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Overview of the Delay Analysis Framework for Construction Project in Abu Dhabi, UAE

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Abstract: **The Delay Analysis Framework consolidates diverse techniques and methods to achieve a reliable, timely, economic, and automated schedule analysis and damage calculation. However, and because of the occurred delays for projects and growing complexness for recent construction projects in UAE, delays and cost overrides became common realities in the construction sector. That motivated the researchers and practitioners to use several approaches to calculate project delays and assign delay responsibility between the involved parties. This paper is prepared to demonstrate and evaluate different delay analysis frameworks that used to settle and resolve the occurred delays and support the delay analyst. In this regard, the study is comparing diverse frameworks to evaluate the capability of delay analysis frameworks through the measurement of many variables such as ability in assigning the responsibilities for the project delay, saving delay analysis cost, time, efforts and resources, dealing with concurrent delays and the flexible limit of application. The previous studies addressed several delay analysis framework that used by the Contractors in the construction projects in UAE and other countries. It's useful to review those delay analysis frameworks from another view to gain insight into the capability of theses delay analysis framework through the measurement of many variables. Therefore, in this review, previously reported novel for the functions and advantages of the delay analysis frameworks are briefly discussed through evaluating seven measurements. The study found that the Integrated Forensic Delay Analysis Framework is more complex and it required several techniques to be applied. Also, the Developed Integrated Framework Analysis by Golnaraghi and the Integrated Forensic Delay Analysis Framework are required high level of detail and records comparing to the Conceptual Delay Analysis Framework by Abdelhadi. Moreover, the study recommended overcome the weakness of the previous delay analysis framework and develop the appropriate delay analysis framework to promote their use properly, in order to help reduce the frequent delay of claims settlement and provide high advantages.**

Keywords**: Claim, Delay Analysis Framework, Extension of Time, Concurrent Delays.**

1. INTRODUCTION

The Delay Analysis Framework consolidates diverse techniques and methods to achieve a reliable, timely, economic, and automated schedule analysis and damage calculation (Abu-Osbeh, 2011). It is necessary to consolidate framework for delay analysis matters to be undertaken in a timely way. The delay matters cover calculating delay impacts on project period, delays documentation, calculating delay-associated damages and assigning project delay responsibilities among the parties, (Ibrahim Nasr, 2013).

In the UAE, claimant parties in several construction projects can determine and settle any claim by utilizing the standard settlement guides of negotiations; intercessions; arbitrations; or litigations. The greater part of construction disputes in UAE (77.1%) are determined using negotiations while only 4.9% of disputes were settled by using litigations (Zaneldin, 2006) as shown in Figure 1. The research revealed that 50% of the construction projects in UAE encounter delays and are not completed on time (Faridi, 2006). A major criticism of the United Arab Emirates (UAE) construction companies is the growing rate of delays in project delivery (Motaleb, 2010).

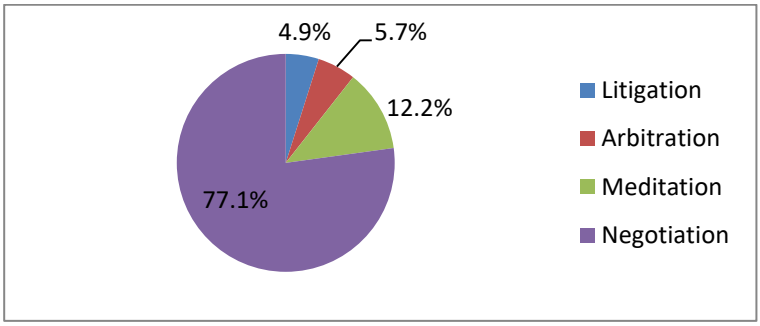

Figure Error! No text of specified style in document.**: The Common Resolution Guides Used to Resolve Claims in UAE (Zaneldin, 2006)**

Project delay analysis using simple and complex methods in presenting or defining the delay claim such as Global Impact Technique (Arditi & chamroon, 2006). Net Impact Technique (Mohan & Al-Gahtani 2006), As Planned Vs. As Built Schedule Analysis (Yusuwan & Adnan , 2013), Impacted As Planned Schedule Analysis (Braimah & Ndekugri, 2008) and Collapsed/ 'But for' As-built schedule analysis (Al-Gahtani, 2006).

The aforementioned methods are considered efficiently acceptable for analysing a schedule impact consequential from project delays were illustrated the dissimilarity in their applicability on the real construction projects (Abdelhadi, 2015).

Analysing delays includes important data collecting, sorting of delay, analysing the impact of diverse delay cases and solving the concurrent delay issues by considering particular liabilities. These functions are regularly achieved through different applications and techniques, and part of these functions is still done manually (Golnaraghi, 2011). The consequences from several researches indicated that the result of delay analysis are frequently not expected, whereas one method may not be used commonly over another in all cases; or one method may confirmed to be the more advantageous as of the viewpoint of the Owner or the Contractor. By concerning time, available resources, and access to project control documents, may be one more way realistic or cost effectual (Lee, 2005). Furthermore, and according to Rustom (2012), there are a number of techniques for analyzing the impact of the delay on time schedule, only a few are theorizing accepted and inclusive to consider delays and risk.

In this regard, the study is comparing diverse frameworks in order to develop the integrated framework that recover the obstacles in the other delay analysis frameworks such as complexity, lack of records, ability in assigning the responsibilities for the project delay, delay analysis cost, time, efforts and resources, dealing with concurrent delays, the analysis accuracy and limit of application as shown in the next sections. Therefore, in this review, the study investigated the implementation of the seven measurements on three different delay analysis frameworks to evaluate the capabilities of those delay analysis frameworks.

2. MEASUREMENTS OF THE CAPABILITY FOR DELAY ANALYSIS FRAMEWORKS

The first element to be measured when comparing diverse frameworks for analyzing the impact of the delay is the complexity of the delay analysis framework. Complex means necessitating effort, cost and time. A sample of this having a delay analysis cost more than the whole claim value (Braimah & Ndekugri, 2008). Also, Williams (2003) mentioned that usually, all methods appear to be simple in theory but they are difficult in practice.

The second element for comparing different delay analysis frameworks is the level of the details required for the analysis. It is one of the key decisions to take when determining which delay analysis frameworks to be use. The major factor for the choice on the proper level of detail for the delay is the accessibility of the records, time and resources obtainable to accomplish the analysis (Braimah & Ndekugri, 2008). According to Arcuri(2007), delays and changes are integrated into the delay analysis meanwhile appropriate sources as shown in Figure 2.

