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CONSTRUCTION DELAYS OF BUILDING REPAIR PROJECT AFTER THAILAND'S 2011 MAJOR FLOOD: CASE STUDY OF EDUCATIONAL GOVERNMENT SECTORS

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ABSTRACT

Many buildings and properties of the central region of Thailand had been damaged by major flood in 2011. A set of nine buildings was selected as a case study to represent the building repair of the Higher Educational Government Sectors. Five approaches of the retrospective technique were used to analyze the impact of these delays on the schedule. The actual project completion was 17 days behind the as-plan schedule. However, time extensions obtained from schedule impact analysis techniques were -8, 0, 0, 17 and 29 days. Time extensions of 17 and 29 days were obtained from the approaches, which ignored all details of each delay. The negative time delays imply that the delay caused by the contractors had significant impacts on the repair project. Results from this study showed that the owner and excusable delay had no influence on request for extension because the longer delay durations of the System Work and the Other Jobs were caused by the contractor. The unexpected situation discovered was black molds growing on many pieces of gypsum board walls and ceilings, thus required replacements.

1. INTRODUCTION

The 2011 major flood crisis in central region of Thailand caused damages on the buildings and properties. Damages of the industrial and residential properties spread over a wide area of the several provinces in the north and west of Bangkok. This included the areas in some provinces in the Lower Northern region and Central Plains. The Government needed to provide the flood mitigation for national reconstruction. Jensantikul (2015) studies disaster management in Thailand toward the government policy in responsibility to flood disaster in Thailand during 1942-2012. Poapongsakorn, & Meethom (2013) discussed the government policy for quick response in drafting a flood management master plan for assistance and compensation for the 2011 major flood victims, and also pointed out the weakness of the master plan. The impacts from the flood crisis resulted in the difficulty to response of the victims but the challenge to manage by the relevant institutions.

Samchaiy et al. (2012) studied the life and response of the victims to the 2011 flood disaster.

Repair was needed to restore back all the damages. Many factors causing by the flood affected the repair processes. The material manufacturers might take a long time to produce the materials, causing shortages and thus making them more expensive. The available budget was insufficient to cover the expense. Also, there was a shortage of construction workers. The unexpected duration of the flood forces most company to stop working on the construction. Workers need to leave their jobs for an indefinite period. There was the possibility of delays in construction projects causing the contractor might not deliver the project at the scheduled time.

Many researchers have studied the causes of delay in construction projects. Othmana and Ismail (2014) investigated the delay in government project delivery in Kedah, Malaysia. Kim *et al*. (2015) studied the delay factors affecting the completion of the government construction projects in Vietnam. Morris and Hough (1987) found that there were four key factors were the most common problems on cost overruns. This included the design changes, the poor planning, the unpredictable weather condition and the price fluctuation of building materials. Haseeb et al. (2011) studied the problems of projects and their effects on delays in the construction industry of Pakistan. Pakistan natural disaster such as flood and earthquake was the common factor of delay. Some others factors, for example, included the financial and payment problems, the improper planning, the poor site management, the insufficient experience, the shortage of materials and equipment.

Several techniques using the As-planned and As-built schedules for delay analysis have been proposed by researchers to determine the impact of delay affecting the overall project completion (Leary and Bramble, 1988; Reams; 1990; Wickwire *et al*., 1991; Alkass *et al*., 1991, 1993). Arcuri et al. (2007) reviewed eight different schedule impact analysis techniques applying to a simple drainage structure. The first five approaches analyze the project delays by using the retrospective technique, which includes (1) Global impact approach, (2) Net impact approach, (3) Adjusted as-planned CPM approach, (4) Adjusted as-built CPM approach, and (5) Collapsed as-built schedule (but-for) approach. The last three approaches analyze the effects of delays by using the contemporaneous technique, which includes (6) Impacted updated CPM (Veterans Administration) approach, (7) Modification impact analysis (U.S. Army Corps of Engineers') approach and (8) Time impact analysis approach. The focus is on determining the contractor-awarded time extension. Each of the approaches give an overview of its application, it strengths, and weaknesses and provides different results.

Apart from conventional construction, however, the general construction or repair of the buildings in higher educational institutions requires the additional issues needed to be concerned. This included the more safety restrictions in the surrounding areas. The impact of sound on teaching was another factor needed to be minimized. In addition, different departments need to open their academic semester at the same time. These factors can cause delays in building projects in higher education institutions.

