ICSBE2016-94

# PREPARATION OF EXTENSION OF TIME (EOT) CLAIMS AND DELAY ANALYSIS TECHNIQUES USED IN THE CONSTRUCTION INDUSTRY

**J.A.M Maduranga*, A.P.W.M.G.M. Palamakumbura and P.B.G. Dissanayake**

*[1]University of Peradeniya, Peradeniya, Sri Lanka*
**E-Mail: mmaduranga.ja@gmail.com, TP: +94714871836*

**Abstract:** Delays are one of the most common issues faced by construction projects in Sri Lanka. Most of the cases are complex and difficult to analyse. Various delay analysis methods have been developed and used in the construction industry for the purpose of analysing delays, their effects and their consequences, but there is no standard method to analyse a delay claim. In this study, existing methods for assessing the effects of delaying events and factors contributing to extension of time claims were reviewed through an industry survey. Furthermore, delay analysis techniques were tested for a case study to identify their strength and weakness. This study has given a clear understanding on the applicability of the existing delay analysing techniques and the related disputes in extension of time claims that would help the construction industry.

**Keywords:** Extension of Time, Delay Analysis

## 1. Introduction

Construction delays are major problem in construction projects. The correct assessment of delays is fundamental to contract extensions of time, liquidated damages, delay costs and the avoidance of disputes between the owner and contractor.

Claims may result from a number of different factors. The largest contributors to claims is post-contract changes by the clients, different site conditions from those stated in the tender document and unfulfilled duties by the engineers/architects. Delays form the basis of many of these claims. This study identified the different categories of delays and different types of delays that exist. There are a number of ways in which delays to construction projects may be assessed and the responsibility analysed. Some of these techniques are well established and well documented. Others are less known (Bordoli & Baldwin, 1998). To identify the methods currently adopted within the construction industry, a research study comprising an extensive literature search, an industry wide questionnaire and interviews with industry experts was initiated. The survey included number of industry organizations in Sri Lanka, including contractors, consultants and employers.

This study carried out a review of various delay analysis methods used in the construction industry and summarized their advantages and disadvantages and also discussed the most important issues in delay analysis that affect the results of the analysis. Basically, all methods have strengths and deficiencies when trying to reconstruct delay causes in some post-project dispute resolution exercises. Incomplete project documentation and the incomplete memories of individuals also hamper the application of these methods (Carmichael, 2009). This study did not try to suggest a preferred method, but rather confined itself to comments applicable to all methods.

## 2. Literature review

### 2.1 Delay analysis methods

There are many methods to analyse the delays in construction projects. There is no exact method for delay analysis therefore applicability of each method changes from project to project.

The study done by Braimah (2013), discussed about the results of each method for a case study and identified the advantages and disadvantages of each method. The study done by Alkass et al, (2010), analysed a case project with delay analysis method and compared them.

#### 2.1.1 As-planned vs. As-built

The study done by Braimah (2013), discussed this method. This methodology simply

compares the activities of the original CPM baseline schedule with those of the as-built schedule for detailed assessment of the delays that occurred.

Under this method, all delaying encountered on the project (Excusable–compensable delays (EC), Excusable–Non compensable delays (EN) and Non excusable–Non-compensable delays (NN)) are depicted on the as-built schedule. The difference between the as-planned and as-built completion dates is the amount of time for which the claimant will request for compensation. The critical path is determined once in the as-planned and again in the as-built schedule. This technique and the net impact technique utilizing bar chart are similar in that they all show the net effect of all claimed delays. Action of delay responsibility between the owner and the contractor for the sample project

In this method, first calculate the Sum of Non-excusable–Non-compensable delays (NN). Then calculate the Sum of Excusable Compensable delays (EC). Then Assume concurrent delay due to both parties (lower of NN & EC delays). Then take the Owner responsible delays/Contractor responsible delays as the rest after removing the concurrent delay. Net Total Project delay is the difference between as planned project time and as built project time. Contractor responsible delays/Owner responsible delays are calculated by subtracting the Owner responsible delays/Contractor responsible delays calculated above.

### 2.1.2 Impacted as- planned method

The technique can be used for analysis of delay during and after project completion (Braimah, 2013). It measures the effect for as-planned schedule from each delay event. Therefore the critical path is important for this method.

