Modified Isolated Delay Type Technique

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ABSTRACT

Construction projects are complex, from their design to the execution phase. Delivering a project on time is unpredictable due to the inherent uncertainty. Delays are normally considered to be an inseparable part of construction projects. Delays often lead to claims for costs incurred. Assessing construction claims caused by delays is complicated, as are the proceedings for achieving claim resolution. Loss of anticipated revenue, opportunity cost, increased overhead, cost escalation and liquidated damages are some of the main reasons for delay claims from key project stakeholders. A sound request for a delay claim must be supported by a reliable delay analysis technique. This paper discusses a new technique that is capable of evaluating concurrent delays. The technique is windows-based; therefore, it can trace all of the changes in the critical path(s). Apportionment of delay accountability may result in a false outcome if the effect of concurrent delays and changes in the critical path is overlooked. The procedures of this proposed technique are explained. The technique was tested against a hypothetical case and compared to existing delay analysis techniques with satisfactory results. The proposed technique allocates delays among the different project parties.

INTRODUCTION

Preparing construction delay claims is complicated, and so are the proceedings for claim resolution. These are costly and time-consuming tasks for all parties. A sound delay claim must be supported by an accurate and reliable delay analysis technique. In the past two decades, several techniques have been proposed to quantify delay liability (Hegazy and Zhang, 2005). More than thirty techniques are available to measure the impacts of delay on a project's completion date; such techniques are referred to as delay analysis techniques.

Delay analysis (DA) is a means of providing the validation and quantification of the time and/or cost consequences required to achieve resolution in the different scenarios of a delay claim. However, DA techniques can provide a wide range of results for the same scenario. This paper presents and explains a new delay analysis that deals with different types of concurrent delays and considers the actual critical path of a project. To validate the proposed method, a dozen techniques are applied to a hypothetical case and the results analyzed and compared.

DELAYS IN CONSTRUCTION

A delay may be caused by any of the parties involved “directly or indirectly” in a project. Kartam (1999) states that schedule delays can be classified based on responsibility, timing, and source of delay. Generally, construction delays are classified into two major categories based on the responsibility: excusable and non-excusable delays. Excusable delays are categorized as either compensable or non-compensable (Al-Gahtani et al., 2007; Kao et al., 2009).

Any delay for which a contractor has no control over the delaying cause event(s) is classified as ‘excusable’. These delays are caused by unanticipated events, resulting in an extension of time given to the contractor if the project completion date is affected. Furthermore, excusable delays may be considered to be either compensable or non-compensable, as described in the following sections (Stumpf, 2000). Excusable delays may require a more detailed analysis to evaluate the possibility of covering a delay(s) by either float consumption or by awarding a time extension. Excusable compensable (EC) delays may entail compensation for damages. The owner may be held contractually accountable for a third party’s actions (Arditi and Robinson, 1995). Excusable compensable delays usually result in an extension of time as well as monetary compensation, but this classification does not automatically entitle the contractor to an extension of time or to reimbursement. Excusable non-compensable (EN) delays are those that arise from neither the contractor’s nor the owner’s error or negligence. These delays are caused by “Acts of God” or unanticipated events over which neither party has any power or control. Usually, contracts include a “Force majeure” clause. In the case of excusable non-compensable delays, the contractor is entitled to an extension of time, but no additional costs.

Non-excusable delay is caused by the contractor’s action or inaction. The contractor is held accountable for non-excusable (NE) delays, and therefore not entitled to an extension of time or reimbursement. In addition, with NE delays, a contractor could be exposed to liquidated or actual damages by the owner (Arditi and Robinson, 1995). The above delays, based on the time of their occurrence, can fall into one of the following three categories: independent, serial, and concurrent. Identifying independent and serial delays is straightforward. The consequences of such delays can be processed simply by assessing their effect on the schedule. Conversely, concurrent delays are the most challenging type of delay due to their complicated nature. The processes for dealing with the issue of responsibility are not straightforward (Baram, 2000). Concurrent delays are defined as two or more independent delays that take place at the same time or that overlap to some extent, causing a delay in the project. They share the feature of having the same impact on the project duration. Concurrent delays occur frequently, particularly when multiple-responsibility tasks are carried out simultaneously. Table 1 reviews the different perspectives on concurrent delay evaluation from six previous studies. It is in the best interest of all major project stakeholders to agree to the definitions of such delays and to specify them in their contract.