The aim of this study is to investigate the schedule impact analysis on the building repair project containing of a set of nine buildings, which were damaged by the 2011-Flood. The buildings were selected from an area of a Higher Educational Institution which contained a total of 80 buildings.

The five approaches of the retrospective technique were employed. This includes (1) Global impact approach, (2) Net impact approach, (3) Adjusted as-planned CPM approach, (4) Adjusted as-built CPM approach, and (5) Collapsed as-built schedule (but-for) approach. Results provide the effect of a delay as the time extension. In addition, the study is intended to record the details of activities that can be found in the building repair project for future reference. Finally, this study figured out the unexpected evidence caused by the major flood.

2. TYPES OF SCHEDULE IN IMPACT ANALYSIS

Schedule impact analysis is defined as the process of quantifying and apportioning the effect of delay or change on a project schedule (Arcuri *et al*., 2007). Types of schedule impacts include delay, disruption, changes, suspensions, and termination. In general, there are three parties involved in the schedule impact analysis, which are owner, contractor, and third party or unexpected events. Delays causing by the owner, contractor, and the third party are considered as Owner Responsible Delay (ORD), Contractor Responsible Delay (CRD), and Excusable Delay (ED), respectively. Common examples of third party or unexpected events (1) Acts of God or of the public enemy, (2) Acts of the Government in either its sovereign or contractual capacity, (3) Fires, (4) Epidemics, (5) Quarantine restrictions, (6) Strikes, (7) Freight embargoes, and (8) Unusually severe weather (Wickwire *et al*., 2003).

To determine the impact of delays, different types of schedules are referenced, such as the As-planned, Adjusted, and As-built schedules (Alkass *et al*., 1996). The As-planned schedule is the original plan of the contractor for the work to completion. This schedule shows only the original activities with their start and finish dates which can display one or more critical paths of the project. The Adjusted schedule is generated as the response of the As-planned schedule when some original activities have been changed, such as the change of orders, the change or delays of construction, or the acceleration of construction work. The critical path and the start/finish dates of some activities or the whole project may be different from that originated in the As-planned schedule. The As-built schedule is the final schedule that shows the start and finish dates including the sequence of real activities of the whole project. The critical path of the project may be different from that of the originally As-planned schedule.

3. MODEL REVIEW

The timetable for the selected repair of a set of nine-flood-affected buildings, which is the representative of the building repair of Higher Educational Institution Government Sectors causing by the 2011-major flood crisis is presented in the Figure 1. Start, finish, and duration of each activity are summarized in the as-planned bar charts. There are 13 activities which require 46 days for project completion following the As-planned scheduling.

However, by inserting the delay activities accompanying with their duration into the as-planned chart, it obtained As-built bar chart, Figure 1. Separation of activities by each delay supports the process of schedule impact analysis. All delay activities include one case of the ORD, six cases of the CRD, and one case of ED.

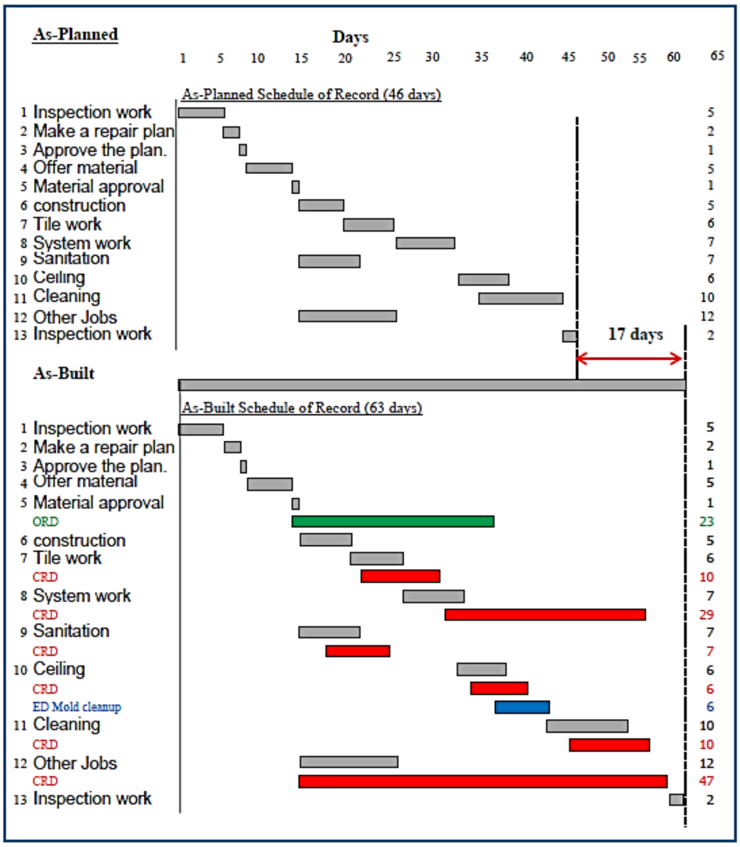


Figure 1: Bar chart of repair project with activities and delays.

