A SYSTMATIC APPROACH FOR APPORTIONING CONCURRENT DELAY

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Abstract

Apportioning responsibilities of concurrent delay to the owner and the contractor is a difficult task, due to the sophisticate nature both in the schedule and in the factors that cause the delay. This research attempts to develop a simplified yet systematic approach that can be used for a fair apportionment of concurrent delay. A concurrent delay is defined herein as when the contractor and the owner have both caused independent critical path delays during the same approximate time period. Incorporating the concepts of windows analysis and critical path method (CPM), the developed approach has three "windowing of delay" steps to quickly apportion the delay in each of these windows, and a fourth step to sum up those apportioned delays to obtain each party's final responsibilities. This developed approach is found to be simple and effective at this stage; it will be tested against real cases in the near future.

Keywords: Concurrent delay, delay analysis, schedule analysis.

1. Introduction

Terms relating to descriptions of construction delays are excusable, non-excusable, compensable, and non-compensable. They are frequently used for a single event that causes the delay, and such delay is relatively easy in determining which party is responsible for, either the contractor or the owner. Usually, if the owner is responsible for the delay, then it's an excusable and compensable delay; if the contractor is responsible then it is a non-excusable and of course, non-compensable delay; and if none of the parties is responsible, such as a delay caused by a typhoon, then the delay is excusable but non-compensable. However, when a delay is caused by both parties, i.e., both the owner and the contractor are responsible for the delay; then the apportioning of responsibilities becomes a difficult task. Each party tends to blame the other one if such kind of delay occurs. When the construction delay becomes a dispute, both owners and contractors invariably use concurrent delay as an excuse to avoid responsibility for claims of extended overhead or for liquidated damages assessments [1].

2. Concurrent Delay

There are various definitions of "concurrent delay", listed as follows:
(1) If two delays occur at the time, they are concurrent [2],
(2) Concurrent delay takes place on different activities within the same period of time [3],
(3) A concurrent delay occurs when two or more causes of delay overlap [4], and
(4) Concurrent delay occurs when a contractor and an owner have both caused independent critical path delays during the same approximate time period [5].

It is believed that the "concurrent" means two delays happening at the same time, at least some of the time should be overlapping; and these two delays should have no logical relationship between them; i.e., they should be independent. In addition, both the owner and the contractor should be responsible for each of these two delays. Thus, for the purpose of this research, the last definition is incorporated in this paper.

There are also arguments that depict a concurrent delay is a delay caused by both parties on an activity which delays the critical path. This is actually not a concurrent delay since it is a delay caused by a single activity; in such case the "concurrent" means both parties have influences on the same activity. Usually there is a distinct solution to apportion such delay by finding out how much time was delayed by each party. For example, say that an activity "complete shop drawings" was on critical path and was delayed for 10 days; if the first 4 days was caused by the owner's late providing of design and then another 6 days was delayed by the contractor's shop drawing work. Thus, apportioning the 10 days delay of the "complete shop drawings" activity would be 4 days attributable to the owner and 6 days to the contractor. In other words, as long as the "concurrent delay" is a delay on a single activity, then it is not a concurrent delay in this research.

3. Delay analysis techniques

There are many delay analysis techniques used for calculating responsibilities of the contractor and the owner. They can be classified into three major categories, as shown in Table 1: (1) Simple Summation; (2) One-party Analysis; and (3) Timeframe Analysis. Some variations of these typical techniques are also shown in the Table. However, these typical techniques are applicable only for general delay conditions, not for the special condition of concurrent delay; the variations also have shortcomings when solving problems relating to concurrent delays. It is the intention of this research to explore a systematic approach for apportioning concurrent delays based on theories and processes of these delay analysis techniques.

Typical techniques in Type 1 are Global Impact and Net Impact techniques, both of them use simple calculations to put "faults" on the contractor by summing up delaying days of each activity, with or without considering overlapping of delays. The delay of each activity is calculated based on the comparison between the actual and the planned duration of that activity. Type 1 techniques were only used at the early stage of delay analysis due to their bias favorable to the owner.