Table 1. Different Evolutions of Concurrent Delays (Adopted from Peters, 2003)

<table>
<tr><th>Researchers</th><th>EN Vs. NE</th><th>EN Vs. EC</th><th>EC Vs. NE</th></tr>
<tr><td>De Leon (1987)</td><td>EN</td><td>EC</td><td>EN</td></tr>
<tr><td>Reams (1989)</td><td>EN</td><td rowspan="5">EN</td><td>N/A</td></tr>
<tr><td>Arditi and Robinson (1995)</td><td>NE</td><td>N/A</td></tr>
<tr><td>Baram (2000)</td><td>NE</td><td>EN</td></tr>
<tr><td>Construction claims monthly (2002)</td><td>NE</td><td>NE</td></tr>
<tr><td>Arditi and Pattankitchamroon (2006)</td><td>EN</td><td>EN</td></tr>
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DELAY ANALYSIS TECHNIQUES

Braimah and Ndekugri (2009) define delay analysis as the procedure of investigating the events that resulted in a project delay. DA requires expert judgment and opinion, and many subjective decisions must be made during the DA procedure. Furthermore, selecting the appropriate DA technique is crucial for achieving authentic resolution in a delay claim. Arditi and Pattankitchamroon (2006) list the factors for DA technique selection. They draw attention to four criteria:

- Data requirements
  - Availability of information
  - Type of Information
- Time of the analysis
- Capability of the methodology
- Time and cost efforts involved

An ideal delay technique should take into account all types of delays, including pacing delays and concurrent delays, as well as accelerations, with respect to the resource allocation profile (Mohan and Al-Gahtani, 2007). Delay analysis techniques can be classified into two groups:

- Non-CPM(Critical path method) based techniques such as “S-curve” and “Global Impact” analysis; and
- CPM-based techniques such as “Windows” analysis and “But-for” analysis.

Most of these methods quantify the impact delay event on the project schedule by utilizing CPM schedules. The following is a list of the delay analysis techniques currently used in the industry: 1. As-Planned, 2. As-Built, 3. Time impact analysis, 4. But-for, 5. Isolated delay type, and 6. Windows snapshot technique.

PROPOSED DELAY ANALYSIS TECHNIQUE (MIDT)

The levels of effort required to implement the techniques listed above vary from virtually effortless to complex and overwhelming detailed analyses. These methods can provide a wide range of results for the same scenario. A DA technique should (ideally) have the following characteristics: a) utilize a CPM schedule technique; b) have a systematic approach; c) scrutinize different types of delays before analyzing the schedule; d) consider all delay scenarios; e) have a reasonable total float distribution between project parties; f) consider real critical path(s); and g) be implementable with hindsight and foresight.

The isolated delay type analysis technique (IDT) is the approach that has been adopted for the present research because it offers the best combination of the abovementioned characteristics. The proposed technique uses the same concept as the IDT method and maintains its advantages. Hereafter, this proposed technique is called the Modified Isolated Delay Type (MIDT). Alkass et al. (1996) have highlighted the advantages of the IDT technique. However, the IDT is unable to address all possible scenarios of concurrent delays. For example, the IDT does not consider the combined result of overlapping, classified individual delays caused by different parties (concurrent delay). The MIDT, however, has been enhanced to incorporate the combined results of concurrent delays into the schedule analysis. This synthesis of concurrent delays is based simply on the definitions stated in the concurrent delay clauses of a contract or agreement reached between the parties.

Another drawback of the IDT is that it imposes all types of excusable delays (EC and EN). Therefore, the outcome includes the effect of both EN and EC delays, which appear at the end of the project. Thus, the IDT does not reflect any distinction between the EC and the EN influences on the generated result. The analyst cannot provide a breakdown of the excusable delays. The MIDT attempts to overcome this shortcoming by imposing the EC and EN delays separately.

Furthermore, the IDT analysis does not consider the project's real critical path because the generated schedules do not reflect the actual events. In contrast, the MIDT utilizes the generated schedules for calculation, reflecting all delays to ensure that the project's critical path(s) coincide(s) with the actual critical path(s). In the following sections, the procedures of applying the MIDT will be demonstrated.

