model developed by Lee & Jaskowski, Biruk and Halpin 2003, and regression model developed by Hanna & Gunduz 2005, Jaselskis & Ashley 1991; cited in Jaskowski and Biruk, 2011) failed to provide more reliable solution for predicting activity and whole project durations. However, Jaskowski and Biruk (2011) agreed that the simulation model developed by Dawood (1998) is a quantitative delay analysis model which considered the impact of each delay factor independently for predicting durations of activities and whole project. Therefore, the research presented in this paper seeks to integrate the delay factors within the simulation model of delay analysis system to predict the activity or project durations, considering the influence of each risk factor independently.

Considering the above points, it is concluded that the causes and effects of delay factors in construction industry vary from country to country due to environmental, topographical and technological constraints. Previous research did not incorporate the importance weight (of delay factors (that have major contribution in project delay) in quantifying the impact of delays in construction projects. In anticipation of the effect of globalisation and technological difference between developing and developed countries, it is necessary to identify the actual reasons of delay in order to reduce the impact of delay in any construction project. Therefore, a new methodology for analysing and quantifying the impact of the delay factors is necessary by integrating the influence value of each possible delay factor in a construction project so that a preventative measure can taken in advance to minimise the impact of project delay and reduce the project cost.

III. RESEARCH METHODOLOGY

According to Wael et al (2007), a questionnaire is one of the most cost effective ways to collect and analyse a large number of responses from the involved parties in the construction industry in order to achieve better statistical analysis of the data. In this study, therefore, a questionnaire was used to collect the data related to delay factors associated with construction projects. The survey data were analysed to rank the delay factors and determine the Important Weight (IW) of delay factors using the frequency and severity index method. A framework for a Delay Analysis System (DAS) is developed using the findings from a literature review and industry survey. Frequency and severity index methods are used to identify the delay factors in Libyan construction industry. A case study of a building project is used to evaluate the functions of the DAS. The next section discusses the industry survey.

A. Questionnaire design

A questionnaire was designed by analysing the existing questions, which were used in previous study for identification of delay factors in construction projects Wa'el and Mohd (2007). The aim of the survey is to identify the frequency of occurrence and the severity level of delay factors associated within construction projects. Contractors, owner and consultants were requested to answer the questions pertaining to their experience within construction industry. The questionnaire was divided into three parts. Part one was related to general information of the respondent's experience and associated company. Part two was related to the performance of the projects, involved by respondents. Part three included a list of 75 delay factors, which identified from literature related in construction project. These factors were further classified into four (4) categories and eight (8) sub-categories according to the sources of delay.

Delay factors listed in the questionnaire 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 and the degree of severity of each factor? Both frequency of occurrence and severity were measured on a four-point rating scales because the four point scales provides better results in case of measuring frequency and severity of a factors. These scales also have been used widely by several research in past with satisfactory results in the engineering and applied science. Frequency of occurrence was categorised: never, occasionally, frequently and constantly (1 to 4 rating scale). Similarly, degree of severity was categorised: No effect, fairly severe, severe and very severe (1 to 4 rating scale). The responses were collected from the construction projects in Libya.

B. Data collection

A random sampling was employed to select the potential respondents: construction companies, consultants and owners in Libya. A total of 125 questionnaires were distributed to the randomly identified respondents. A total of 72 out of 125 (57.6%) responses were received. The details of survey including the questionnaire distribution and the respective number of responses are presented in Table 1.

TABLE I
NUMBER OF RESPONDENTS

Questionnaires	Contractors	Consultants	Owners	Total
Distributed	38	45	42	125
Respondents	24	20	28	72

C. Survey data analysis

This section discusses the survey data analysis. A method called "importance-based rank" is utilised for a group ranking of each professional group (contractors, consultants and owners). 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. The ranking analysis methods suggested by Assaf and Al-Hejji (2006) such Frequency Index (FI), Severity Index (SI) and Importance Weight (IW) were used to analyse the survey data and discuss the survey results. Frequency index method was selected for the ranking of each delay factor considering the frequency of occurrence identified by participants in the survey.

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

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

Similarly, severity index method was selected to rank delay factors based on severity as indicated by the participants.

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

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 index.

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

The ranking results are presented in Appendix-A. The appendix shows the Importance Weight (IW) of each delay factor and its rank on frequency and severity scale separately.

D. Results of survey

The delay factors associated with construction projects were grouped into four main categories (contractors, consultant, owners and externals factors) as shown in Table 2. Furthermore, the analysis with Importance Index (II) for a particular category of delay factors is practical and valuable in determining the average Importance Index (II) of all categories Kometa et al (1994). Accordingly, another method of Important Index (II) was identified in order to take into account the number of causes for each category thus ranking these categories. That was multiplying the AW of the category by the modulus of the number of the causes of the category. This was calculated as shown below

$$II = M * AW \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Whereas,

$$M = \frac{\text{the number of category delay factors}}{\text{Total number of all delay factors}}$$

AW = Average weight

TABLE II
IMPORTANCE INDEX (II) OF MAIN CATEGORIES BY RESPONDENT

Ctg	M	AW	II	RANK
CON	0.177	2.146	0.393	4
OWN	0.187	2.248	0.418	3
CNS	0.133	3.621	0.628	1
Other	0.198	2.419	0.420	2

Moreover, the delays factors were also grouped into eight sub-categories as shown in Table 3. The details of survey results related to all subcategories of delay factors are discussed below.

TABLE III
IMPORTANCE INDEX (II) AND RANK OF DELAY SUBCATEGORIES

Sub Ctg	M	A W	I I	RANK
C/MP	0.080	2.746	0.220	8
C/EQ	0.160	1.854	0.297	6
C/MT	0.160	2.389	0.382	5
C/PM	0.307	1.595	0.490	2
OWN	0.187	2.248	0.420	4
CNS	0.133	3.362	0.447	3
EP	0.133	2.138	0.284	7
EF	0.400	2.701	1.081	1

Ctg: category, AW: average weight, II: importance index
M: modulus of the number of the factors in the delay category
CON: contractor, MP: manpower, EQ: equipment, MT: material
PM: project management, OWN: owner, CNS: consultant
EP: early planning and design, EF: external factor

Moreover, the delay factors were also ranked into eight sub-categories and the survey results are presented in Table 3 above. The survey results revealed that the delay due to materials found at fourth important sub-category. Similarly, the delay due to equipment found at seventh rank. Manpower subcategory of delay factor was ranked as the second positions.