Typical techniques in Type 2 are Impact As-planned and Collapsed As-built techniques. The former one is also termed as "What-if" technique, while the later one is named as "But-for" technique. Results of these techniques are a single number of days; i.e., a subtraction of resulting delays obtained by “inserting” or “neglecting” each party’s “faults”, in turn, on the as-planned or the as-built schedule. For example, say that the contractor and the owner are at fault for 15 days and 8 days, respectively; then the 7 days difference would be an inexcusable delay to the contractor. While these techniques contain much more fairness than Type 1, they both ignore the fact that critical paths are changeable due to delays in various activities in the schedule; i.e., they cannot reflect the interrelationships among activity delays. These techniques also neglect concurrent delays, because each time they only analyze one party’s faults.

Typical techniques in Type 3 are Snapshot and Windows Analysis techniques, sometimes termed as “Contemporaneous period analysis” techniques. They analyze delays within several timeframes determined by certain criteria, say before and after the impact of an event. They are improvements to the Type 2 techniques in that they consider the effects of varying critical paths when delays occur along execution of the project. For every two timeframes, these techniques would come up with a ratio to distribute the delay between the two timeframes, to the owner and to the contractor; or even more precisely, to excusable and/or compensable delays. Finally, a summation of one party’s distributed delays will be its final responsibility for the project. Since these techniques are event-driven based and each event’s corresponding responsibility can be easily attributed, they usually come up with better results solutions; therefore, many variations of such technique were developed. This timeframe concept is deemed more accurate in schedule analysis thus is adopted in this research to develop a systematic approach for apportioning concurrent delays.

Table 1: Types of delay analysis techniques

Type	Typical Techniques	Variations
Type 1: Simple Summation	1. Global Impact [3] 2. Net Impact [3]	
Type 2: One-party Analysis	1. Impact As-planned (What-if) [6] 2. Collapsed As-built (But-for) [6]	1. Modified But-for [7]
Type 3: Timeframe Analysis	1. Snapshot [8] 2. Windows Analysis [9]	1. Delay Section [9] 2. Daily Windows [10] 3. Modified Windows [11] 4. Isolated Delay [8]

4. Apportioning concurrent delays

Figure 1 shows a sample case of concurrent delay extracted from an as-planned schedule. There are two overlapping delays caused by one party on activity A and by the other party on activity B, respectively. Since this research focuses on two independent activities with delays happening at approximate the same time, remaining duration and float of each activity at the time the delay starts becomes a crucial issue as to determine which activity has more impact on the schedule when the delay continues. Thus, in this research, the remaining activity duration and float are used for analyzing apportionment. The remaining activity duration is determined by: (1) if the delay occurs right before starting of the activity, the remaining duration is the original activity duration in the as-planned schedule (e.g., Activity A in Figure 1); or (2) if the delay occurs after starting of that activity, the remaining duration is the original duration minus the number of days started (e.g., Activity B in Figure 1). The float of each activity will be total float in the as-planned schedule. In other words, this research maintains the original activity duration as well as its float, whether the activity has been started or not. The rationale behind is that, the activity duration and float were planned by the contractor and was agreed by the owner prior to starting of the project.

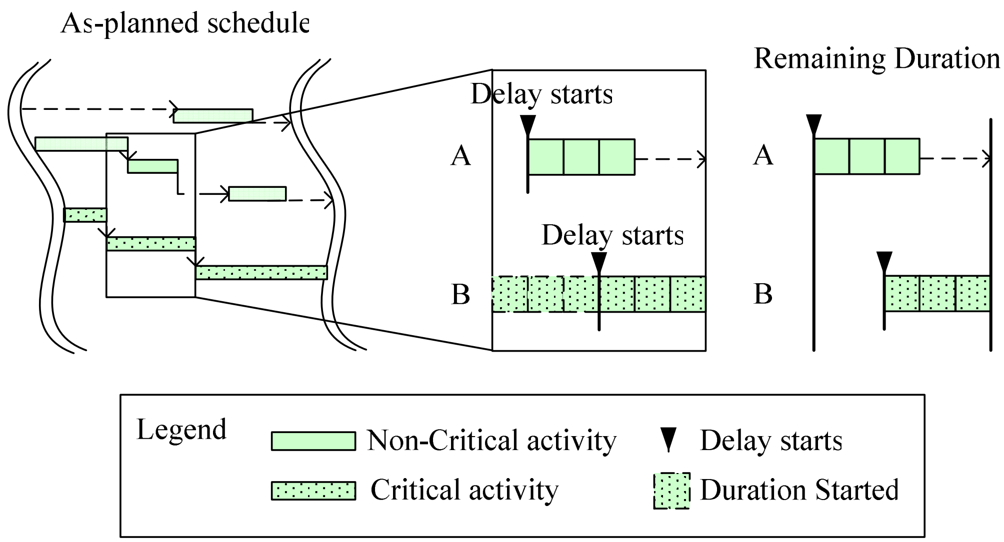


Figure 1: Remaining duration of impacted activities.