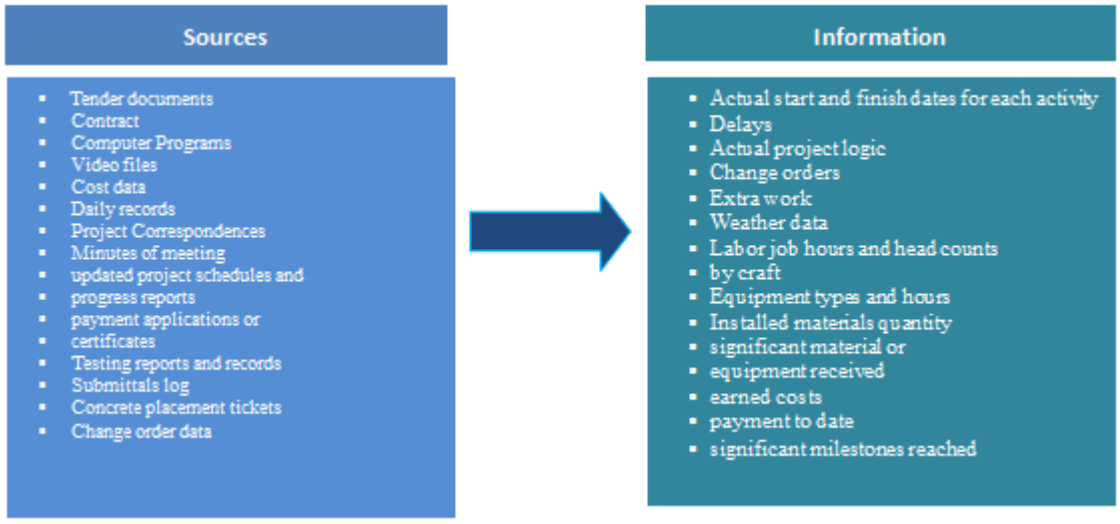

Figure 2: Sources and Information Record for changes and delays (Arcuri, 2007)

The third element for comparing different delay analysis frameworks is the framework capability in allocating the liabilities for project delay by verifying the responsibilities of delay for project stakeholders. Iain Murdoch (2003) investigated various methods in which delay responsibilities can be limited in a construction contract and analyses methods taken in some of the standard systems presently available. Construction projects regularly overdo budget and program and the contract will locate which project party takes responsibility.

Sophisticated clients and contractors are increasingly aware of the nature of the risks associated with their projects and both standard form and bespoke contracts address allocation of risk in more and more detail (Murdoch, 2003).Also, Williams (2003) clarified that the key function of the delays analysis is to verify the effect, cause, compensation, and responsibility.

The forth element for evaluating the delay analysis framework is the cost. The specialist for the delay analysis should investigate all the factors prior selecting complicated methods as his decision, if not precise, may have critical consequence. A sample of this having a delay analysis cost exceeds the total claim value or failing to accomplish the delay analysis because of the lack in records (Kumaraswamy & Yogeswaran, 2003).

Fifth element for comparing different delay analysis frameworks is how the nominated framework is dealing with the concurrent delay hen more than one kind of delay occurs at the similar time and both, either independently or together, effect the critical path, a concurrent delay happens (Ostrowski &Midgette, 2006). Concurrent delays increase the complexity of the delay analysis (Menesi, 2007). Menesi specified that the three main problems in determining concurrent delay are as follows:

- It is hard to settle the concurrency duration of more than one delay event. Whereas, the concurrent delay events may happen with respect to more than one concurrent activity.
- Updated critical paths could be created because of using the total floats for non-critical activities.
- If the concurrent delay is allocating on critical paths, and if the owner delays the critical path, the contractor can slowdown his work to be critical.

A sixth element for evaluating the capability of the delay analysis framework is the accuracy of the analysis. Ten techniques have been evaluated by using a case study. None of the present techniques resolve accurately all of the four general delay issues: concurrent delay, real time delay, pacing delay and acceleration. The technique of Window/But-for is found to be fairly accurate (Al-Gahtani& Mohan, 2011). Furthermore, and according to Rustom (2012), there are a number of techniques for analyzing the impact of the delay on time schedule, only a few are theorizing accepted and inclusive to consider delays and risk.

The seven elements for evaluating the capability of the delay analysis framework is the limit of application for the delay analysis framework. The main source of the claims exposed to the capabilities and limitations of the techniques in their functional use. Improving a good knowledge of these techniques is significant in understanding the actual intricate issues involved and their improvement required (Braimah, N., 2013).

3. EVALUATE THE CAPABILITY OF SOME DELAY ANALYSIS FRAMEWORKS

One conceptual framework was developed by Abdelhadi (2015) as shown in Figure3 examined the common delay analysis methods that used by the Contractors in the construction projects in UAE. In addition, the study addressed the issues affecting the selection of such method by analysing five case studies from the construction project in UAE. The study resulted in the necessity to discriminate between the methodologies for the delay analyses and the level of detail of the analysis as the same factors may affect both variables.