Furthermore, the project management sub-category was ranked as eighth position. The consultant sub-categories were ranked as first, whereas the owner sub-categories ranked as fifth for responsible for delay in construction projects. Finally, the early planning and design subcategory ranked sixth whereas, the external factors sub-categories were ranked third as shows in Table 3.

Following the findings from the literature review and industry survey, a conceptual framework was introduced to analyse the impact of delay factors in a building construction project. The next section discusses the input, process and output the proposed framework

IV. DEVELOPMENT OF A FRAMEWORK OF DELAY ANALYSIS SYSTEM

A conceptual framework of the DAS was designed to analyse the critical delay factors and quantify the impact of the delay factors in a construction project. The list of the critical delay factors were identified by analysing the collected data from the industry survey. Figure 1 presents conceptual framework of the DAS, which is arranged into inputs, process and outputs. The figure used in this paper represents a research methodology for the analysis of impacts due to possible delay factors in construction projects.

The details of inputs, process and outputs of the DAS are discussed in next sections.

A. Inputs of the DAS framework

The main inputs of the DAS are: a list of critical delay factors, Important Weight (IW), and a list of the critical activities of a construction project. The IW of delay factors were identified from a Libyan construction industry by analysing the frequency and severity of each delay factor as discussed above. The list of project activities in a building project is analysed using Critical Path Method CPM to identify the critical activities. These critical activities are a key input in the DAS because these activities are responsible for the delay of a project and overrun the project cost.

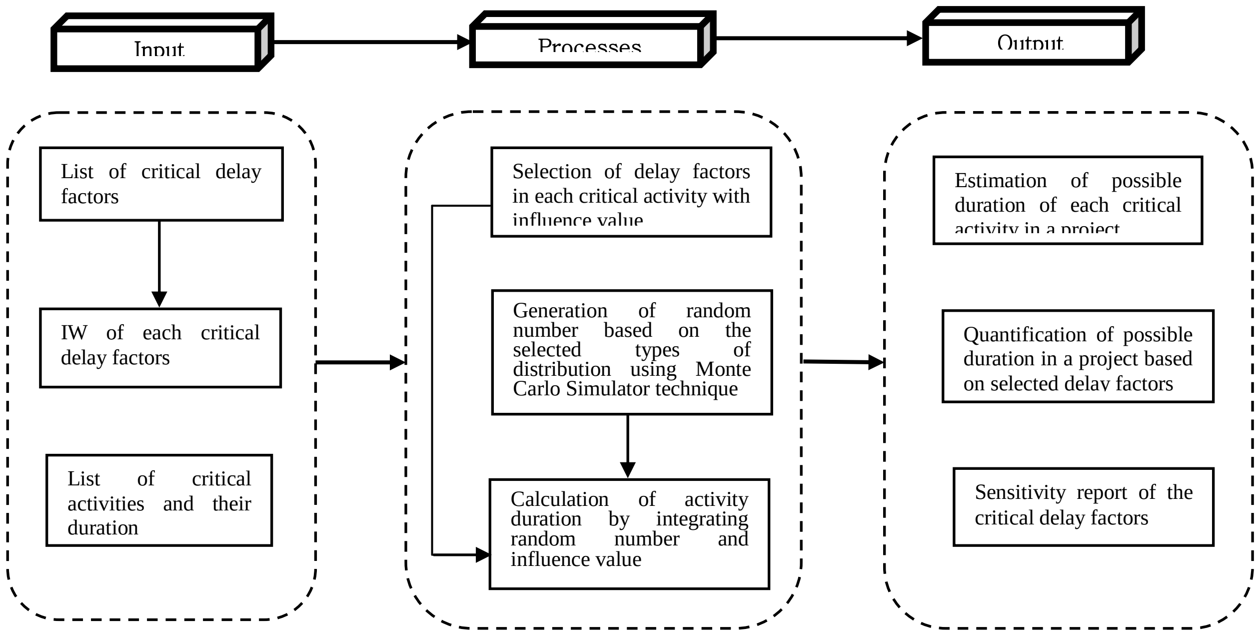


FIGURE I
SPECIFICATION OF THE SIMULATION MODEL OF DAS

Moreover, the critical activities of a project are considered for analysing impact of delay in the DAS because the duration of the critical activities are considered to identify the project duration and these activities have high impact on overall project delay. In this conceptual model of the DAS, the near critical activities are not integrated because these activities have less impact compared to the critical activities even though risk factors are analysed for both critical and near critical activities. Each activity in the critical path is called as critical activity since the total float of each critical activity is equal to zero. The delay in one activity in critical path has an impact in the whole project. Therefore, only critical activities were taken into account to analyse the impact of delay factors in a construction project. In the DAS, critical activities and relevant delay factors are the key inputs for analysing the impact of the delay in a construction project. For example, the duration and slack time of each critical activity of a project which is considered as inputs of the DAS are shown in Appendix-B. The process of the DAS is discussed in next section

B. Process of delay analysis system

The process of the DAS system was divided into four sub-sections: the identification of influence value of each critical delay factor, the selection of the delay factors affecting each critical activity, the identification of risk distribution for generating random numbers, and the integration of delay factors with critical activity. The details of process including the Mont Carlo Simulation (MCS) technique are discussed as follows.

1) Selection of delay factors affecting each critical activity

The possible types and numbers of critical delay factors, affecting each critical activity were selected through site knowledge base approach. The site knowledge was collected from construction professionals through interviews) during the construction industry survey. The influence value of each delay factor is calculated using the equation 5, which is the ratio of IW of each delay factor to the sum of IW of all delay factors, affecting a critical activity. The IW of each delay factor was identified by analysing the survey data, collected through the industry survey. Each activity has (risk) delay factors where the total influence of all risk factors should be 100% for an activity. In this study, equation 5 is used to calculate the influence values of each delay factor as below.

Influence of each delay factor = $\frac{(IW)}{\sum_1^n IW}$ .... (5)

Whereas,

IW = Important Weight of each critical delay factor.
n = Number of delay factors affecting each critical activity

For example, a critical activity, which have four different types of delays factors (Cause Id No: 69, 64, 43, 8), affect the duration of the critical activity (see Table 4). The calculation of Influence of each delay factors is presented in Table 4 below.