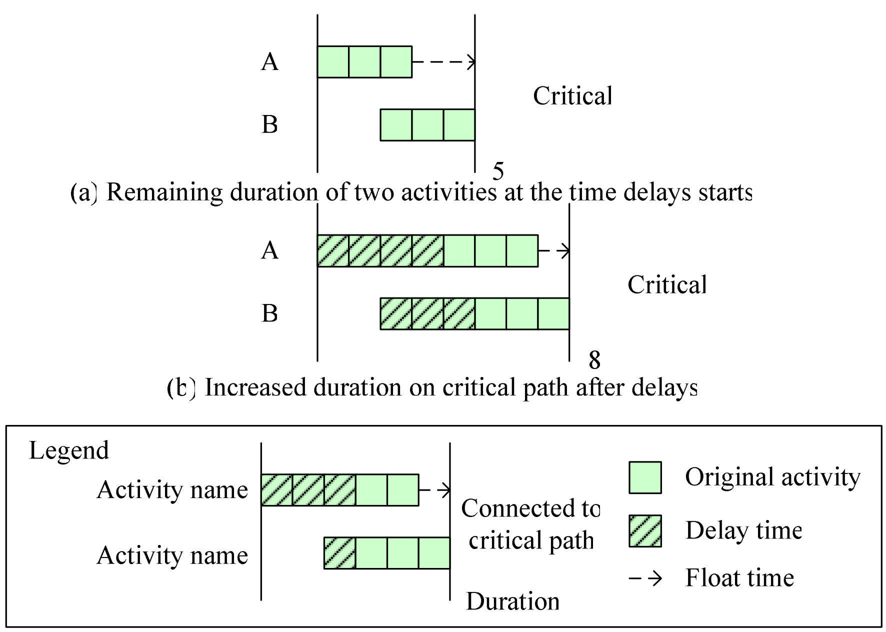


Figure 2: Increased duration after delays.

To apportion the responsibilities to the contractor and the owner, the challenge is to determine which of the concurrent delays (1) has the most significant impact, (2) occurs first in time, or (3) overrides the effect of the other delays [3]. However, these are concepts of "principles", not procedures that can be followed for every case.

For example, as shown in Figure 2, the critical path prolongs for 3 days (8 days minus 5 days) after the concurrent delay occurs at approximate the same time. If the aforementioned methods are used, then the apportioned responsibility of this 3 days will be opposite if different criteria is used, as shown in Figure 3 (a). Furthermore, in Figure 3 (b), a windows analysis is applied using two windows separating at the end of the first delay. Notably, the first window will apportion the 2 days delay in that window into 4/3 days and 2/3 days to the owner and the contractor, respectively; while the second window will apportion the 1 day delay in that window to the contractor and none to the owner. Thus, after summation this concurrent delay is finally apportioned 4/3 days and 5/3 days to the owner and the contractor, respectively. It can be found that the apportionments are very different and confusing if different methods are employed.