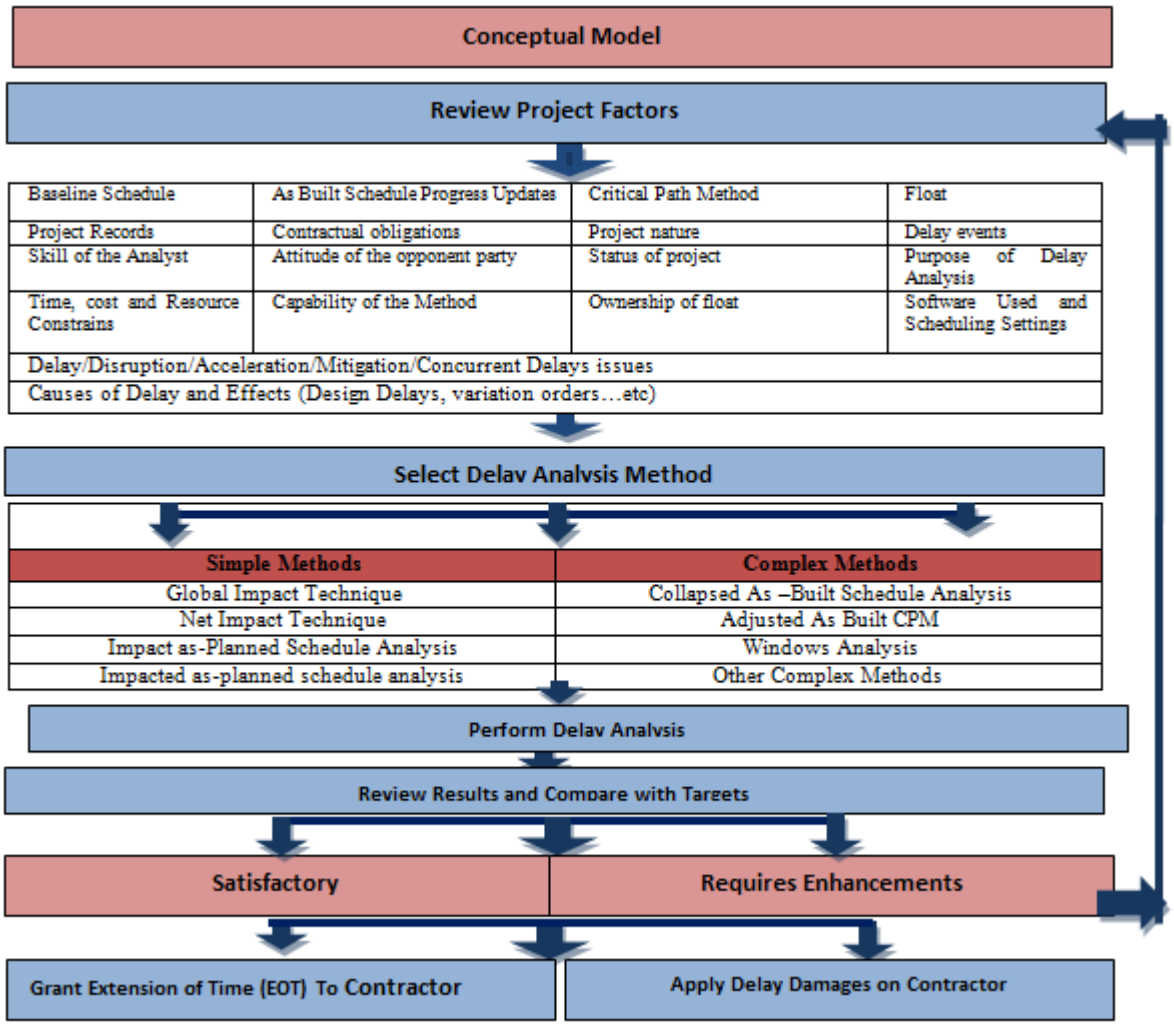

Figure 3: Conceptual Framework for the common Delay Analysis Methods in Construction Projects in UAE (Abdelhadi, 2015)

It's quite useful to look for Abdelhadi's Conceptual Framework from another view to gain insight into obstacles for the subject framework and this will help to see how the proposed Framework for this study is different from Abdelhadi Conceptual Framework. For this purpose, the SWOT (Strengths, Weaknesses, Opportunities and Threats) Analysis Matrix had been used as shown in Figure 4.

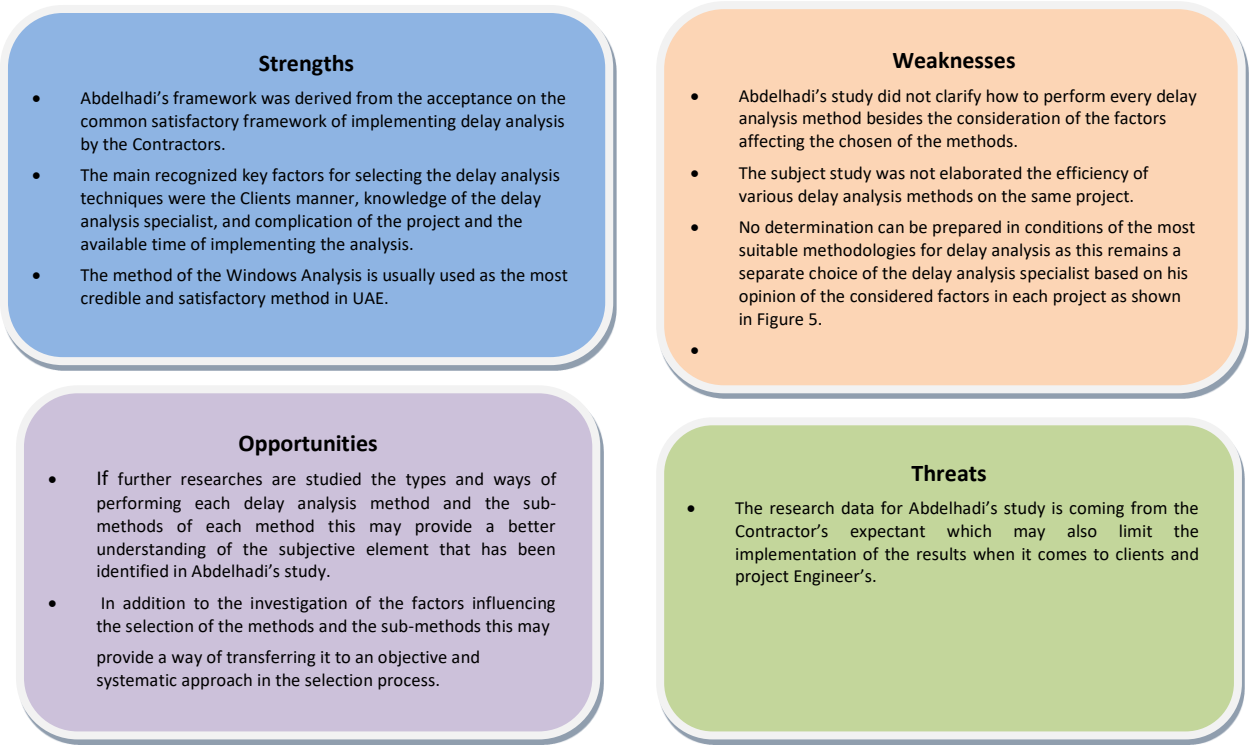

Figure 4: SWOT Analysis Matrix for Abdelhadi Conceptual Framework (Abdelhadi, 2015)

The selection map for the delay analysis method in Abdelhadi Conceptual Framework first depends on the selection of an appropriate delay analyst having the appropriate experience, reputation and reasons for impartiality so that he make and justify subjective views on the factors and the delay analysis methods. The selection map addresses all the relevant factors and the potential effects of such factors; however, it does not provide specific instruction for the selection of the delay analysis method as such decision relies on the subjective view of the delay analyst as shown in Figure 5.