TABLE IV
THE CRITICAL DELAY FACTORS AND THEIR IMPACT VALUE FACING IN CRITICAL ACTIVITY

Critical activity No	Causes ID NO	The critical delay factors in Libyan construction industry	IW	Influence of factors
2	69	waiting time for approval of drawings and test samples of materials	76.73	0.29
	64	Severe weather conditions on the job site	65.27	0.25
	43	Delay in furnishing and delivering the site to the contractor by the owner	82.93	0.31
	8	Inadequate equipment used for the works	41.32	0.16
			266.25	1.00

Similarly, all critical activities of the building projects were analysed. Influence factors of critical activities were determined by considering IW of each delay factors that were calculated from survey aiming to incorporate in Mont Carlo Simulation (MCS). The delay impact of each critical activity was analysed and combined with associated delay factors to determine the delay of a construction project.

2) Generation of random number

Random numbers for each delay factor are generated from a particular representative distribution. The random values are generated between minimum and maximum (0, 1) using the Monte Carlo simulation technique assuming a suitable risk distribution. There are different types of random distribution values such as uniform, triangular, normal and beta. The type of distribution can vary from one activity to another activity (Dawood, 1998). However, this depends on the types of (risk) delay factors and their nature of impact on each critical activity in a project and these aspects were considered for assuming the risk distribution for delay analysis in this system. The risk distribution types depends on the nature of delay factors, which is selected past experience and knowledge of construction professionals through construction industry survey.

3) Integration of random number and influence value

The equation developed by Dawood 1998 was used in the DAS to calculate the possible duration of activity considering the impact of delay factors because the equation assist to quantify the expected project duration considering the impacts of delay factors affecting each critical activity. The equation also helps to identify/predict the best possible duration of the activity.

Therefore, this method was considered for calculation of the possible duration of a project in this study. The random numbers and influence values are a multiple factor. This is used to estimate the best possible duration of each critical activity. The possible duration of each critical activity in a project is identified/predicted using the equation 6 developed by Dawood (1998), shown below.

Duration of activity = Min Time + [Max Time – Min Time] x [(RF1 x Random1) + (RF2 x Random2) + (RF3 xRandom3) + (RF n x Random n)...]................ (6)

Whereas;

Min Time is the minimum that can be assigned to an activity.
Max Time is the maximum that can be assigned to an activity.
Random 1 = random numbers generated by MCS for selected type of risk distribution
RF n is the influence of delay factor (n) on a particular activity.

RF n=Influence factor = $\frac{(IW)}{\sum_{1}^{n} IW}$

The minimum and maximum duration of each activity used in the DAS were identified using the site information and knowledge of construction manager through site meeting. After identifying the duration of each critical activity, equation 6 is used to identify/predict the best possible duration of the activity, considering the impacts of delay factors affecting each activity in a construction project. The results of the most critical delay factors and their impact value are shown in Appendix-C.

C. Outputs of delay analysis system

The outputs of the DAS are the possible duration of a construction project and the sensitivity report of each critical delay factor affecting the project. This includes the maximum, mean and minimum possible duration of each critical activity and the whole project. The outputs are produced by processing the inputs through the DAS using equation 6 as discussed above. Moreover, the system also provides a sensitivity report of all critical delay factors, considered in the system for analysing the impact of delay. This sensitivity report provides information about the sensitivity of each critical delay factor (which delay factors have high influence in project duration in comparison to others). The possible delay in a project is identified by comparing the project duration between actual project duration and the system generated project duration. The introduced DAS in this study is expected to assist construction managers in analysing the construction resources, and reducing the impact of delay factors in terms of time and quality in a construction project.

V. Case Study Demonstration

A case study is used to evaluate the functions of the DAS. The selected building project for the case study was completed on a turnkey contract basis and the project value was around £ 10 million. The required data for inputs of the DAS such as project activities and delay factors affecting the building project were collected from the construction company that completed the project. This input was processed as discussed in the above sections.

A. Results and discussion

This section outlines about results and discussion of the case study. The input was processed as discussed above. After running the DAS, the possible durations of the building project were identified as shown in Figure 2 and Figure 3. The results found that the minimum, mean and maximum duration of the building project are 463, 476.61 and 469.92 days. The case study results revealed that the mean duration of project was found to be higher than the planned duration (373 days) after considering the impact of delay factors. This confirmed that the project might delayed by 97 days when comparing the planned duration

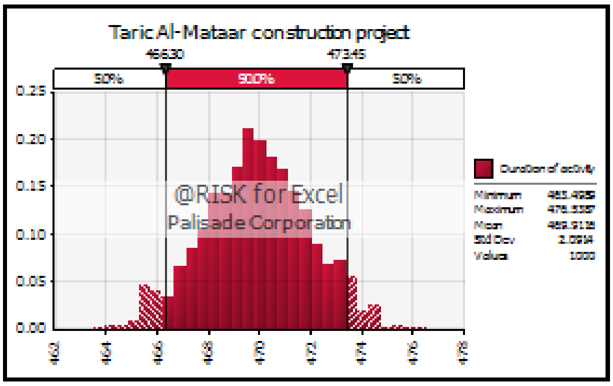


FIGURE II
Distribution of Possible Project Duration

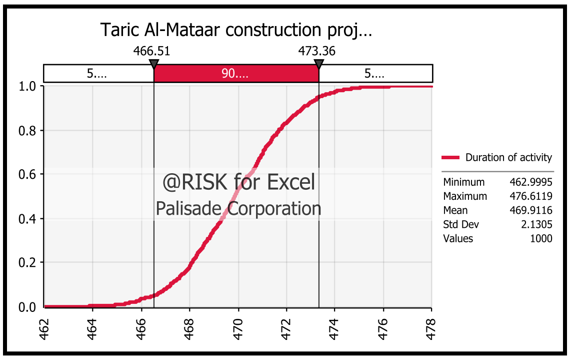


FIGURE 3
Distribution of Possible Project Duration

B. Sensitivity report of delay factors

A sensitivity analysis and the correlation coefficient with different delay factors of the case study were performed. The graphical outputs of the sensitivity analysis and results of correlation coefficient are presented in (Figures 4 and 5). The sensitivity analysis results showed that the delay in supervision, poor planning, 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 highly sensitive delays factors in the building project.