The ORD occurred due to the late approval of materials after the contractor had requested for the approval. The offering materials by the contractor might be different or not equivalent to the original materials due to the lack of materials in the markets or the material manufacturers could not produce the right number of items, as promised, on time. The owner, therefore, needed to search for more information to make a decision to use the offering materials or the better materials. Material approval, in general, was required to finish before starting of the following activities. However, there was a strong temptation to dive straight to finish the repair project. Some activities could be done along with other activities and do not have to wait for an activity to be completed. The owner allowed some approval activities of the material to be started before the completion of the whole approval. For the as-planned scheduling, the Owner Approval Drawings started and lasted for one day, Day 14. However, in the delay of the As-built scheduling, the time duration of the ORD activity was started from Day 14 and delayed to Day 36.

In this unusual flood condition, many factors had affected on the construction process in a huge different dimensions. The problems in many areas were related to the materials or machinery in the damaged buildings. The contractors needed to order these damaged items and repair their machineries. On the other hand, material manufacturers were also experiencing the similar problems since some of their materials and machineries were affected by floods.

They could not produce the material immediately, and the storing materials were not enough. There was the material shortage because of the same material requirements at the same time. The material prices went up. Apart from this, due to the long duration of the flood, most workers could not afford to work on the construction. Many workers had to return home and change their careers.

There was a shortage of construction workers. In addition, the transportation of materials was quite difficult because many roads had been damaged and could not be repaired for the time being. For the repair project, there were six cases of the CRD. This included (1) Tile work due to the manufacturing could not produce the material on time, (2) System work causing by the shortage of original materials, (3) Sanitation causing by the shortage of original materials, (4) Ceiling due to the lack of capital reserves including with the increasing of the material costs, (5) Cleaning and (6) Other Jobs causing by the delay of the others' activities or the available budget balance was insufficient to cover the expense.

The ED caused by an unexpected event which was not include in the plan. Mold was found growing behind the back of many pieces of gypsum board walls and the ceilings due to the moisture and dirt from the flooded water for such a long time. In addition, unexpected corrosion of materials, such as the galvanized steel light walls and steel doors, was also investigated. As a result, the workload had increased because of the need to clean the mold and to replace a rusted steel frame with a new one. It was found that the ED took six days.

As shown in Figure 1, some activities can be done before other activities and do not need to wait for an activity to be completed. There are 13 original activities showing the time required to complete the As-planned work, which is 46 days. Total number of days to complete the As-built work is 63 days, which is 17-day longer than the As-planed duration.

Activity	As-Planned		As-Built		Duration
	start	Finish	start	Finish	
1 Inspection work	1	5	1	5	5
2 Make a repair plan	6	7	6	7	2
3 Approve the plan.	8	8	8	8	1
4 Offer material	9	13	9	13	5
5 Material approval	14	14	-	-	1
6 construction	15	19	15	19	5
7 Tile work	20	25	-	-	6
8 System work	26	32	-	-	7
9 Sanitation	15	21	-	-	7
10 Ceiling	33	38	-	-	6
11 Cleaning	35	44	-	-	10
12 Other Jobs	15	26	-	-	12
13 Inspection work	45	46	62	63	2
ORD : Material approval	-	-	14	36	23
CRD : Tile work	-	-	21	30	10
CRD : System work	-	-	31	59	29
CRD : Sanitation	-	-	18	24	7
CRD : Ceiling	-	-	35	40	6
ED : Mold cleanup	-	-	38	43	6
CRD : Cleaning	-	-	47	56	10
CRD : Other Jobs	-	-	15	61	47

Table 1: Duration of Activities and Delays of Repair Project.

Table 1 summarizes all activities that appear in both the As-planed and As-built scheduling. This includes the duration, start and finish dates for each activity. All delays are also presented in the lower part of Table 1.