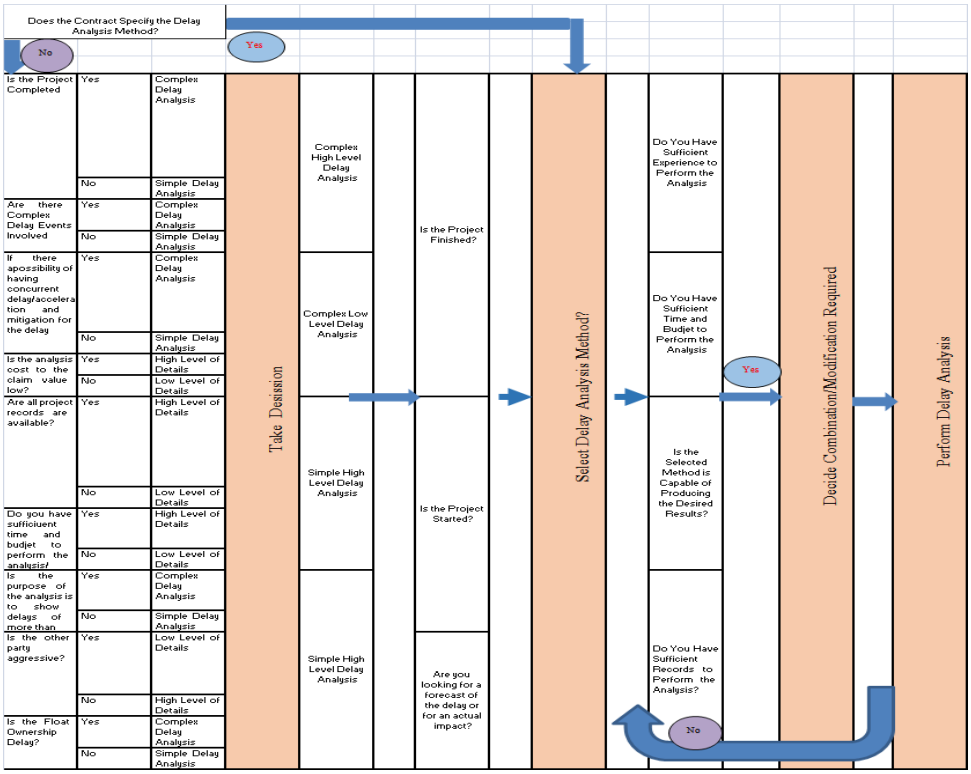

Figure 5: The Selection Map for the Delay Analysis Method in Abdelhadi Conceptual Framework (Abdelhadi, 2015)

To determine the capability of Abdelhadi's delay analysis framework six elements had been investigated by referring to Abdelhadi's study as shown in the below table. These elements are: complexity, level of records required, ability in assigning the responsibilities for the project delay, delay analysis cost, time, efforts and resources, dealing with concurrent delays, the analysis accuracy and the limit of application for the delay analysis framework as shown in Table 1.

Table 1: Investigation of the Capability for Abdelhadi's Delay Analysis Framework

SR	Delay Analysis Framework	Elements						
		Complexity/Simply Apply	**The level of detail and records required**	**Ability in Assigning the responsibilities for the project delay**	**Delay Analysis Cost, time, efforts and resources**	**Dealing with Concurrent Delays**	**The Analysis Accuracy**	**Limit of Application**
1	**Conceptual Delay Analysis Framework by Abdelhadi's(2015)**	The delay analysis specialist must make sure it has adequate skills and experience to carry out the analysis. The suggestion for the decision creators in projects is that they confirm the selected delay analysis specialist is honest independent and having sufficient experience so that his individual decisions and hypothesis can be justified. The framework is simple if the analyst select Windows Analysis with law level of detail OR Any Method for law level of details. While the framework is complex if the analyst select Windows Analysis with hgh level of detail OR Any Method with high level of detail (Abdelhadi, 2015).	The availability of project records: -Baseline and As Built Program - Progress periodic updates (Abdelhadi, 2015).	This framework optimizing project delay responsibility and liability for the Contractor (Apply Delay Damages on Contractor)and Owner(Grant Extension of Time (EOT) To Contractor)at the end of the analysis as shown in the above Figure(Abdelhadi, 2015)	Budget and time limitations are also significant issues that evenly influence the delays analysis method. It is viewed as a inadequate factor as the delay analysis specialist will face the compromise of the quality and details when this may influence the accuracy, the logical of the delay analysis results and fairness. Hard effort requires of the other commonly used methods such as the Windows Analysis in the framework(Abdelhadi, 2015)	Issues relating the concurrent delay, , must be analyzed at an early phase in the selection procedure in parallel with the procedure of considering the attitude of the party' factor (Abdelhadi, 2015).	The framework concentrates on the major recognized methods of delay analysis and categories rather than the exact delay analysis methods. More detailed studies of each of the sub-methods may give more accurate results (Abdelhadi, 2015) .	Abdelhadi analyzed only 5 case studies from the Construction projects in the UAE. The findings may therefore be limited to UAE and to similar type of projects only. the research data is coming from the Contractor's expectant which may also limit the implementation of the results when it comes to clients and project Engineer's. More realistic findings could be obtained if a larger range of data is collected from different Contractor's expectant. The study also concentrated on the main recognized categories and methods of delay analysis rather than the specific delay analysis sub-methods (Abdelhadi, 2015)

Another developed integrated framework is designed by Golnaraghi (2011) includes four key roles, that are: identifying delayed work, assorting work delay, determining delay effects on work schedule, and analyzing the cost of losses as shown in Figure 6. In the start the delay analyst have to allocate the whole relevant details such as the Baseline Program and the updated program. Upon using the key roles, the delay analyst will find the outcomes about the delay responsibilities and relevant costs.