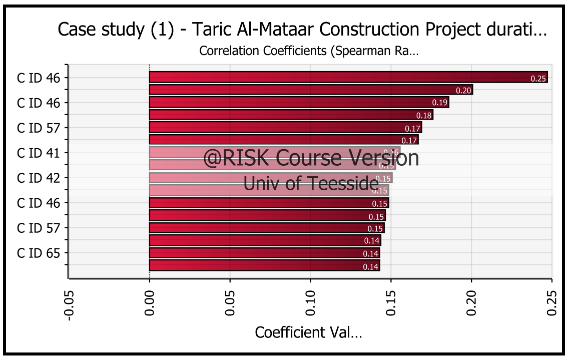


FIGURE IV
CUMULATIVE DISTRIBUTIONS FOR PROJECT DURATION BETWEEN DELAY FACTORS AND CORRELATION COEFFICIENT

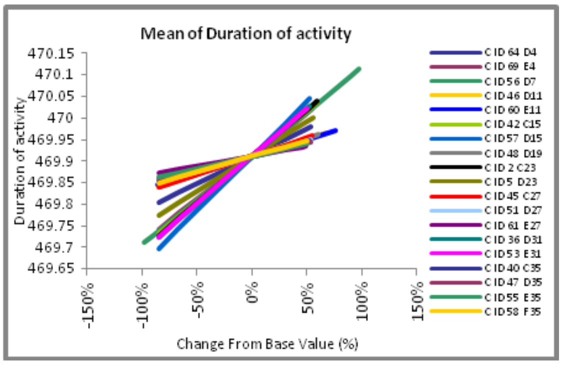


FIGURE V
GRAPHICAL RESULT OF SENSITIVITY ANALYSIS

VI. CONCLUSIONS

The research study has introduced a new methodology to analyse and quantify the impact of delay factors by developing a delay analysis system (simulation model). A framework of the system was developed using the findings from the literature review and industry survey in Libyan construction projects. A total of seventy five delay factors, considered most common in building construction, were listed from literature review to identify the importance weight (IW) of each delay factor by conducting the industry survey and ranking those factors using frequency and severity index methods. These delay factors were classified into eight subcategories and four main categories related to owner, consultants, contractors and others. The survey results found that the rank levels of delay factors were different from the views of three parties' contractor, consultant and owner.

A case study was demonstrated to evaluate the functions of the introduced delay analyse system by analysing and quantify the impact of delay factors in a building project using the IW of delay factors. The simulation result showed that the building project might be delayed by 97 to 103 days from the planned project duration when a total of 24 most critical delay factors apply. The project might be delayed by more days if a total of seventy five delay factors were considered.

The findings of the case study show an indicative figure of the possible delay in terms of time when considering the critical delay factors affecting a construction project. The key contribution of this study is a methodology development for analysing and quantifying the impact of delay factors in construction projects through better investigated, understood and documented report. The system is expected to help policymakers, decision makers and other stakeholders within the construction industry to gain a fuller understanding of the industry, enabling them to make efficient decisions to formulate short and long-term construction strategies and policies aiming to improve the industry's processes and operations.

REFERENCES

[1] A.A. Bubshait, M.J. Cunningham, "Comparison of delay analysis methodologies", *Journal of Construction Engineering and Management*, vol. 124, no. 4, pp. 315-322, 1998.

[2] S. AbouRizk, P. Knowles, U.R. Hermann, "Estimating labor production rates for industrial construction activities", *Journal of Construction Engineering and Management*, vol. 127, no. 6, pp. 502- 511, 2001.

[3] O. Abdelnaser, J. Peter, A. Mahmood, A. Hussin, H. Aziz, "Causes of construction delays", case studies in Langkawi Island, Malaysia, Paper presented at International Conference on built environmental in Kuala Lumpur, Malaysia, organized by University of Malaya, 2005.

[4] S.M. Ahmed, S. Azhar, P. Kappagntula, D. Gollapudil, "Delays in construction: a brief study of the Florida construction industry", Proceedings of the 39th Annual ASC Conference, Clemson University, Clemson, SC, USA, pp. 257-266, 2003.

[5] W.A.M. Alaghbari, "Factors affecting construction speed of industrialized building systems in Malaysia", Master's thesis, University Putra Malaysia, Serdang, 2005.

[6] A.H. Al-Moumani, "Construction Delay: a quantitative analyses", *International Journal of Project Management*, vol. 18, no. 1, pp. 51-59, 2000.

[7] S.A. Assaf, M. Al-Khalil, M. Al-Hazmi, "Causes of Delay in Large Building Construction Projects", *Journal of Project Management in Engineering*, vol. 11, no. 2, pp. 45-50, 1995.

[8] D.K.H. Chua, Y.C. Kog, P.K. Loh, E.J. Jaselskis, "Model for construction budget performance neural network approach", *Journal of Construction Engineering and Management*, vol. 123, no. 3, pp. 214-222, 1997.

[9] N. Dawood, "Estimating project and activity duration: a risk management approach using network analysis", *Construction Management and Economics*, vol. 16, no. 1, pp. 41- 48, 1998.

[10] Y. Frimpong, J. Oluwoye, I. Crawford, "Statistical methods", 2nd ed., Academic, New York, 2003.

[11] General People's Committee, Regarding permission for investors to execute their investment activities in Libya, decision no. (22) 2003.

[12] A.S. Hanna, M. Gunduz, "Early warning signs for distressed projects", *Canadian Journal of Civil Engineering*, vol. 32, no. 5, pp. 796-802, 2005.

[13] P. Jaskowski, S. Biruk, "The conceptual framework for construction project risk assessment", *Reliability: Theory & Applications*, vol. 2, no. 3, pp. 27-35, 2011.
[14] E.J. Jaselskis, D.B. Ashley, "Optimal allocation of project management resources for achieving success", *Journal of Construction Engineering and Management*, vol. 117, no. 2, pp. 321-340, 1991.
[15] Y.C. Kog, D.K.H Chua, P.K. Loh, E.J. Jaselskis, "Key determinants for construction schedule performance", *International Journal of Project Management*, vol. 17, no. 6, pp. 351-359, 1999.
[16] S.T. Kometa, P.O. Olomolaiye, F.C. Harris, "Attributes of UK construction clients influencing project consultants' performance", *Journal of Construction Management and Economics*, vol. 12, no. 5, pp 433-443, 1994.
[17] S. Lee, D.W. Halpin, "Predictive tool for estimating accident risk", *Journal of Construction Engineering and Management*, vol. 129, no. 4, pp. 431-436, 2003.
[18] N.R. Mansfield, "Causes of delay and cost overruns in Nigerian construction project", *International Journal of Project Management*, vol. 12, no. 4, pp. 254-260, 1994.
[19] M. Mezher, W. Tawil, "Causes of delays in the construction industry Lebanon", *Engineering Construction and Architectural Management*, vol. 5, no. 3, pp. 251-260, 1998.
[20] C.A.R. Morano, C.G. Martins, M.L.R. Ferreira, "Application of techniques for the identification of risk in the E & P ventures Engevista", vol. 8, no. 2, pp. 120-133, 2006.
[21] R. Sonmez, J.E. Rowings, "Construction labor productivity modelling with neural networks", *Journal of Construction Engineering and Management*, vol. 124, no. 6, pp. 498-504, 1998.
[22] S.O. Ogunlana, K. Prokuntong, V. Jearkjirm, "Construction Delays in Fast Growing Economy Comparing Thailand with Other Economies", *International Journal of Project Management,* vol. 14, no. 1, pp. 37-45, 1996.
[23] W. Alaghbari, M.R.A. Kadir, A. Salim, Ernawati "The significant factors causing delay of building construction projects in Malaysia", Engineering, Construction and Architectural Management, vol. 14, no. 2, pp. 192-206, 2007.
[24] Y. Kim, K. Kim, D. Shin, "Delay Analysis Method Using Delay Section" *Journal of construction engineering and management*, vol. 131, no. 11, pp. 1155-1164, 2005.
[25] E.K. Zaneldin, "Construction claims in United Arab Emirates: Types, causes, and frequency", *International Journal of Project Management*, vol. 24, no. 5, pp. 453-459, 2006.
[26] T.M. Zayed, D.W. Halpin, "Pile Construction Productivity Assessment", *Journal of Construction Engineering and Management*, vol. 131, no. 6, pp. 705-714, 2005.