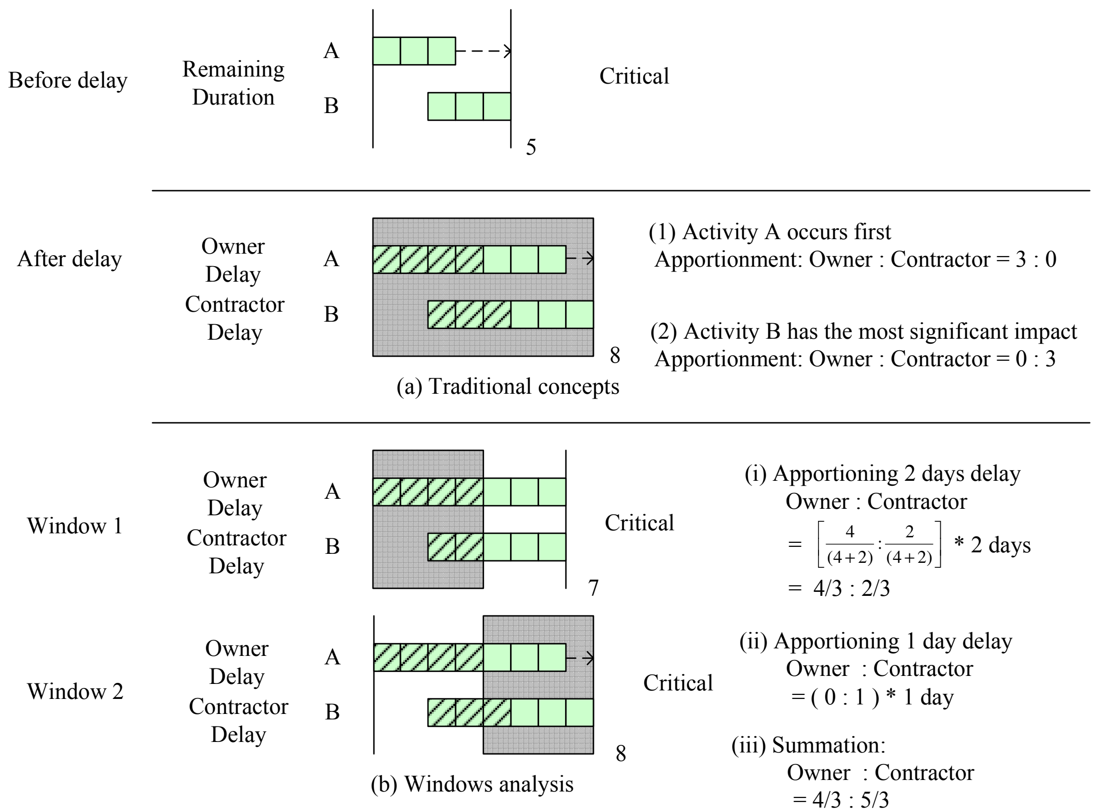


Figure 3: Sample case apportioned by (a) traditional concepts and (b) windows analysis.

5. The systematic approach

To avoid generating conflicting or inconsistent results this research develops a simplified yet systematic approach incorporating the concept of windows analysis. The developed approach consists of four steps:

<u>Step 1</u>: Windowing the delay of the first activity which occurs delay; if the schedule is delayed, then such delay, in number of days, is apportioned to the party who causes delay to that activity;
<u>Step 2</u>: Windowing the delay of the "concurrent" delay of both activities; if the schedule is delayed, then such delay is apportioned to the activity which is critical; if both are critical then evenly apportion to both parties;
<u>Step 3</u>: Windowing the rest of the delay till the end of remaining duration, if the schedule is delayed then the apportioning is similar to step 1; and
<u>Step 4</u>: Summing up the apportioned duration from step 1 to step 3 for both parties.

Before performing these four steps, the two activities with the concurrent delay need to be identified first. As illustrated in Figure 4 (a), activities A and B in the as-planned schedule encounter a concurrent delay. Figure 4 (b) shows remaining duration of these two activities after the two delays start, and an initial duration D_0 which represents the duration from the beginning of the first delay to the beginning of critical path right next to these two activities. Figure 4 (c) shows the after delay schedule with duration D_d. I.e., the difference between D_0 and D_d is the overall impact of the concurrent delay to the as-planned schedule.