MIDT ANALYTICAL PROCESS

The MIDT and IDT techniques use similar documents in their analytical processes. The project documents have an important impact on the MIDT's outcome. Therefore, they should contain relevant information about the delay(s) that occurred during the course of a project. Figure 1 illustrates the analytical processes used in the MIDT technique. The MIDT uses an as-planned schedule as a starting point and assesses delay(s) progressively to identify the liabilities of the responsible party(s). Like the IDT technique, the MIDT technique must be executed from the perspectives of the owner and of the contractor.

In achieving accuracy, the as-planned schedule is divided into analysis periods. The criteria used in the MIDT and the in the IDT to establish the size of each analysis period are the same. These criteria originate from major delays, or from changes in the critical path(s) or in the periodic times. Attention should be given to determining the size of each analysis period, since larger analysis periods increase the possibility of losing the ability to follow critical path(s) tracking which may lead to a false result.

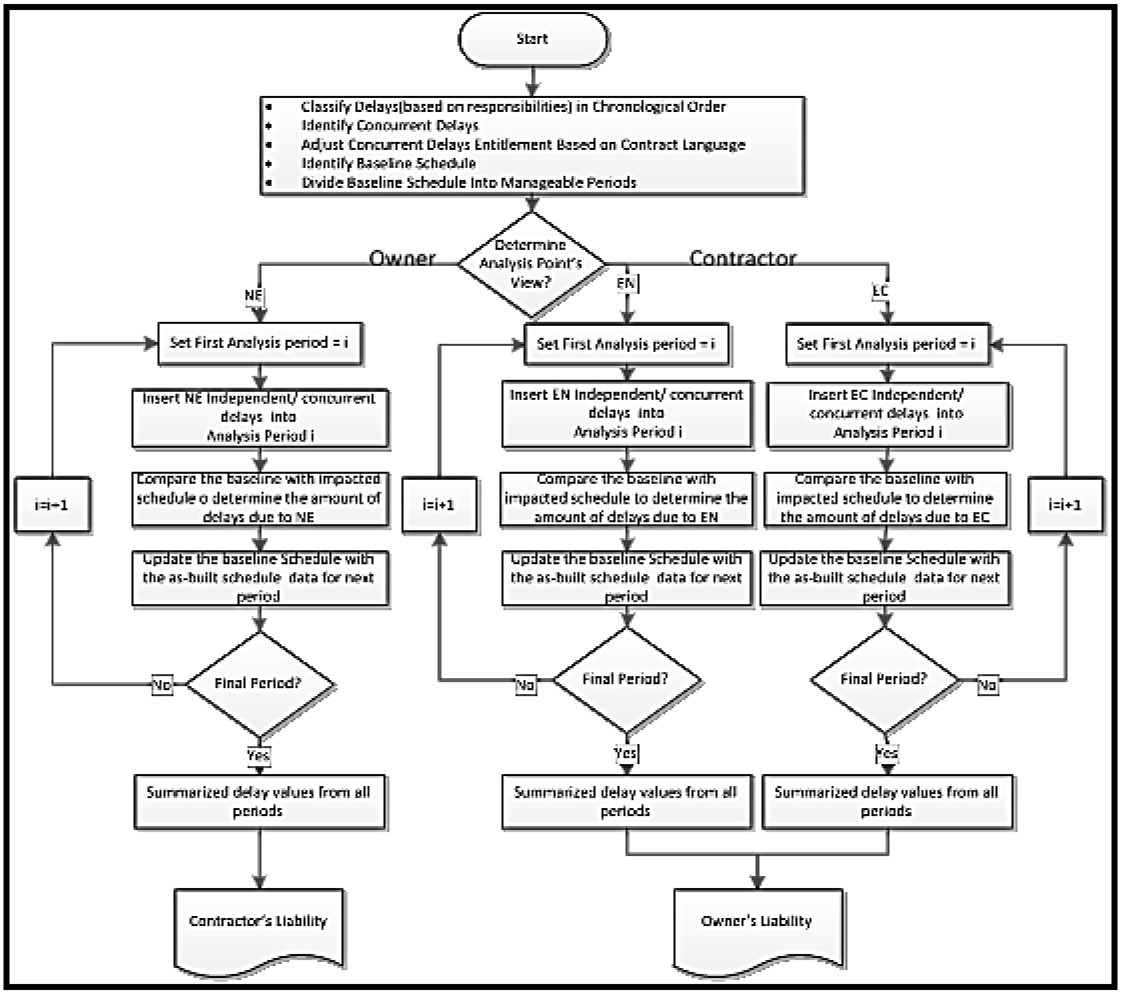

Figure 1. The MIDT analytical procedure

In the MIDT technique, the delays caused by the other party are inserted into the associated baseline schedule to generate a new schedule, now known as the "Impacted schedule" for the analysis periods. Meanwhile, inserting the combined result of concurrent delays into the baseline schedule should be performed simultaneously with the independent delays.