APPENDIX

APPENDIX - A: IMPORTANCE WEIGHT, IMPORTANCE INDEX AND RANKING SCALE OF EACH DELAY FACTORS BY THE THREE PARTY'S LIBYAN CONSTRUCTION INDUSTRY

a) Ranking of the delay factors identified in Libyan construction projects from "Contractors" aspects

No	Delays Factors	Ctg	IW	R	II	Rank
2	Delay in materials delivery	C/TM	74.33	24	2.894	1
10	Low skill of manpower	C/MP	62.50	24	2.604	2
69	Waiting time for approval drawings and test samples of materials	EF	60.22	24	2.509	3
70	External work due to public agencies(roads, and public services	EF	58.62	24	2.443	4
75	Rework due to errors during construction	EF	57.82	24	2.409	5
5	Shortage of required equipment	C/EQ	57.80	24	2.408	6
1	Shortage of required materials	C/MT	57.01	24	2.375	7
64	Severe weather conditions on the job site	EF	53.93	24	2.247	8
65	Rise in the prices of materials	EF	52.28	24	2.178	9
61	Ambiguities, mistakes, and inconsistencies of drawing	EP	47.66	24	1.986	10
13	Shortage of technical professionals in contractor's organization	C/PM	46.99	24	1.958	11
35	Rework due to errors activities during construction the project	C/PM	46.98	24	1.957	12
22	Improper technical studies by contractor during the bidding stage	C/PM	46.42	24	1.934	13
68	Poor economic conditions, (currency, inflation rate, est.)	EF	46.34	24	1.931	14
31	Delay in sub-contractor work	C/PM	46.33	24	1.930	15
74	Unstable laws and regulation	EF	46.20	24	1.925	16
28	Improper construction methods implemented by the contractor	C/PM	44.41	24	1.850	17
32	Problems between the contractor and his subcontractors	C/PM	43.43	24	1.810	18
12	Shortage of contractor's administrative personnel	C/PM	39.50	24	1.646	19
20	Loose safety rules and regulations within contractor's organization	C/PM	38.41	24	1.600	20
7	Shortage of supporting and shoring installations for excavations	C/EQ	37.75	24	1.573	21
29	Difficulties in financing the project by the contractor	C/PM	37.60	24	1.567	22
34	Poor site management and supervision by contractor	C/PM	37.43	24	1.560	23
23	Ineffective planning and scheduling of the project by contractor	C/PM	37.13	24	1.547	24
67	Poor site conditions (location, ground, etc)	EF	35.49	24	1.520	25
4	Changes in materials specifications	C/MT	35.21	24	1.467	26
16	Slow preparations of change orders required	C/PM	34.64	24	1.443	27
60	Changes in the scope of the project	EP	33.85	24	1.410	28
25	Ineffective control of project progress by the contractor	C/PM	33.15	24	1.381	29
24	Delays to field survey by the contractor	C/PM	32.82	24	1.368	30
62	Subsurface site conditions differing from contract document	EP	32.23	24	1.343	31
15	Contractor 's poor coordination with other parties in project	C/PM	32.22	24	1.341	32
14	Poor communication between contractor with other parties	C/PM	32.21	24	1.340	33
27	Delay in the preparation of contractor submission	C/PM	31.05	24	1.294	34
3	Changes in materials prices	C/MT	30.47	24	1.270	35
11	Lack of motivation of contractor's members	C/PM	29.91	24	1.246	36
17	Ineffective contractor head office involvement in the project	C/PM	29.17	24	1.215	37
8	Inadequate equipment used for the works	C/EQ	28.46	24	1.186	38
63	Original contract duration is too short	EP	24.99	24	1.041	39
66	Lack of equipment and tools on the market	EF	23.4	24	0.975	40
26	Inefficient quality control by the contractor	C/PM	22.95	24	0.956	41
21	Poor qualifications of contractor's staff assigned to the project	C/PM	21.88	24	0.912	42
9	Shortage of manpower (skilled, semi-skilled, unskilled labour)	C/MP	19.57	24	0.815	43
27	Delay in the preparation of contractor submission	C/PM	19.05	24	0.794	44
19	Poor controlling of subcontractors by contractor	C/PM	19.04	24	0.793	45

c) Ranking of the delay factors identified in Libyan construction projects from "Owners" aspects

No	Delays Factors	Ctg	IW	R	II	Rank
9	Shortage of manpower (skilled and unskilled labour)	MP	95.58	28	3.414	1
45	Delay in the settlement of contractor claims by the owner	OWN	88.73	28	3.169	2
60	Waiting time for approval of drawings and test materials	EF	84.45	28	3.016	3
43	Delay to delivering the site to the contractor by owner	OWN	82.93	28	2.962	4
41	Contract modifications (replacement and addition of new work)	OWN	82.03	28	2.93	5
2	Delay in materials delivery	MT	81.31	28	2.904	6
64	Severe weather conditions on the job site	EF	78.91	28	2.818	7
48	Interference by the owner in the construction operations	OWN	74.98	28	2.678	8
42	Financial problems (delayed payments, and economic problems)	OWN	74.08	28	2.646	9
10	Low skill of manpower	MP	72.31	28	2.588	10
60	Changes in the scope of the project	EP	68.19	28	2.435	11
70	External work due to public agencies (roads, public services)	EF	67.47	28	2.41	12
36	Lack of experience of owner in construction	OWN	65.37	28	2.334	13
65	Rise in the prices of materials	EF	64.5	28	2.304	14
1	Shortage of required materials	MT	63.80	28	2.279	15
61	Ambiguities, mistakes, and inconsistencies of drawings	EP	62.28	28	2.224	16
7	Shortage of supporting and shoring from the consultants	EQ	59.55	28	2.127	17