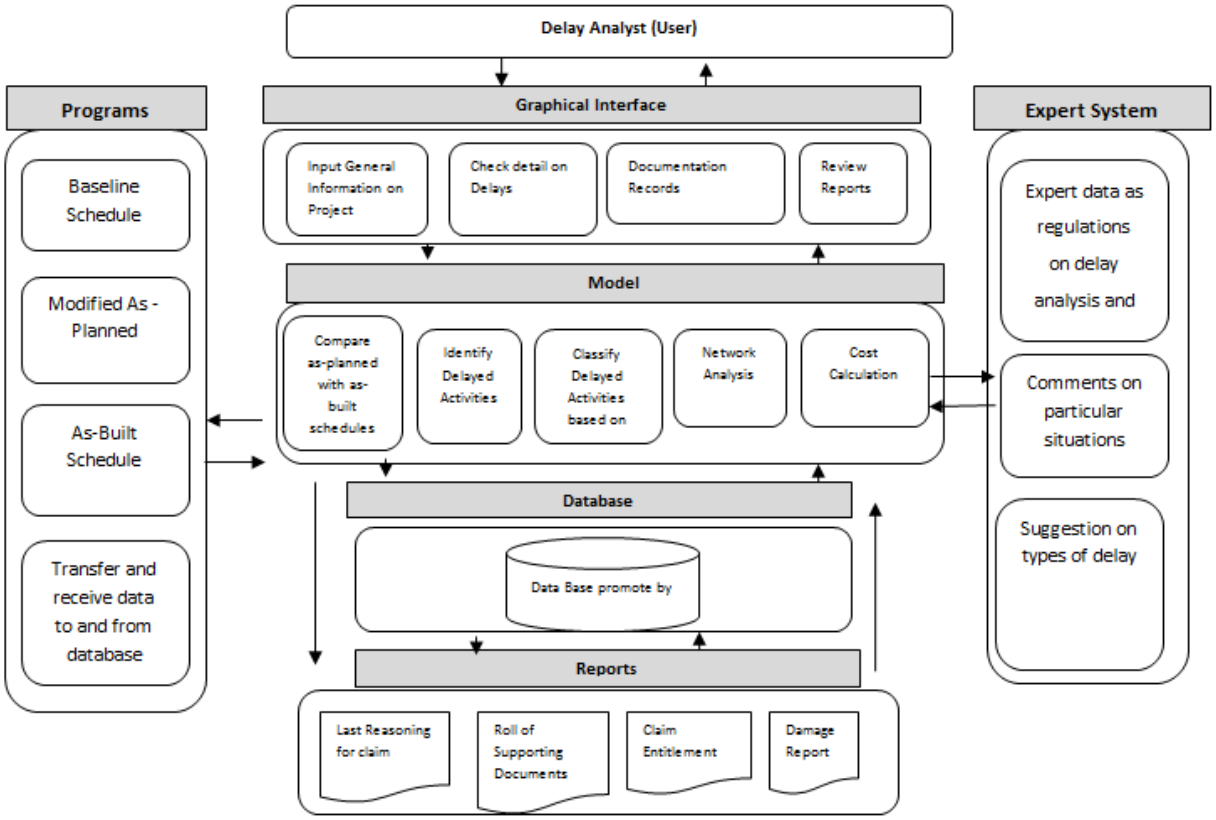

Figure 6: Developed integrated framework for Delay Analysis (Golnaraghi, 2011)

The developed framework can help delay analysts in claims evaluation, despite of whether they are from the owners or Contractors. The framework includes six parts containing the user, an expert data, graphical user and two accessible software were used; MS as the project scheduling software and Microsoft Access as the database (Golnaraghi, 2011).

The framework use the Modified Isolated Delay Type (MIDT) technique, the delays are assigned in the Baseline Schedule and known as "Impacted Schedule". The Impacted Schedule has to be measured up to the Baseline Schedule to calculate the effect of delay. Prior to transfer to the following analysis duration, its previous duration must be justified to synchronize with the periods and convene the reasonable relationship as per the timely real progresses. Such is identified as a new As Planned Program for the subsequently analysis duration (Golnaraghi, 2011).

A developed framework exactly assigns delays amongst the various project parties. The framework was experienced contra a theoretical method to emphasize its usefulness and boundaries, in contrast to available delay analysis methods. To maintain the anticipated framework, massive Expert Data is prepared to categorize the diverse sorts of delays to display commendations on delays. The Expert System and the anticipated delay analysis framework are connected to the system database. Similarly, the established component of calculating related costs improves the efficiency of the framework. The improved framework supports the user to decrease the cost and time for claims elaboration in a methodical logic (Golnaraghi, 2011).

The main benefits of the Golnaraghi's Framework are that it can be applied to evaluate the delay claim in a accurate manner, thus saving cost and time, categorize delays and give solution for delayed works by using Expert Data System, allocate delay responsibility to project stakeholders depend on consistent manner and rational for all project stakeholders, compute the related cost in a practical way (Golnaraghi, 2011).

The Golnaraghi's Framework addressed the incapability elements on the developed framework. The framework is not addressing the effect of resource allocation and delay analyst does not experience acceleration, the Framework in a diversity of delay cases for complicated projects. Furthermore, the computerized delay analysis is based wholly on "Finish to Start" links. It is excluding other category of activity relationships. It supposed to be well-known that the other **r**elationships between the activities can be useful by applying lags. In addition, the framework is not included calculating software to estimate the cost of delays (Golnaraghi, 2011).

To determine the capability of developed integrated framework by Golnaraghi's six elements had been investigated by referring to Golnaraghi's study as shown in the below table. These elements are complexity, level of records required, and ability in assigning the responsibilities for the project delay, delay analysis cost, time, efforts and resources, dealing with concurrent delays, the analysis accuracy and the limit of application for the delay analysis framework as shown in Table 2.

Table 2: Investigation of the capability for the Developed Integrated Framework by Golnaraghi's(2011)

SR	Delay Analysis Framework	Elements				
		Complexity/Simply Apply	**The level of detail and records required**	**Ability in Assigning the responsibilities for the project delay**	**Delay Analysis Cost, time, efforts and resources**	**Dealing with concurrent delays**
1	**Developed Integrated Framework by Golnaraghi's(2011)**	The integrated framework facilitates the practice of claim analysis elaboration in an automatic way as follows: -Gather and assign the project's information. - Gather data from MS Project Software to categorize delayed activities. - Verify and modify the delayed activities. -Categorize the delays as separate and synchronized delays. - Check with the Expert Data System to categorize delayed activities according to their claim. - Compute the total costs of the delays. -Generate the reports for the claim.	The framework use only Microsoft Project records formed in a particular format; the delay analyst have to contain the Baseline program and As Built Program 2. Framework used the Modified Isolated Delay Type (MIDT)technique as of two dissimilar view of point: owner and contractor	The framework allocates delay liability to project stakeholders based on a reasonable manner all stakeholders.	-The integrated framework facilitates the procedure of delay analysis preparation in a systematic way that saves time, cost and effort. - The framework is incorporated a lot of commercial software that are simply use. -The improved system is decreased the time and cost and arranging project data in a solid-structured format	The frame work organized the delays into separate delay and synchronized delays. The impact of synchronized delays in allocating the delay can adjust the general outcomes of the analysis application. A number of applications try to control this issue, but it is observable that additional studies are necessary in determining the synchronized delays. This framework demonstrates that concurrent delays could guide to impractical outcomes. In addition It provides a delay analysis application to analyze concurrent delays, depend on the accessible technique. The framework was incorporated the Isolated Delay Type (IDT) analysis method to calculate the impact of the concurrent delays.

Another delay analysis framework called Integrated Forensic Delay Analysis Framework was developed by Muhanad Abu-Osbeh (2011) to identify delays and document their associated information, resolve the effect of delays on the work duration and settle on liabilities, calculate damages and apply the procedure of delay analysis to reduce cost, time and enhance the accuracy. The approach applied for this framework contains the design ,amendment of the literature, module for delay analysis, module for cost calculation, module for cost effect, module for overhead cost, and module for the liquidated damages cost.