Amount of delay = Completion dates after the impacts – Completion date before the impacts

### 2.1.3 As-Planned but for Method

This method is performed quickly because it is not required to consider about actual progress of the work. This method is analysed according to contractor's point of view and owner's point of view (Braimah 2013).

Contractor's Point of View.

The as-planned schedule is adjusted by adding the contractor-caused delays (non-excusable). Then the results are compared with the actual completion date and the amount of delay which the owner is responsible is calculated.

Owner's Point of View.

The as-planned schedule is adjusted by adding the owner-caused delays (non-excusable). Then the results are compared with the actual completion date then amount of delay which the contractor is responsible is calculated.

### 2.1.4 Collapsed as Built Method

In this method as-planned schedule is used as a baseline schedule. It involves removing the delays of each party from the as-built schedule so that the resulting schedule will give the completion date of the project but for the delays of the other party (Braimah 2013). The results from contractor's point of view and owner's point of view are same in this method.

### 2.1.5 Windows-Snapshot Technique

Khalid et al, (2011) had discussed this method which uses the window concept as a method of analysis, which does not specify one method to analyse the window delay schedule. To follow a specific method in the case study, any delayed event in the snapshot window, critical path would be the cause of the project delay in that window. The delay in the project for each window is determined by comparing the project completion dates for each snapshot window, before and after the delayed events on each window segment. The three types of delay for each snapshot window are deduced by observing the delayed events on the critical path of each window schedule. Any delayed events that fall on the critical path within the snapshot window therefore are considered critical delays. Finally, the concurrent delay

is observed visually in each snapshot window when incidents occur on the critical path(s). The accuracy of the Snapshot technique in solving the real time issue is questionable. Although the technique tries to use the window concept to solve the real delay issue, sometimes it fails to quantify it accurately due to the vagueness that characterizes the technique's definition of window intervals. In addition, the accuracy of determining the concurrent delay is affected equally by the vague definition of window periods. Due to the difficulties of tracking the critical paths, this technique is less accurate for solving the concurrent delay issue. Some delay analysis issues, acceleration and pacing delays, are not solved by this technique. In summary, this method does not provide a systematic approach to analysis and can lead to misleading analysis results, especially by increasing the schedule network complexity. Advantages and disadvantages of this method are discussed by Braimah (2013).

### 2.2 Evaluating Extension of Time Claims

To avoid unnecessary disputes arising, it is important to understand common issues like contractual procedures of preparing, submitting and assessing claims; the treatment of float and of concurrent delays; the importance of construction programs and the mechanism of updating programs; and keeping of accurate and contemporaneous records (Wilson, 2002).

#### 2.2.1 Essential Elements to be included in an Extension of Time (EOT) Claim

Essential elements of EOT claims have been discussed by Asem et al, (2002) as shown in Table.2.1

Table.2.1 Essential Elements of EOT Claims

| Essential Elements of EOT Claims | Description |
|---|---|
| Identification of the delay event | Identify the event; the circumstance that gives rise to change causing delay |
| Liability for the Event | Does the responsibility rest with the Employer; neutral events such as force majeure or exceptionally inclement weather or as a consequence of matters within the contractors control. |
| Contractual Entitlement | What guidance does the contract give in the event of a particular event that impacts on the progress of the work or completion being delayed |
| Contractual Compliance | What time frames are provided in the contract for the contractor and the Employer to comply with in a claim situation. |
| Cause and Effect | Factual Statement Covering;<br>i) Detail of planned work affected<br>ii) Reference to the planned sequence<br>iii) Duration<br>iv) Methodology<br>v) The status of work in relation to that planned activity at the time of the event<br>vi) The description of the change to that plan as a consequence of the event |
| Concurrency | This is linked with the liability for each event noted above. |
| Float | Consideration need to be given to who owns the float in the program and the effect this has on the received completion date. |

## 3. Problem Statement, scope and objectives

### 3.1 Problem Statement

Evaluating extension of time is a major task in construction projects as it directly affects the cost and completion date of the project. Though there are many methods to carry out delay analysis no method can give accurate answers for all projects and each method have some disputes. Therefore, the selection of a suitable method for the relevant project is more important.

### 3.2 Scope of research

This study examines the delay analysis methods of civil engineering projects and evaluates the applicability of delay analysis methods in Sri Lanka.

### 3.3 Project objectives

- To find what are the methods used in the construction industry to determine the extension of time (EOT).
- To analyse different EOT evaluating techniques.
- To examine the applicability of delay analysis methods in Sri Lanka.
- Evaluate the appropriate procedure in the preparation of EOT claims.