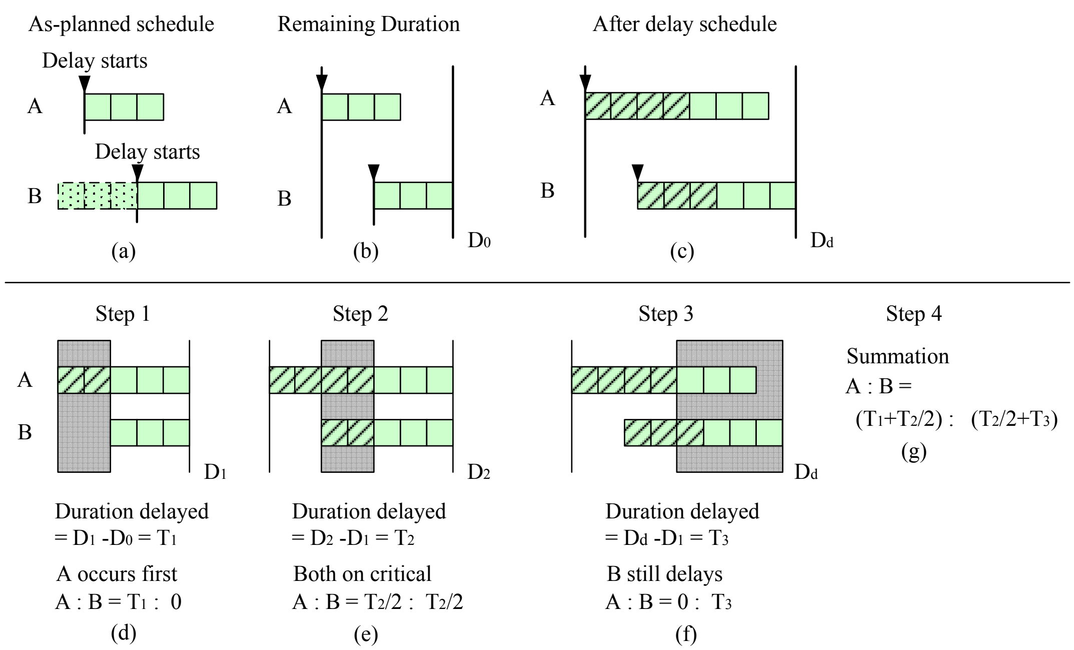
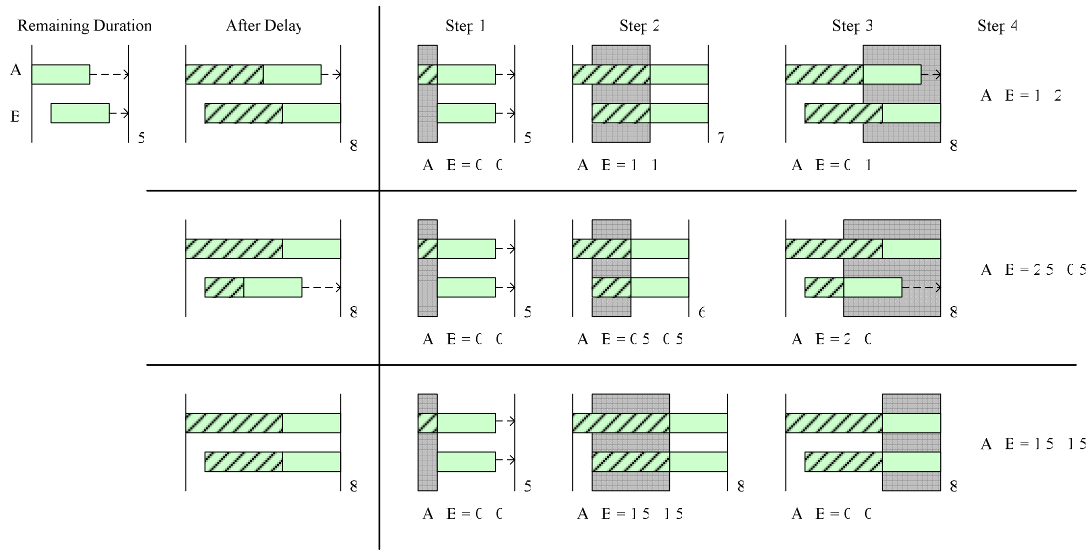


Figure 4: The systematic approach to apportion a concurrent delay.