The EIC (Event Identity Concept) and ELM (Equal Liability Method) were used for a part of the concurrency issues. IDWAT (Isolated Daily Window Analysis Technique) was also incorporated in the framework. The framework used to create the As-Built Schedule, As-planned Schedule, and any updated schedule during the projects cycle (Muhanad Abu-Osbeh, 2011).

Also MS project software was used as a scheduling implement, while the Access of MS Project was applied to establish the database. MS Project was used as a mediator by incorporating the Forensic Schedule Analysis to made scheduling and controlling purposes. The VBA (Visual Basic for Applications) was applied to perform the cost analysing modules and schedule analysis. The framework was verified by using analysed cases and by measuring its outcomes with those of earlier studies (Muhanad Abu-Osbeh, 2011).

According to (Muhanad Abu-Osbeh, 2011) the framework combines different techniques and module to achieve automated, credible, economic delay analysis calculation. The procedures used to improve the framework are as follows:

a. Implementing and designing solid base for delays and real costs.

b. Customizing and designing specific lists in Microsoft Project (MS) to perform the schedule analysis procedure.

c. Implementing and designing daily data records forms within the project scheduling technique.

d. Connecting the scheduling technique with the database to transfer data.

e. Inserting an event concept to assist document delay that includes all of the delay scenarios.

f. Implementing IDWAT technique to calculate delay effects based on the ELM Method and the common method of concurrency issues.

g. Computerizing schedule analysis process.

h. Produce schedule analysis and cost report.

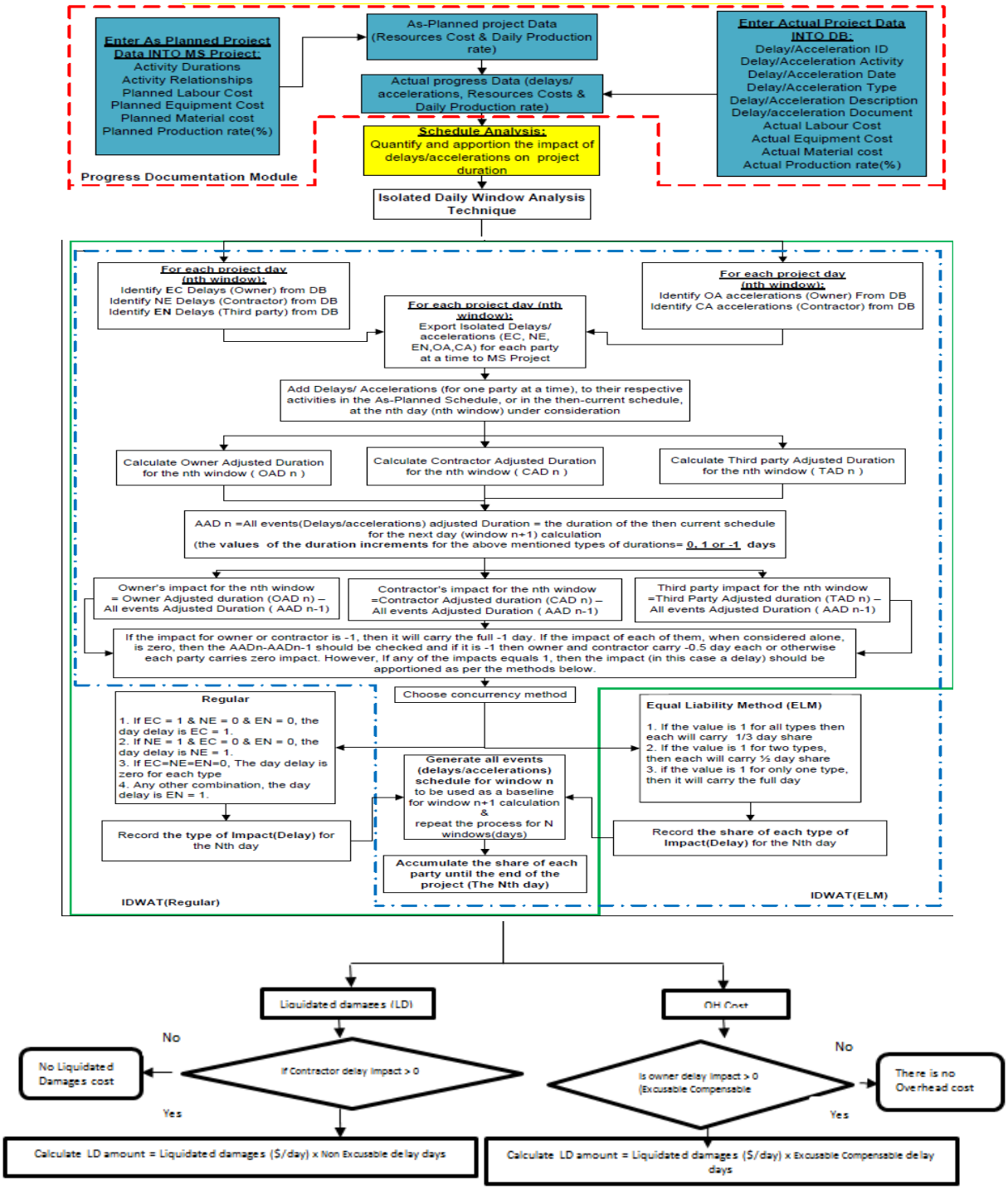

Figure 7: Integrated Forensic Delay Analysis Framework (Muhanad Abu-Osbeh, 2011)

To determine the capability of Integrated Forensic Delay Analysis Framework six elements had been investigated as shown in the below table. These elements are complexity, level of records required, and ability in assigning the responsibilities for the project delay, delay analysis cost, time, efforts and resources, dealing with concurrent delays, the analysis accuracy and limit of application for the delay analysis framework.

Table 3: Investigation of the capability for the Integrated Forensic Delay Analysis Framework (Muhanad Abu-Osbeh, 2011).