The impacted schedule must be compared to its corresponding baseline schedule to measure the impact of delays. Before moving to the successor analysis, its predecessor period must coincide with the durations reported and meet the logical relationship according to the actual progress times to establish a new baseline schedule for the next analysis period. In MIDT, the activities are classified into four types for each analysis period:

Type A: these are the activities that start and finish within the current analysis period. To analyze Type A activities, their durations have to be matched with the As-built schedule.

Type B: activities that have neither their start nor their finish dates within the current analysis period. Their durations must be the same as those of the As-planned schedule.

Type C: activities that start in the current analysis period but continue into the next analysis period(s). The analyst must adjust the start date of type C activities with their As-built (actual) start date. For the remaining duration of type C activities, their As-planned duration must be subtracted from its working days prior to the current analysis period.

Type D: these are the activities that started in an earlier analysis period but are completed in the current analysis period. The analyst must adjust only the duration of the portion of activity falling within the current analysis period.

MIDT - OWNER’S VIEWPOINT

To utilize the MIDT, the delays that fall within the first analysis period must be identified. After classifying the delays into types and identifying concurrent delays within this analysis period, the contractor-caused delays are incorporated into the first baseline schedule. From the owner’s point of view, only non-excusable delays and the combined result of concurrent delays are added to the first baseline schedule (impacted schedule). The project duration is re-calculated and compared to the baseline duration. The variation between the first baseline and the first MIDT is the amount of delay to the project caused by NE delays within the first analysis period. The MIDT analysis for the second period follows the same procedures as for the first analysis period. However, before incorporating the delaying events that occur in the second period, the analyst should modify the first analysis period by including all the excusable and non-excusable delays. This step guarantees that the MIDT can properly track critical path(s). The remaining analysis periods have a similar format to the first MIDT analysis period, and their analysis follows the above steps.

MIDT- CONTRACTOR’S VIEWPOINT

The MIDT analysis is performed twice from the contractor’s viewpoint, once for excusable non-compensable (EN) delays and again for the excusable compensable (EC) delays. This approach provides a breakdown of all types of excusable delays for which the owner is held responsible.

To perform the MIDT analysis from the contractor’s viewpoint, delaying events within the first analysis period, identified as EN delays (both independent and concurrent delays), were added to the first baseline schedule of this analysis period to generate the first impacted schedule. Prior to moving to the next analysis period, a new baseline schedule is needed, so the first period is adjusted by adding all the delays. This step ensures that any changes in critical path(s) are traceable, and that the schedule reflects the actual project progress.

The EN delays are incorporated into each analysis period, and before proceeding to the next interval, the current period is adjusted by adding all the delays or delaying events to reflect any changes in logic and duration. The same procedures are repeated for excusable compensable (EC) delays to measure their effect on the completion date. It should be taken into consideration that the contractor is entitled to a time extension, which is a combination of the effect of the EC and EN delays on the As-planned schedule. However, the only EC delays may entitle the contractor for compensation.

EVALUATING MIDT TECHNIQUE

To evaluate the delay analysis techniques mentioned above, a hypothetical case previously used to evaluate IDT was adopted (Alkass et al., 1996). This straightforward case study includes all the various delay types in terms of responsibility and concurrency. The critical paths in the as-planned schedule of this hypothetical case study are as follows:

- First critical path: Activities 1, 3, 6 and 9
- Second critical path: Activities 2, 5, 8 and 10
- Non-critical path: Activities 4 and 7

The As-planned schedule illustrates that the project was planned to be delivered in 23 days. However, it was delayed by 18 days, so the total project duration was extended to 41 days. Furthermore, throughout the course of the project, the numbers of activities and their relationships did not change (Figure 2).