## 4. Methodology

In this research, a survey was done to identify the current status of project delays in the construction industry. Therefore the questionnaire based survey and face to face interviews were carried out to collect the data. Then the collected data was analysed numerically and a case study were conducted to identify the applicability of the delay analysis methods.

### 4.1 Direct interviews

Interviews were conducted with the experts in the construction industry. The survey covered both road and building projects representing contractor, consultant and client. Face to face interviews were carried out to obtain the details which can't be collected by the questionnaire survey. On the other hand it was useful for further improvement of the questionnaire.

### 4.2 Questionnaire survey

The questionnaire survey was an effective method to collect data from a large number of organizations in Sri Lanka within a short time period. The questionnaire was prepared based on the literature review and direct interviews. Questions were short and specifically prepared in simple language to identify and answer easily. Questionnaires were distributed among professionals including the project managers, chief engineers, planning engineers etc. in various organizations.

Following factors were considered in the questionnaire.

- Factors contributing to delay analysis
- Delay analysing period
- Major Causes for EOT
- Problems when analysing EOT

The questionnaires were distributed using the following methods.

1. Online questionnaire (Google form)
2. Post
3. Direct handover

The questionnaires were distributed among the professionals in both government and private sector.

The response rate for the questionnaire was acceptable. 140 Nos. of questionnaires were distributed among the professionals. 74 responses were received and the overall response rate was 53%.

### 4.3 Analysis

For the close ended questionnaire, the questions were related to the problems of current delay analysis techniques and procedure. The answers are rated as follows.

1. Strongly disagree
2. Disagree
3. May be
4. Agree
5. Strongly agree

Analysis of data was carried out using mean value method.

$\text{Mean} = \sum ni * xi / \sum ni$

Xi= Likert scale for item. Where i=1, 2,3,4,5

n=frequency of item

According to the mean value of each opinion, the influence of each problem will be identified.

### 4.4 Case Study

Case study was carried out to find the applicability of the existing delay analysis techniques. Bridge construction project was selected as the case project. The delayed project was analysed using following methods.

- As-Planned but for Method
- Impacted as- planned method
- Collapsed as Built Method
- Window analysis and
- As-Planned vs. As-Built Method.

When analysing, the results obtained from each methods were compared. Then improvements and limitations for each method were identified and the applicability of delay analysis techniques was evaluated for the construction industry.

## 5. Results and Discussion

The information obtained from the questionnaire survey is given below. They are arranged according to the value of the Likert scale.

### 5.1. Factors contributing to delay analysis

**Table 5.1 Factors contributing to delay analysis procedure**

| Factor | Value | Rank |
|---|---|---|
| Contract data | 4.267 | 1 |
| Consider variations of the critical path | 4.244 | 2 |
| Analysis depend on the critical path | 4.152 | 3 |
| Updated baseline schedule | 4.054 | 4 |
| Analysis depend on :- Baseline schedule | 3.938 | 5 |
| Analyse EOT for each delayed activity one by one | 3.744 | 6 |
| Project cost contributes to conditions of EOT | 3.690 | 7 |
| Analysis depend on - As built schedule | 3.647 | 8 |

### 5.2. Delay analysing period

Table 5.2 Time period of Delay analysing

| Time Period | Value | Rank |
|---|---|---|
| End of number of delay activities | 3.943 | 1 |
| End of specific time period | 3.892 | 2 |
| Monthly | 3.775 | 3 |
| End of each delay activity | 3.750 | 4 |
| Periodically (For selected multiple time periods) | 3.656 | 5 |
| On contractors demand | 3.258 | 6 |
| End of the project | 3.086 | 7 |
| Weekly | 2.789 | 8 |
| Day by day | 2.314 | 9 |

### 5.3. Major Causes for EOT

Table 5.3 Major Causes for EOT

| Cause | Value | Rank |
|---|---|---|
| Adverse climatic conditions | 4.489 | 1 |
| Unforeseeable disturbs of third parties (public authorities, people…) | 4.349 | 2 |
| Additional quantities(change of contract) | 4.205 | 3 |
| Adverse physical conditions | 4.188 | 4 |
| Employer caused delays | 4.091 | 5 |
| Engineer/consultant caused delays | 3.737 | 6 |
| Unforeseeable shortages (material, labour, equipment, etc.) | 3.610 | 7 |
| Suspension of work | 3.368 | 8 |
| Contractor caused delays | 2.727 | 9 |