SR	Delay Analysis Framework	Elements						
		Complexity/Simply Apply	**The level of detail and records required**	**Ability in Assigning the responsibilities for the project delay**	**Delay Analysis Cost, time, efforts and resources**	**Dealing with concurrent delays**	**The Analysis Accuracy**	**Limit of Application**
1	**Integrated Forensic Delay Analysis Framework**	The framework is complicated and need long process for application: Implementing and designing a. a. Solid databases for delays, documents and actual costs. b. Customizing and designing new lists in Microsoft Project (MS) to perform the schedule analysis procedure. C. Implementing and designing data records forms within the project scheduling system on a daily basis. d. Connecting the scheduling system with the database to transfer data for documentation, schedule analysis and cost quantification. e. Inserting an event concept to assist document delay that includes all of the delay scenarios. f. Implementing IDWAT technique to calculate delay effects based on the Equal Liability Method (ELM) and the common method of concurrency entitlements. g. Implementing modules for quantifying direct costs, overhead cost, impact cost and Liquidated Damages (LD). h. Computerizing schedule analysis process. i. Produce schedule analysis and cost report.	- High level of details are required including delay date, delay description, delay category, related costs, delay documents, ,Detailed forms that make daily data entry easy subject to the project progresse -As-planned schedule, as-built schedule -The framework used IDWAT Technique and But-For Technique	Assign responsibility for delaying the project. The technique is used but with modified tables for the three views (Owner, Contractor-Claim, and Contractor Damage). The three views (Owner, Contractor-Claim, and Contractor Damage). are manually considered as follows: 1. For the point of view for owner. The modified schedule is produced from the owner's perspective by adding the delay that the owner accepts responsibility for the delay. 2. For the contractor's point of view. The justified schedule is prepared by adding the delays which were accepted by the contractor. 3. For Contractor's point of view intended for the damage, the modified schedule is changed by adding the delays, which were accepted by the contractor, and third party delays (if any).	-The delay analyst can get delay data to maintain several claims in a form that is easily accessible and organized. This makes it clear to save time and cost. - Documentation of delay details as it occurs, Compile the details and the speed of returning this details when required for analysis. - Document delay in fundamental way by using the concept of delay identity. - Provide an immediate delay and acceleration analysis facility during and after construction through the modeling of two delay analysis techniques (But-for and (IDWAT). - Extract the necessary delay detail immediately, depend to the procedure used, so that it can be performed the schedule calculations. - Provide reports for delay analysis and acceleration and calculations of damage to all parties.	Provide an equal liability (ELM) method for synchronization benefits for different parties. All parties are afforded the similar liability in costs and time according to their portion of delay. It provides a method of equal liability (ELM) for determining obligations for different parties in synchronization of delays.	Comparisons with the previous studies have verified the accurateness of the outcomes achieved by the framework. The framework is proposed to be applied by contractors and owners to record delays as it occur. It provides accurate, fast and economical division of liability for delay and determines the cost with minimum faults.	1. The critical path is limited to the fundamental relationship between the activities and is planned to be adjusted during the project cycle. 2. Only, seven calendar days is used. Applying different kinds of calendars is required. 3. The cost of impact calculation was done using only one case. It is required to Consider other cases and Methods of calculating delays are limited. For example, if the cost of an effect is higher, more options (more activities) can be inserted in the account.

4. COMPARING THE CAPABILITY OF THE SELECTED DELAY ANALYSIS FRAMEWORKS

The study is comparing Conceptual Delay Analysis Framework by Abdelhadi (2015), Developed Integrated Framework Analysis by Golnaraghi (2011) and Integrated Forensic Delay Analysis Framework (2015) in order to measure the frameworks capability in recovering the obstacles in the delay analysis such as complexity, lack of records, ability in assigning the responsibilities for the project delay, delay analysis cost, time, efforts and resources, dealing with concurrent delays, the analysis accuracy and limit of application for the delay analysis framework as shown in Table 4.

5. RESULT AND CONCLUSION

From Table 4, Conceptual Delay Analysis Framework by Abdelhadi (2015) and Developed Integrated Framework Analysis by Golnaraghi(2011) are simply apply comparing to the Integrated Forensic Delay Analysis Framework (2015) which is more complex and it required several techniques to be applied such as The "but-for" technique , IDWAT technique , ELM technique and Event Identity Concept (EIC).

On the other hand, the Developed Integrated Framework Analysis by Golnaraghi (2011) and the Integrated Forensic Delay Analysis Framework (2015) are required high level of detail and records comparing to the Conceptual Delay Analysis Framework by Abdelhadi (2015).

Furthermore, the three frameworks are capable to assign the responsibilities for the project delay. Moreover, the Conceptual Delay Analysis Framework by Abdelhadi (2015) and Integrated Forensic Delay Analysis Framework (2015) are capable to deal with the concurrent delay while the Developed Integrated Framework Analysis by Golnaraghi (2011) showed that concurrent delays may lead to unrealistic results. The delay analysis technique is also proposed to solve concurrent delays, according to the available technique.

In addition, Developed Integrated Framework Analysis by Golnaraghi (2011) and Integrated Forensic Delay Analysis Framework (2015) are capable to provide accurate analyses results comparing to the Conceptual Delay Analysis Framework by Abdelhadi (2015) which is focusing on the main categories and methods of delay analysis rather than sub methods to analyze the specified delays. A more detailed study of each of the specific sub-methods may provide more accurate results.

The Conceptual Delay Analysis Framework by Abdelhadi (2015) has a small limit of application whereas the framework was applied for only five case studies from the construction projects in the United Arab Emirates. The five case studies including 5star hotels (approximate Value is 65 million US Dollars) and the Windows Delay Analysis method concluded that the contractor is entitled for 913 days of extension of time only. The second project was International high school project (approximate Value is 120 million US Dollars), the contractor appointed the third party consultant at a later stage during the settlement negotiation process, and he performed a revised Windows Analysis. The case was eventually settled through mediation. Both methods concluded that the Contractor is entitled to 820 days of extension of time. The third project was construction of a highway road in UAE. Its value is around 113 million US Dollars, the project records reveals that a claim was submitted by the contractor using the Windows Analysis method. The claim was for 62 days of extension of Time and it was accepted by the Project Engineer and Client.

The forth-case study, which was applied Abdelhadi's Framework, was the construction of a large sewage treatment plant in UAE. Its value is around 406 million US Dollars. It suffered from huge delays due to design issues and variation orders. An Arbitration case was then filed and a revised delay analysis was presented using the windows analysis method. Both delay analysis methods suggested and extension of time entitlement of 183 days. The fifth-case study was construction of a 32 levels residential tower in Dubai, UAE. Its value is around 25 Million US Dollars. It suffered from delays due to variation orders. The claim was for extension of time using the Impacted As Planned Method and it was for 67 days of extension of time. Therefore, the results may be limited to the United Arab Emirates and to similar projects of the type of national front only.

In addition, the Developed Integrated Framework Analysis by Golnaraghi (2011) is limited to 18 types of delay and it was applied to one case study of delay. The system cannot achieve an outcome beyond this range. The case study is the construction of a concrete tunnel project in Canada. Its value is around 10,699,535 Canadian dollars (CAD). During the course of the project, the contractor experienced several delays. Thus, it could not have been delivered on the agreed upon date. The project was represented a delay of 96 working days. The contractor claimed compensation to recover the damages due to the project time and cost overrun. The MIDT (Modified Isolated Delay Type) technique was used and 100 working days was obtained, which is 6 days more than the total actual delay of the project, which was calculated by contractor using Windows Analysis Technique. The MIDT generated result was thus more accurate than that of the windows analysis technique.