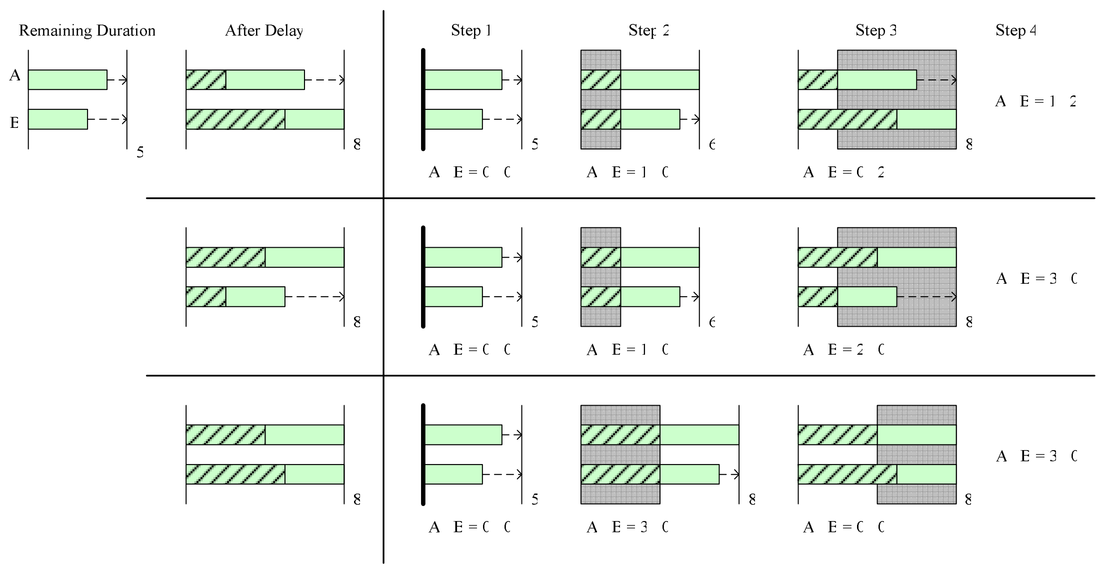
After D_0 and D_d are determined, the next three steps are windowing the periods of the first delay, overlapping delay, and the last delay to the end the remaining duration, as shown in Figure 4 (d), (e), and (f). Impacts to the schedule after each of the windowed delay are termed D_1, D_2, and D_d, respectively. Therefore, duration delayed by each windowed delay can be calculated as T_1, T_2, and T_3.

The apportioned equations in the lowest part of Figure 4 depict an example of performing these four steps. In Step 1, the delayed duration T_1 is fully apportioned to the one who has fault on A since it cause delay first; in Step 2, the delayed duration T_2 is evenly apportioned to both parties because both have fault on them and both activities become critical; and in

Step 3, the delayed duration T_3 is fully apportioned to the one who has fault on B since it still causes delay. Finally, Step 4 sums up the apportionment in each of the previous three steps, as shown in Figure 4 (g).



(a) Two delays start at different time.



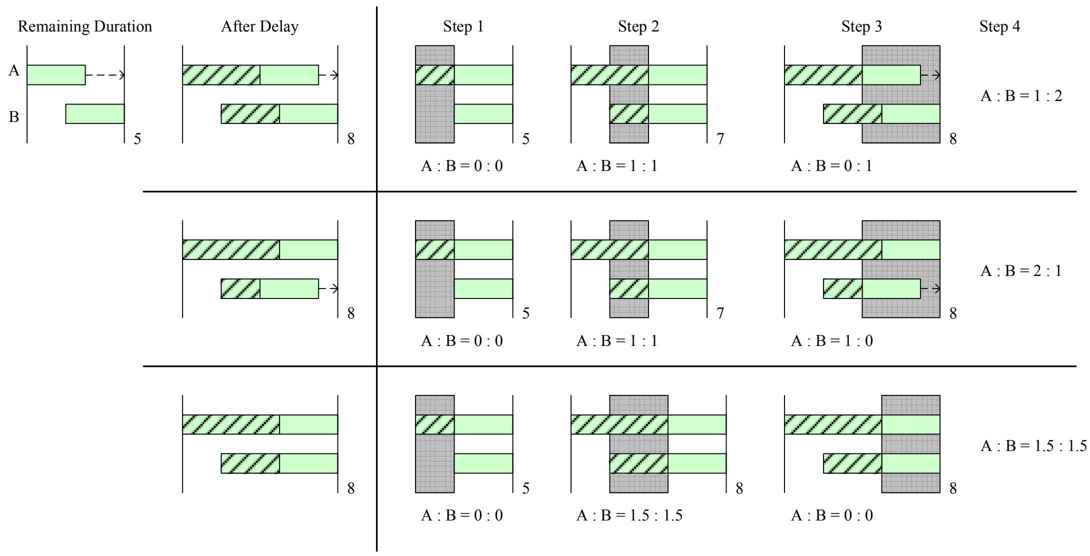
(b) Two delays start at the same time.

Figure 5: Neither of the activities on critical path before concurrent delay occurs.