40	Lack of coordination with contractors	OWN	57.59	28	2.057	18
46	Delay in issuing of change orders by the owner	OWN	56.87	28	2.031	19
4	Changes in materials specifications	MT	54.89	28	1.960	20
47	Slow decision making by the owner organisation	OWN	53.59	28	1.914	21
44	Unrealistic contract duration	OWN	44.83	28	1.601	22
68	Poor economic conditions (currency, inflation rate, etc.)	EF	41.92	28	1.496	23
37	Improper project feasibility study	OWN	39.99	28	1.428	24
49	Delay in progress payments by the owner	OWN	38.41	28	1.372	25
66	Lack of equipment and tools on the market	EF	37.82	28	1.351	26
5	Shortage of required equipment	EQ	35.24	28	1.259	27
39	Slowness in making decisions	OWN	30.61	28	1.093	28
3	Changes in materials prices	MT	29.59	28	1.057	29
38	Lack of working knowledge	OWN	29.55	28	1.055	30
6	Failure of equipment	EQ	29.53	28	1.054	31
74	Unstable laws and regulation	EF	27.46	28	0.981	32
8	Inadequate equipment used the works	EQ	27.45	28	0.980	33
75	Rework due to errors during construction	EF	25.43	28	0.979	34
67	Poor site conditions (location, ground, etc.)	EP	25.41	28	0.977	35
73	Slow site clearance	EF	25.41	28	0.975	36

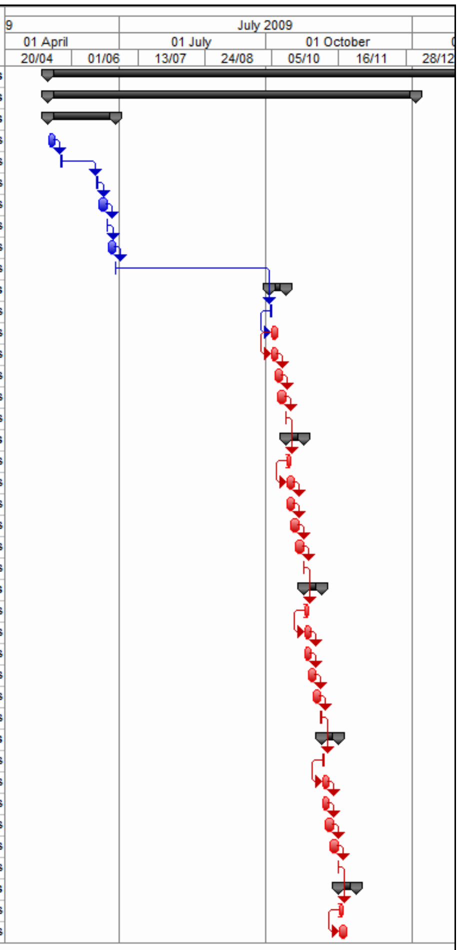
b) Ranking of the delay factors identified in Libyan construction projects from "Consultants" aspects

No	Delays Factors	Ctg	IW	R	II	Rank
50	Poor qualification of consultant engineer's staff	CNS	90.25	20	4.513	1
3	Changes in materials prices	MT	90.23	20	4.332	2
60	Changes in the scope of the project	EP	86.63	20	4.523	3
69	Waiting time for approval of drawings and test of materials	EF	85.52	20	4.275	4
56	Delayed and slow supervision in making decisions	CNS	84.41	20	4.221	5
52	Delay in the approval of consultant submissions by the consultant	CNS	83.24	20	4.163	6
57	Poor planning and incomplete contract documents	CNS	83.2	20	4.16	7
9	Shortage of manpower (skilled, semi-skilled, unskilled labour)	PM	73.24	20	3.662	8
61	Ambiguities, mistakes, and inconsistencies of drawings	EP	72.63	20	3.651	9
10	Low skill of manpower	PM	72.11	20	3.605	10
8	Inadequate equipment used for the works	EQ	68.06	20	3.403	11
54	Slow response and poor inspection	CNS	66.02	20	3.301	12
53	Poor design and delays in design	CNS	63.85	20	3.193	13
63	Original contract duration is too short	EP	63.75	20	3.187	14
58	Slowness in giving instruction	CNS	63.00	20	3.150	15
64	Severe weather conditions on the job site	EF	62.97	20	3.148	16
65	Rise in the prices of materials	EF	62.00	20	3.100	17
51	Delay in the preparation of drawings	CNS	59.63	20	2.982	18
75	Rework due to errors during construction	EF	54.25	20	2.713	19
55	Absence of consultant's site staff	CNS	50.63	20	2.531	20
4	Changes in materials specifications	MT	49.79	20	2.489	21
1	Shortage of required materials	MT	49.00	20	2.450	22
6	Failure of equipment	EQ	48.00	20	2.430	23
62	Subsurface site conditions materially differing from contract	EP	44.53	20	2.226	24
5	Shortage of required equipment	EQ	43.64	20	2.182	25
67	Poor site conditions (location, ground, etc.)	EF	39.84	20	1.992	26
70	External work due to public agencies (roads, and public services	EF	36.56	20	1.828	27
74	Unstable laws and regulation	EF	35.94	20	1.797	28
66	Lack of equipment and tools on the market	EF	33.00	20	1.650	29
73	Slow site clearance	EF	32.67	20	1.633	30
59	Poor communication between the consultant and other parties	CNS	32.65	20	1.632	31
7	Shortage of supporting and shoring installations for excavations	EQ	32.62	20	1.623	32
68	Poor economic conditions (currency, inflation rate, etc.)	EF	32.59	20	1.621	33

APPENDICES - B: THE CRITICAL WORK ACTIVITIES IDENTIFIED BY MS PROJECT

IN THE CASE STUDY, MS PROJECT USED TO IDENTIFY THE CRITICAL ACTIVITIES OF THE BUILDING PROJECT SO THAT DELAY IN EACH CRITICAL ACTIVITY CAN ANALYSE AND IDENTIFIED POSSIBLE DELAY DUE TO THE DELAY FACTORS. DURATION AND SLACK TIME OF EACH ACTIVITY OF THE PROJECT ARE SHOWN BELOW.