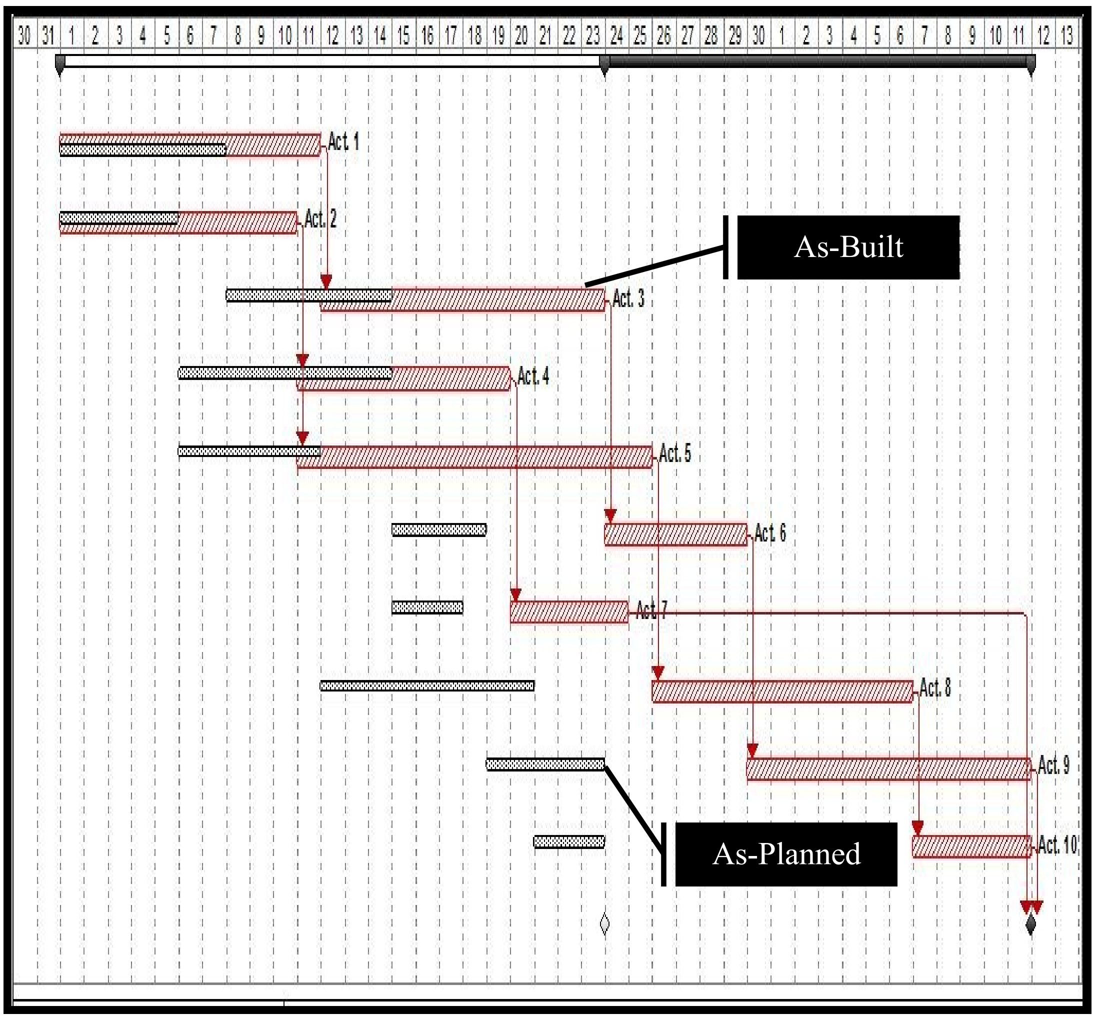

Figure 2. As-planned Vs. As-built schedule

Delays were classified into three categories based on their responsibility: excusable compensable (EC), excusable non-compensable (EN), and non-excusable delays (NE). In this case study, sixteen analysis periods were defined based on major delaying events. Table 2 summarizes the sizes of these analysis period intervals:

Table 2. The MIDT's analysis periods' duration

Analysis Period Number	Start-Finish Date	Duration
AP1	1-3	3
AP2	3-6	3
AP3	6-12	6
AP4	12-13	1
AP5	13-14	1
AP6	14-16	2
AP7	16-18	2
AP8	18-21	3
AP9	21-23	2
AP10	23-25	2
AP11	25-28	3
AP12	28-30	2
AP13	30-34	4
AP14	34-36	2
AP15	36-38	2
AP16	38-41	3

After applying the MIDT and summing the differences that appeared over these 16 analysis periods results in a total delay of five days (NE) caused by the contractor, and 13days (4 EC+9 EN) attributable to the owner. It should be noted that that the concurrent delays are evaluated according to the following laws: Scenario 1: Excusable delay concurrent with Non-excusable delay, considered as a net Non-Excusable delay. Scenario 2: Excusable delay concurrent with Compensable delay, considered as a net Excusable delay. Scenario 3: Compensable delay concurrent with Non-excusable delay, considered as a net Non-Excusable delay.