6. Examples of possible cases

Before the concurrent delay occurs, remaining duration of the two activities are classified into three types: (1) neither of the activities is on critical path, as shown in Figure 5; (2) only one activity is on critical path, as shown in Figure 6; and (3) both are not one critical path, as shown in Figure 7. Notably, each of the above type has two scenarios, depending on if the delays start at same time. All these three types have only three possible results after delay: either one or both remain on the critical path. If both activities were not on the critical path, they won't delay the project's schedule and the concurrent delay does not exist.

All of the illustrated examples in Figure 5, 6, and 7 have the same duration of five days on critical path before, and the same duration of eight days after, the concurrent delay occurs. The apportioned days to each party's fault on activity A and B, with a sum of three days' concurrent delay, are shown under the Step 4 in each of the figures.



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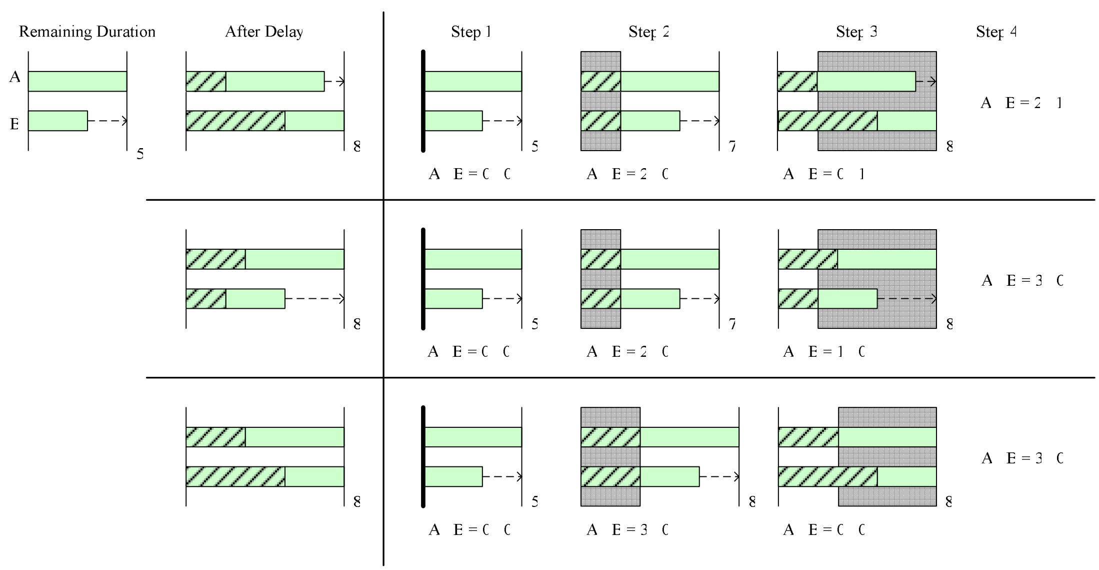
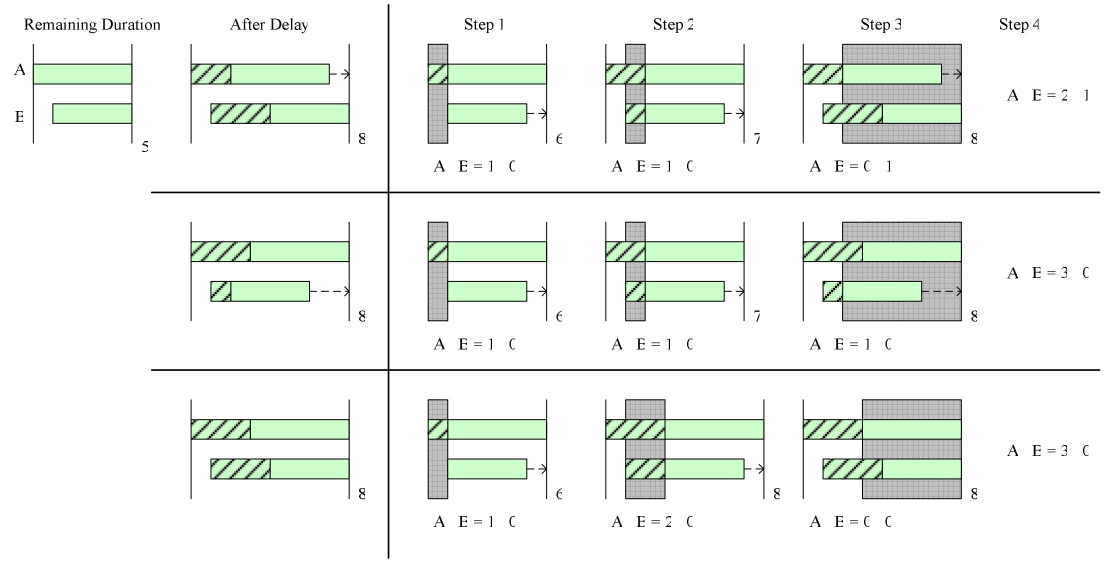