ID	ID	Task Name	Duration	Start	Finish	Predecessors	Total Slack
1	**1**	**1 Block 1 (BAB TARABLUS)**	**373 days**	**Sun 17/05/09**	**Mon 24/05/10**		**0 days**
2	**2**	**1.1 Structural works**	**231 days**	**Sun 17/05/09**	**Sat 02/01/10**		**9 days**
3	**3**	**1.1.1 General works**	**43 days**	**Sun 17/05/09**	**Sun 28/06/09**		**9 days**
4	4	1.1.1.1 Excavation	4 days	Sun 17/05/09	Wed 20/05/09		9 days
5	5	1.1.1.2 Lean concrete	1 day	Mon 25/05/09	Mon 25/05/09	4FS+4 days	9 days
6	6	1.1.1.3 Founda formwork erection	2 days	Tue 16/06/09	Wed 17/06/09	5FS+21 days	9 days
7	7	1.1.1.4 Foundation rebar fixing	5 days	Thu 18/06/09	Mon 22/06/09	6	9 days
8	8	1.1.1.5 Foundation concrete pouring	1 day	Tue 23/06/09	Tue 23/06/09	7	9 days
9	9	1.1.1.6 Isolation works	4 days	Wed 24/06/09	Sat 27/06/09	8	9 days
10	10	1.1.1.7 Back filling	1 day	Sun 28/06/09	Sun 28/06/09	9	9 days
11	**11**	**1.1.2 Ground Floor (GF)**	**11 days**	**Sat 03/10/09**	**Tue 13/10/09**		**0 days**
12	12	1.1.2.1 Ground floor wall & column rebar	2 days	Sat 03/10/09	Sun 04/10/09	10FS+90 days	3 days
13	13	1.1.2.2 Ground floor wall & column	4 days	Sun 04/10/09	Wed 07/10/09	12SS-1 day	0 days
14	14	1.1.2.3 Ground floor wall & column concrete	4 days	Sun 04/10/09	Wed 07/10/09	13SS	0 days
15	15	1.1.2.4 Ground floor slab formwork Slab Formwo	5 days	Tue 06/10/09	Sat 10/10/09	14FS-2 days	0 days
16	16	1.1.2.5 Ground floor slab rebar fixing	5 days	Thu 08/10/09	Mon 12/10/09	15FS-3 days	0 days
17	17	1.1.2.6 Ground floor slab concrete	1 day	Tue 13/10/09	Tue 13/10/09	16	0 days
18	**18**	**1.1.3 Floor 1**	**11 days**	**Wed 14/10/09**	**Sat 24/10/09**		**0 days**
19	19	1.1.3.1 Floor wall & columan rebar	2 days	Wed 14/10/09	Thu 15/10/09	17	0 days
20	20	1.1.3.2 Floor wall & columan	4 days	Wed 14/10/09	Sat 17/10/09	19SS	0 days
21	21	1.1.3.3 Floor wall & columan concrete	4 days	Wed 14/10/09	Sat 17/10/09	20FS-4 days	0 days
22	22	1.1.3.4 Floor slab formwork	5 days	Fri 16/10/09	Tue 20/10/09	21FS-2 days	0 days
23	23	1.1.3.5 Floor slab rebar fixing	5 days	Mon 19/10/09	Fri 23/10/09	22FS-2 days	0 days
24	24	1.1.3.6 Floor slab concrete pouring	1 day	Sat 24/10/09	Sat 24/10/09	23	0 days
25	**25**	**1.1.4 Floor 2**	**11 days**	**Sun 25/10/09**	**Wed 04/11/09**		**0 days**
26	26	1.1.4.1 Floor wall & columan rebar	2 days	Sun 25/10/09	Mon 26/10/09	24	0 days
27	27	1.1.4.2 Floor wall & columan	4 days	Sun 25/10/09	Wed 28/10/09	26SS	0 days
28	28	1.1.4.3 Floor wall & columan concrete	4 days	Sun 25/10/09	Wed 28/10/09	27FS-4 days	0 days
29	29	1.1.4.4 Floor slab formwork	5 days	Tue 27/10/09	Sat 31/10/09	28FS-2 days	0 days
30	30	1.1.4.5 Floor slab rebar fixing	5 days	Fri 30/10/09	Tue 03/11/09	29FS-2 days	0 days
31	31	1.1.4.6 Floor slab concrete pouring	1 day	Wed 04/11/09	Wed 04/11/09	30	0 days
32	**32**	**1.1.5 Floor 3**	**11 days**	**Thu 05/11/09**	**Sun 15/11/09**		**0 days**
33	33	1.1.5.1 Floor wall & columan rebar	2 days	Thu 05/11/09	Fri 06/11/09	31	0 days
34	34	1.1.5.2 Floor wall & columan	4 days	Thu 05/11/09	Sun 08/11/09	33SS	0 days
35	35	1.1.5.3 Floor wall & columan concrete	4 days	Thu 05/11/09	Sun 08/11/09	34FS-4 days	0 days
36	36	1.1.5.4 Floor slab formwork	5 days	Sat 07/11/09	Wed 11/11/09	35FS-2 days	0 days
37	37	1.1.5.5 Floor slab rebar fixing	5 days	Tue 10/11/09	Sat 14/11/09	36FS-2 days	0 days
38	38	1.1.5.6 Floor slab concrete pouring	1 day	Sun 15/11/09	Sun 15/11/09	37	0 days
39	**39**	**1.1.6 Floor 4**	**11 days**	**Mon 16/11/09**	**Thu 26/11/09**		**0 days**
40	40	1.1.6.1 Floor wall & columan rebar	2 days	Mon 16/11/09	Tue 17/11/09	38	0 days
41	41	1.1.6.2 Floor wall & columan	4 days	Mon 16/11/09	Thu 19/11/09	40SS	0 days