### 5.4. Problems when analysing EOT

Table 5.4 Problems when analysing EOT

| Dispute | Value | Rank |
|---|---|---|
| Require more details (every delay record etc.) | 4.022 | 1 |
| Disputes between parties (Not agree with results) | 3.825 | 2 |
| logic defects (inaccurate results may be given) | 3.773 | 3 |
| Time Consuming due to numerous activities | 3.737 | 4 |
| Time Consuming due to complex procedure | 3.644 | 5 |
| Many changes in the critical path | 3.644 | 5 |
| Disputes in contract data | 3.625 | 6 |
| Lack of experts | 3.409 | 7 |
| Number of critical paths involve | 3.357 | 8 |
| Several results can be exist | 3.343 | 9 |
| High cost (need experts and more time) | 3.279 | 10 |
| Need of arbitration | 3.229 | 11 |
| Difficulty in selection of critical paths | 3.049 | 12 |
| Less functionality of computer software | 2.947 | 13 |

### 5.5. Case Study

The case study was carried out to identify the applicability of the delay analysis methods. A bridge construction project was used for the case study. Project details are given in table.5.5

Table 5.5 Project details

| | Planned | Actual |
|---|---|---|
| Starting date | 17/09/2013 | 17/09/2013 |
| Finishing Date | 14/04/2014 | 15/01/2015 |
| Duration | 210 days | 486 days |
| Delay | 276 days | |

The project consisted 10 delay activities. The delay activities are separated into two types as non-excusable – non compensable (NN) and excusable compensable (EC).

The results obtained from the each method are summarized in the following table. The delays caused by each party were compared as in the Table 5.6

Table 5.6 Summary of Results

| | Delay Analysing Technique | Number of Delays | |
|---|---|---|---|
| | | NN | EC |
| 1 | Impacted as- planned method | 102 | 202 |
| 2 | As Planned but for Method<br>▪ **Contractor's point of view**<br>▪ **Owners point of view** | 102<br>76 | 174<br>200 |
| 3 | Collapsed as built Method<br>▪ **Contractor's point of view**<br>▪ **Owners point of view** | 95<br>95 | 181<br>181 |
| 4 | As - Planned Vs. As-Built Method | 180 | 96 |
| 5 | Window Analysis | 102 | 174 |

NN – Non excusable Non compensable delays

EC – Excusable Compensable delays

Considering the results, limitations and analysing procedure, merits and demerits can be summarized as in the Table 5.7

Table 5.7 Merits and demerits of each delay analysing method

| Merits | Demerits |
|---|---|
| 1. Impacted as- planned method | |
| Useful to evaluate the individual impact of each delay activity during and after the project on the completion date. | Use fixed as-planned schedule to analyze delays out of context and time but the original baseline schedule may not be a realistic model on |

| | |
|---|---|
| | which to base the whole analysis. |
| Consider the changes in the critical path schedule during the course of the project. | It is not economical because it is required to schedule the entire project in detail at its inception. |
| Consider the impact of delays on the critical path. | It is very time consuming when the project consists of a large number of delay activities. |
| 2. As Planned but for Method | |
| It can be performed quickly because there is no need to consider actual progress of the work. | Owner's point of view and contractor's point of view may yield different results resulting in disputes. |
| Consider the impact of delays on the critical path. | It assumes that the planned construction sequence remains valid during the project duration. |
| | Does not consider the changes in the critical path schedule during the course of the project. |
| 3. Collapsed as built Method | |
| Consider the impact of delays on the critical path. | The removal of the delays from the schedule could result in an unrealistic as-built but-for schedule. |
| It is easier to perform than window analysis and impacted as planned method because total project is update at once. | It ignores the circumstance at the time of the delay. |
| Consider the changes in planned construction sequence. | The use of as-built information to prepare the as-built schedule is subjective and highly amenable to manipulation. |
| | Does not consider the changes in the critical path schedule during the course of the project. |
| 4. As - Planned Vs. As-Built Method | |
| Economical and simple to use | It does not scrutinize delay types and this makes it easy for it to be manipulated and distorted to reflect either the position of the claimant or the defendant. |
| | It ignores the dynamic nature of the critical path and any changes in schedule logic. |
| | No attempt is made to determine the individual impact of each delay on the project completion. |
| | Inability to deal with complex delay situations. |
| | All delays, including delays on non-critical path, were summed up and their net effect calculated. |
| 5. Window Analysis | |
| This method divides a complicated network into a manageable one. | It is time consuming and costly. |
| It takes into account the dynamic nature of the critical path. | Differences in the time periods (or "windows") can produce different results. |
| More windows cause a better accuracy of the results. | It demands complete project records, which are often not available |

## 4. Conclusions

Major factors considered for preparing extension of time claims were contract data, activities on the critical path, variations of the critical path and updated baseline schedule.