While, in the Integrated Forensic Delay Analysis Framework (2015) the CPM logic is limited to the basic relationship of the fixed service (termination of start-up) and is planned to be sustained during the project period. Seven working days' calendar is used, applying different kinds of calendars is required.

In order to improve the in capabilities of aforementioned delay analysis frameworks the study recommended to develop a framework based on the five measurements: simplifies of application, ability in assigning the responsibilities for the project delay, saving delay analysis cost, time, efforts and resources, Dealing with concurrent delays and Limit of application.

Choosing the delay analysis framework is an important part of the claims industry. Many techniques are used in the UAE, and with the involvement of many factors, the chosen practice became more important to define the delays. Contractors pay a lot to the specialist to prove their right using delay analysis methodologies and they submit this as extension of time, trying to maximize their benefits. Meanwhile the client is trying to use other delay analysis methodologies to neglect certain facts, which increase the dispute with the contractor. The study of this field becomes more important, especially in the absence of sufficient research volumes for UAE construction industry.

REFERENCES

[1] Abdelhadi, Y.F.J., 2015. Common Delay Analysis Methods and Factors Influencing the Selection of Such Methods in Construction Projects in UAE.

[2] Arcuri, F.J. and Hildreth, J.C., 2007. The principles of schedule impact analysis. *Report for Virginia Department of Transportation, Virginia Polytechnic Institute and State University*.

[3] Arditi. D. and Pattanakitchamroon, T. (2006), Selecting a delay analysis method in resolving construction claims. *International Journal of Project Management*. (2006), pp. 145-155.

[4] AbouRizk, S., 2010. Role of simulation in construction engineering and management. Journal of construction engineering and management, 136(10), pp.1140-1153.

[5] Bob Cooper, 2015.*Part1-Float Mapping and the Extension Of Time*. Systech International Consultant. Data retrieved from http://www.systech-int.com/assets/frontend/pdfs/Part_1_float_mapping_and_the_extensions_of_time.pdf

[6] Braimah, N., 2013. Construction Delay Analysis Techniques—A Review of Application Issues and Improvement Needs. *Buildings*, *3*(3), pp.506-531.

[7] Braimah, N. and Ndekugri, I., 2008. Factors influencing the selection of delay analysis methodologies. *International Journal of Project Management*, *26*(8), pp.789-799.

[8] Chen, L. and Luo, H., 2014. A BIM-based construction quality management model and its applications. *Automation in construction*, *46*, pp.64-73.

[9] Cheung, S.O., Yiu, T.W. and Yeung, S.F., 2006. A study of styles and outcomes in construction dispute negotiation. Journal of construction engineering and management, 132(8), pp.805-814.

[10] Frigg, R. and Hartmann, S., 2006. Models in science.

[11] Giere, R.N., 2004. How models are used to represent reality. Philosophy of science, 71(5), pp.742-752.

[12] Golnaraghi, S., 2011. *Development of Delays Claims Assessment Model* (Doctoral dissertation, Concordia University).

[13] Harris, H. (2001). Content analysis of secondary data: A study of courage in managerial decision making. Journal of Business Ethics, 34(3), 191-208.

[14] Joyce, Erin, 2014. 4D BIM Has Its Limits With Delay Analysis. *Engineering News-Record, Vol. 274 Issue 2, p23*

[15] Kahssay, G., 2003. *Claims in International Projects in Ethiopia* (Doctoral dissertation, ADDIS ABABA UNIVERSITY).

[16] Kumaraswamy, M. and Yogeswaran, K. (2003). Substantiation and assessment of claims for extensions of time, *International Journal of Project Management*. Vol: 21. pp.27–38.

[17] Lee, H.S., Ryu, H.G., Yu, J.H. and Kim, J.J., 2005. Method for calculating schedule delay considering lost productivity. *Journal of construction engineering and management*, *131*(11), pp.1147-1154.

[18] Marzouk, M.M. and El-Rasas, T.I., 2014. Analyzing delay causes in Egyptian construction projects. *Journal of advanced research*, *5*(1), pp.49-55.

[19] Menesi, W., 2007. Construction delay analysis under multiple baseline updates.

[20] Mohan, S. B. and Al-Gahtani, K. S. (2006). Current Delay Analysis Techniques and Improvement. Cost Engineering. Vol. 48(9), pp. 12-21.

[21] Ragin, C. C. (2014). The comparative method: Moving beyond qualitative and quantitative strategies. Univ of California Press.

[22] Rustom, R., 2012. Formulation of Generic Simulation Models for Analyzing Construction Claims. Construction Economics and Building, 6(2), pp.11-19.

[23] Thalheim, B., 2014. Models, to model, and modelling-towards a theory of conceptual models and modelling-towards a notion of the model. Collection of Recent Papers

[24] Yang, J. and Kao, C. (2009). Review of Delay Analysis Methods: A Process-Based Comparison. The Open Construction and Building Technology. Vol. 3, pp: 81-9.

[25] Vartanian, T. P. (2010). *Secondary data analysis*. Oxford University Press.

[26] Williams, T. (2003). Assessing Extension of Time delays on major projects, International Journal of Project Management. Vol: 21. pp.19–26.

[27] Yang, J. and Kao, C. (2012). Critical path effect based delay analysis method for construction projects. *International Journal of Project Management*. Vol: 30. pp.385–97.

[28] Yin, R. K. (2013). Case study research: Design and methods. Sage publications

[29] Tsai, M.K., Yang, J.B. and Yau, N.J., 2013. Developing computer-based schedule delay analysis methods based on information flow analysis: a case study. *Journal of Civil Engineering and Management*, *19*(6), pp.823-835.

[30] Yang, J.B., Kao, C.K. and Lee, Y.Y., 2006. System requirement analysis of a construction delay analysis system. In *Proceedings of 23rd International Symposium on Automation and Robotics in Construction, Tokyo, Japan* (pp. 102-106).

[31] Yusuwan, N. M. and Adnan, H. (2013). Assessing Extension of Time Application in MalaysianConstruction Industry: Views from professionals. *Social and Behavioural Sciences*. Vol"105. pp. 54-63.

[32] Zaneldin, E.K., 2006. Construction claims in United Arab Emirates: Types, causes, and frequency. *International Journal of Project Management*, *24*(5), pp.453-459.

[33] Zubaida, N.M., 2012. *Claims Management and Substantiation in the United Arab Emirates Construction Sector* (Doctoral dissertation, British University in Dubai).