(b) Two delays start at the same time.

Figure 6: One activity is on critical path before concurrent delay occurs.



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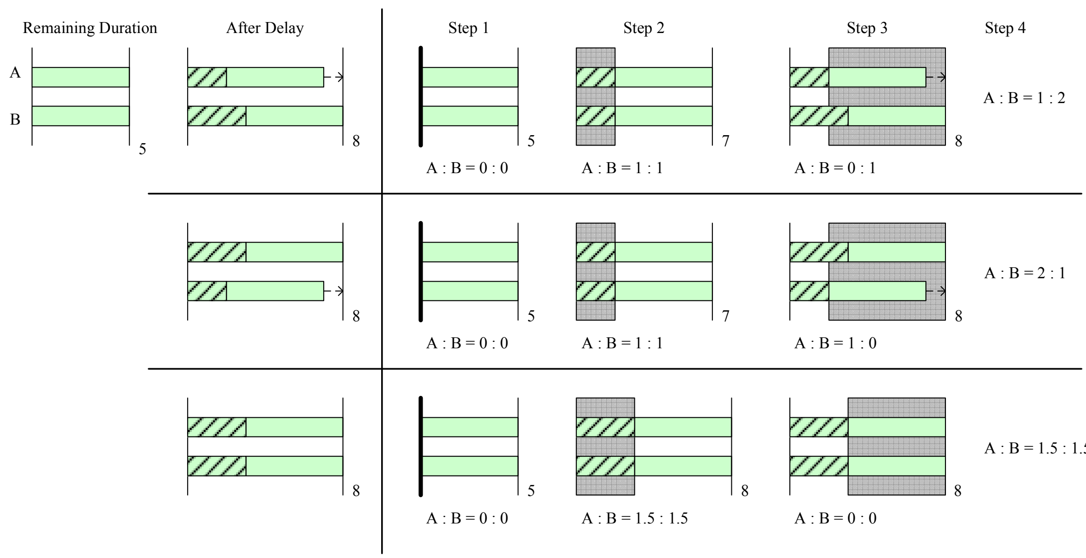

(b) Two delays start at the same time.

Figure 7: Both activities are on critical path before concurrent delay occurs.

7. Discussion

In this proposed approach, there are two issues worth discussion, listed as follows:

(1) *Two delays vs. multiple delays*: The proposed approach considers only two delays concurrently occur during approximate the same time period. There are chances that many delays, caused by both parties, may occur during that time period. In such cases, a pair-wise comparison may have to be performed using this approach; this will be investigated in the future.

(2) *Characteristics of the apportioned days*: Results of this approach are number of days charged to the party who causes the delay on that activity. The apportioned days are deemed to be "non-excusable", if the days are charged to the contractor; or be "excusable and compensable", if the days are charged to the owner. Such characteristics are assumed based on the fact that, if the contractor is responsible, then the contractor looses the apportioned days in project duration and faces liquidated damages as well; i.e., losses on both time and money. Thus, to be fair on apportionment, if the owner is responsible then the contractor should be entitled to an extension of time as well as a compensation of costs.

8. Conclusion

This paper presents a systematic approach, by using three steps of "windowing of delay" and one step of summation, to apportion responsibilities of a concurrent delay. Examples of three basic types are identified and illustrated to demonstrate feasibility of this approach. It is found that this approach is not only simple but also effective for all kinds of concurrent delays which are formed by delays of two activities. More research efforts will be focusing on directions such as concurrent delay formed by multiple activities, incorporation of this approach into traditional windows analysis technique, and testing of real cases using this developed approach.

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