Project planning of critical work activities identified by Ms Project

APPENDICES - C: THE MOST CRITICAL DELAY FACTORS WITH IMPACT VALUE AND RANDOM NUMBERS FOR EACH DELAY FACTOR IN CASE STUDY

Activity No	Random 1	Random 2	Random 3	Random 4	Random 5	Rand 1 RF 1	Rand 2 RF 2	Rand 3 RF 3	Ran 4 RF 4	Rand 5 RF 5	Duration of activity
	C ID 2	**C ID 64**	**C ID 69**			**C ID 2**	**C ID 64**	**C ID 69**			
13	0.60	0.63	0.62			0.35	0.3	0.35			**4.09**
14	0.66	0.60	0.63			0.35	0.3	0.35			**4.11**
	C ID 1	**C ID 56**	**C ID 65**			**C ID 1**	**C ID 56**	**C ID 65**			
15	0.57	0.60	0.50			0.28	0.42	0.30			**5.06**
16	0.60	0.63	0.59			0.28	0.42	0.30			**5.11**
17	0.63	0.63	0.65			0.28	0.42	0.30			**1.03**
	C ID 1	**C ID 46**	**C ID 60**			**C ID 1**	**C ID 46**	**C ID 60**			
19	0.60	0.57	0.53			0.28	0.41	0.31			**2.03**
20	0.55	0.56	0.63			0.28	0.41	0.31			**4.06**
21	0.63	0.66	0.63			0.28	0.41	0.31			**4.11**
	C ID 42	**C ID 57**	**C ID 65**			**C ID 42**	**C ID 57**	**C ID 65**			
22	0.60	0.63	0.62			0.34	0.38	0.28			**5.12**
23	0.65	0.59	0.62			0.34	0.38	0.28			**5.12**
24	0.6	0.56	0.63			0.34	0.38	0.28			**1.02**
	C ID 42	**C ID 48**	**C ID 57**			**C ID 42**	**C ID 48**	**C ID 57**			
26	0.63	0.60	0.63			0.23	0.37	0.40			**2.05**
27	0.65	0.60	0.60			0.23	0.37	0.40			**4.09**
28	0.63	0.62	0.56			0.23	0.37	0.40			**4.08**
	C ID 2	**C ID 5**	**C ID 56**			**C ID 2**	**C ID 5**	**C ID 56**			
29	0.60	0.62	0.63			0.37	0.22	0.41			**5.12**
30	0.57	0.63	0.60			0.37	0.22	0.41			**5.10**
31	0.62	0.65	0.62			0.37	0.22	0.41			**1.03**
	C ID 45	**C ID 51**	**C ID 61**	**C ID 65**		**C ID 45**	**C ID 51**	**C ID 61**	**C ID65**		
33	0.62	0.63	0.66	0.66		0.32	0.26	0.22	0.20		**2.06**
34	0.66	0.65	0.63	0.64		0.32	0.26	0.22	0.20		**4.12**
35	0.62	0.60	0.63	0.65		0.32	0.26	0.22	0.20		**4.10**
	C ID 5	**C ID 36**	**C ID 53**			**C ID 5**	**C ID 36**	**C ID 53**			
36	0.60	0.63	0.65			0.26	0.37	0.37			**5.13**
37	0.66	0.63	0.64			0.26	0.37	0.37			**5.14**
38	0.63	0.63	0.66			0.26	0.37	0.37			**1.03**
	C ID 40	**C ID 47**	**C ID 55**	**C ID 58**		**C ID 40**	**C ID 47**	**C ID 55**	**C ID58**		
40	0.63	0.63	0.65	0.65		0.26	0.24	0.22	0.28		**2.06**
41	0.66	0.65	0.60	0.63		0.26	0.24	0.22	0.28		**4.11**
42	0.64	0.65	0.65	0.66		0.26	0.24	0.22	0.28		**4.12**
	C ID 2	**C ID 51**	**C ID 65**			**C ID 2**	**C ID 51**	**C ID 65**			
43	0.63	0.62	0.66			0.37	0.35	0.28			**5.14**
44	0.63	0.62	0.64			0.37	0.35	0.28			**5.13**
45	0.65	0.64	0.66			0.37	0.35	0.28			**1.03**
	C ID 1	**C ID 42**	**C ID 48**			**C ID 1**	**C ID 42**	**C ID 48**			
47	0.60	0.66	0.64			0.28	0.36	0.36			**2.05**
48	0.65	0.62	0.60			0.28	0.36	0.36			**4.10**
49	0.65	0.65	0.64			0.28	0.36	0.36			**4.12**
	C ID 1	**C ID 2**	**C ID 3**	**C ID 5**	**C ID 45**	**C ID 1**	**C ID 2**	**C ID 3**	**C ID 5**	**C ID 45**	
50	0.63	0.61	0.63	0.64	0.60	0.18	0.24	0.16	0.14	0.28	**5.12**
51	0.62	0.64	0.64	0.62	0.66	0.18	0.24	0.16	0.14	0.28	**5.14**
52	0.56	0.60	0.64	0.65	0.63	0.18	0.24	0.16	0.14	0.28	**1.02**
	C ID 42	**C ID 57**	**C ID 60**			**C ID 42**	**C ID 57**	**C ID 60**			
70	0.63	0.65	0.65			0.34	0.38	0.29			**14.43**
	C ID 2	**C ID 41**	**C ID 46**			**C ID 2**	**C ID 41**	**C ID 46**			
122	0.60	0.62	0.61			0.31	0.34	0.35			**20.43**
124	0.63	0.64	0.62			0.31	0.34	0.35			**20.52**
126	0.63	0.66	0.63			0.31	0.34	0.35			**20.56**
128	0.56	0.62	0.60			0.31	0.34	0.35			**20.38**
130	0.60	0.63	0.66			0.31	0.34	0.35			**20.53**
132	0.64	0.65	0.66			0.31	0.34	0.35			**20.59**
134	0.65	0.63	0.62			0.31	0.34	0.35			**20.53**

136	0.63	0.66	0.66		0.31	0.34	0.35		**20.60**
	C ID 42	**C ID 57**	**C ID 60**	**C ID 65**	**C ID 42**	**C ID 57**	**C ID 60**	**C ID 65**	
139	0.60	0.61	0.60	0.63	0.26	0.30	0.22	0.22	**20.44**
141	0.62	0.63	0.65	0.61	0.26	0.30	0.22	0.22	**20.50**
143	0.66	0.65	0.64	0.63	0.26	0.30	0.22	0.22	**20.58**
145	0.64	0.63	0.65	0.65	0.26	0.30	0.22	0.22	**20.57**
147	0.63	0.66	0.65	0.66	0.26	0.30	0.22	0.22	**20.60**
149	0.66	0.65	0.66	0.65	0.26	0.30	0.22	0.22	**20.62**
151	0.64	0.65	0.63	0.64	0.26	0.30	0.22	0.22	**20.57**
153	0.65	0.62	0.60	0.65	0.26	0.30	0.22	0.22	**20.52**

C ID: causes ID number, RF: risk factor