COMPARISON OF THE MIDT WITH OTHER TECHNIQUES

Table 3 summarizes the results of utilizing different techniques for the specified case study. The net impact and the adjusted As-planned techniques produce the same results, because both techniques consider the net effects of delays. The snapshot and modified window analysis methods generated the same result, similar to that of the net impact and adjusted As-planned technique.

Even though their results were similar, there is no specific relationship between the snapshot technique and the modified window analysis and the other two methods; they just happened to achieve similar analysis results in this case. Although the daily windows delay analysis is an accurate technique, it requires a tremendous amount of effort. Furthermore, in the delay analysis method using Delay Section, a series of complicated analytical procedures are required to achieve an accurate result.

Table 3. Assessment of different delay analysis techniques

No.	Delay Analysis Technique	Project Delays(in days)				
		EC	EN	NE	CD(Concurrent Delay)	TD (Total Delay)
1	Net Impact	-	-	-	-	18
2	Adjusted As-Built	-	-	-	-	18
3	But-For (Owner's point of view)	-	-	-	-	2
4	But-For (Contractor's point of view)	-	-	-	-	9
5	Windows (Snapshot)	-	-	-	-	18
6	Modified Windows Analysis	4	9	5	-	18
7	Delay Section	4	9	4	1	18
8	Daily Windows Analysis	4	9	4	1	18
9	IDT(Owner's point of view)	-	-	6	-	22
10	IDT(Contractor's point of view)	-	16	-	-	
11	MIDT(Owner's point of view)	-	-	4+1	1(Combined)	18
12	MIDT(Contractor's point of view)	4	9	-		

Different methods provide different results and allocations of delay liabilities for the owner and the contractor. There are several explanations for the different results achieved with these techniques. First, there is no common language among practitioners and the construction industry, leading to different interpretations of delay claim issues. Second, several techniques are inconsistent and their procedures are arbitrary. Commercial scheduling programs such as MS Project are not designed to support these techniques. Finally, inaccurate project information leads to false analysis; information resource validity is a requirement for implementing a sound analysis.

ADVANTAGES OF THE MIDT

1. Since the MIDT employs the same concept as the IDT, it is considered to be a systematic and dynamic analysis method. Both utilize the concepts of the snapshot and but-for techniques. The MIDT is classified as a detailed technique, which is a valuable feature for assigning delay liability.

2. Before starting the analysis, the delays must be classified according to their responsibility. The concurrency of classified delays needs to be identified and listed chronologically so they can be utilized in MIDT calculation. The overestimation of delay impact is thereby prevented. This technique can be employed with both hindsight and foresight.

3. In the MIDT, project parties should agree on the combination results of concurrent delays prior to starting the analysis procedure: this helps to assess concurrent delay in a fair and consistent manner.

4. Any changes in critical path(s) are traceable because the analysis is performed within particular time periods. Therefore, the critical path(s) coincide with the actual critical path at the end of the analysis.

CONCLUSION

Applying more reliable and precise techniques is a key step to reduce the frequency and to mitigate the severity of disputes and litigation due to delay claims. The more accurate a DA technique can be, the more precise the result, which in turn eases the process of settling delay claims and serves to reduce their number.

A novel delay analysis technique (MIDT) is presented in this paper. Taking into consideration concurrent delays, it differentiates between the types of excusable delay to apportion delay responsibility. Being a windows-based technique, MIDT considers all changes in the critical path(s). The descriptive analysis procedures of this proposed delay analysis approach were explained and supported by presenting a sample test case to illustrate its accuracy and effectiveness. An automated delay analysis can be developed based on the MIDT thanks to its simplicity.

While the MIDT attempts to resolve the shortcomings of the existing delay analysis techniques, the assessment of complicated delay situations requires more investigation. In addition, determining the optimal length of the analysis periods is subjective and the generated results may change, depending on the period size selected. Thus, an algorithm to define the optimal size of analysis periods is essential.

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