Major time periods for analyzing delays in the industry were end of number of delay activities, end of specific time period and monthly.

Major reasons for extension of time were adverse climatic conditions, unforeseeable disturbance by third parties (public authorities, etc.), additional quantities

(change of contract) and adverse physical conditions.

Problems occurred when preparing extension of time claims were need of addition details (every delay record etc.), disputes between parties (Not agree with results), logic problems (inaccurate results may be given), time consumed due to numerous activities, many changes in the critical path and Disputes in contract data

According to the results obtained from case study, results differ from method to method and accuracy differs with the project schedule and the availability of each delay record. On the other hand delay analysis techniques that analyses a schedule directly as it is, without any major modification of the schedule such as As Planned vs As Built method are simple methods and those that involve extensive program modifications, including running of additive and subtractive simulations such as collapsed as built method and as planned but for method are sophisticated. Although windows analysis require more time, skills, resources and project records to operate, it tend to give more accurate results than the former partly due to the detailed/rigorous analysis it entail.

In general, this study offers valuable insights into the applications of existing delay analysis techniques there issues and improvements required. Parties involved in delay claims need to consider about limitations and qualities in each method as far as possible in the analysis. This consideration will hopefully increase the rigour and transparency in the claims analysis, and hence reduce the chances of disputes in the claims settlement. Finally considering all aspects there is no exact method for preparing extension of time claims without disputes because result changed from method to method and accuracy of same method can change from project to project. Therefore further research is needed to develop a more accurate delay analysis method to overcome existing issues of current methods.

## 5. Recommendations

By considering all the results obtain from above analysis, following recommendations can be made to minimize disputes in the delay analysing procedure and preparation of extension of time claims.

- Delay analysing method should be defined before starting of the project.
- The data required for the delay analysis is recorded accurately by each party.
- Critical path and variations of the critical path need to be identified.
- A Logical procedure need to be followed during delay analysis.
- All the factors relevant to EOT and the delay analysis procedure should be mentioned clearly in the contract data.
- Detailed analysis such as windows analysis which is based on the as built schedule is more accurate than others

## Acknowledgements

Authors would like to express their sincere gratitude to all the professionals in the construction industry who contributed to this study by actively participating in the data collection process despite their busy work schedules.

## References

[1]. Bordoli, D.W. & Baldwin, A.N. (1998), 'A methodology for assessing construction project delays', *Construction Management and Economic,* vol.16, no.3, pp. 327-337.

[2]. Carmichael, D.G. (2009), 'Comments on Delay Analysis Methods in Resolving Construction Claims', *International Journal of Construction Management,* vol. 9, no.1, pp. 1-12.

[3]. Nuhu Braimah 2013, 'Construction Delay Analysis Techniques—A Review of Application Issues and Improvement Needs', *Buildings Journal,* 2013 vol. 3, pp.506-531.

[4]. Sabah Alkass, Mass Mazerolle & Frank Harris, 2010, 'Construction delay analysis techniques', *Construction Management and Economics,* vol.4, no.5, pp.375-394.

[5]. Clark Wilson, L.L.P, 2002, 'An overview of construction claims: how they arise and how to avoid them.' *Lorman Seminar for Construction Contracting for Public Entities in British Columbia*, pp. 1-31.

[6]. M. Asem U. Abdul-Malak, A.M.ASCE; Mustafa M. H. El-Saadi, Marwan G. Abou-Zeid, 2002, 'Process Model for Administrating Construction Claims.' *Journal of Management in Engineering,* Vol. 18, No 2, pp. 84-94.

[7]. Khalid S. Al-Gahtani and Satish B. Mohan 2011, 'Delay Analysis Techniques Comparison' , *Journal of Civil Engineering and Architecture,* Vol. 5, No. 8 , pp. 740-747.