4. RETROSPECTIVE TECHNIQUE

In this study, the scheduling for repair a set of nine-flood-affected buildings was selected as the representative of the building repair of the Higher Educational Government Sector causing by the

2011-irregular flood crisis. Each delay was separated from the other delays and determining the type of delay. The five approaches of the retrospective technique were used to analyze the impact of these delays on the schedule:

1. Global Impact Approach
2. Net Impact Approach
3. Adjusted As-Planned CPM Approach
4. Adjusted As-Built CPM Approach
5. Collapsed As-Built Schedule (But-for) Approach

The next subsections presented the impact on the completion of the project causing by each approach.

4.1 GLOBAL IMPACT APPROACH

The Global Impact Approach ignores the details of each element in the scheduling when delay claims and time extension are requested (Arcuri et al., 2007). In the beginning, the As-planed schedule and the As-built schedule bar charts are determined the whole events by showing their duration, start and finish dates before presenting the delays responsibility by ORD and the ED. This analysis, however, ignores the delayed overlapping between the ORD and ED. In addition, it is not included the CRD. Total delay or the time extension of the project is calculated by summing the durations of the ORD and ED.

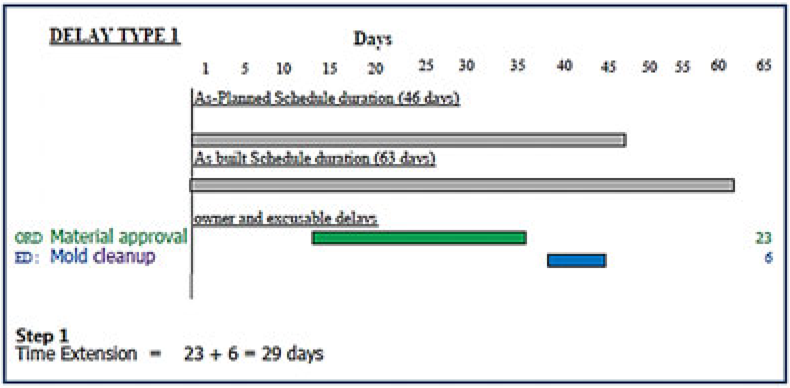


Figure 2: Global Impact Approach.

The time extension = ORD + ED = 23 + 6 = 29 days. Therefore, the contractor can extend the time for another 29 days. It is noted that, in this case, no any overlap between the delays causing by ORD and the ED. The Global Impact Approach is improper to define the time extension since the essential phases of delay activities in the project time scheduling are ignored (Bramble et al., 1990; Arcuri et al., 2007).

4.2 NET IMPACT APPROACH

For the Net impact approach, all activities of the three delays, the ORD, the CRD and the ED, are plotted on a bar chart as shown in the Figure 3. Each delay is presented their start, finish, and duration. However, the time extension is simply taken from the time difference between the as-planned schedule and as-built schedule duration by ignoring the essential phases of the delay, such as the overlapping between these delay periods (Bramble *et al*., 1990; Arcuri *et al*., 2007).

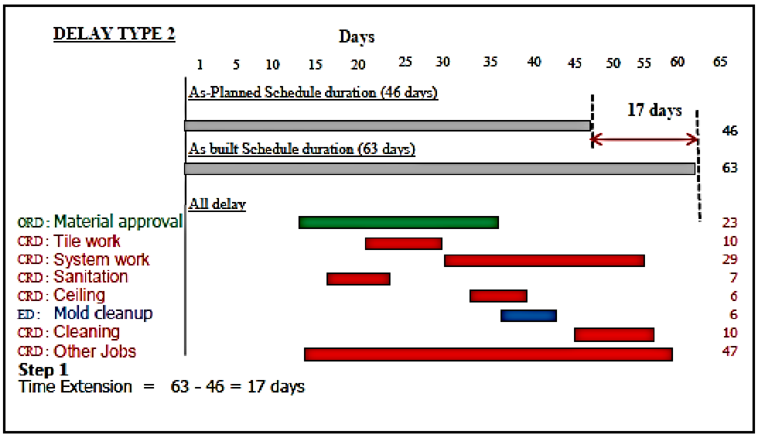


Figure 3: Net Impact Approach

For the Net impact approach, the time extension of the whole project is the time difference between the as-planned schedule and as-built schedule durations, which is 63 – 46 = 17 days. As mentioned above, the time extension is not completed as it ignores the essential phases of the delay, such as the overlapping between these delay periods.

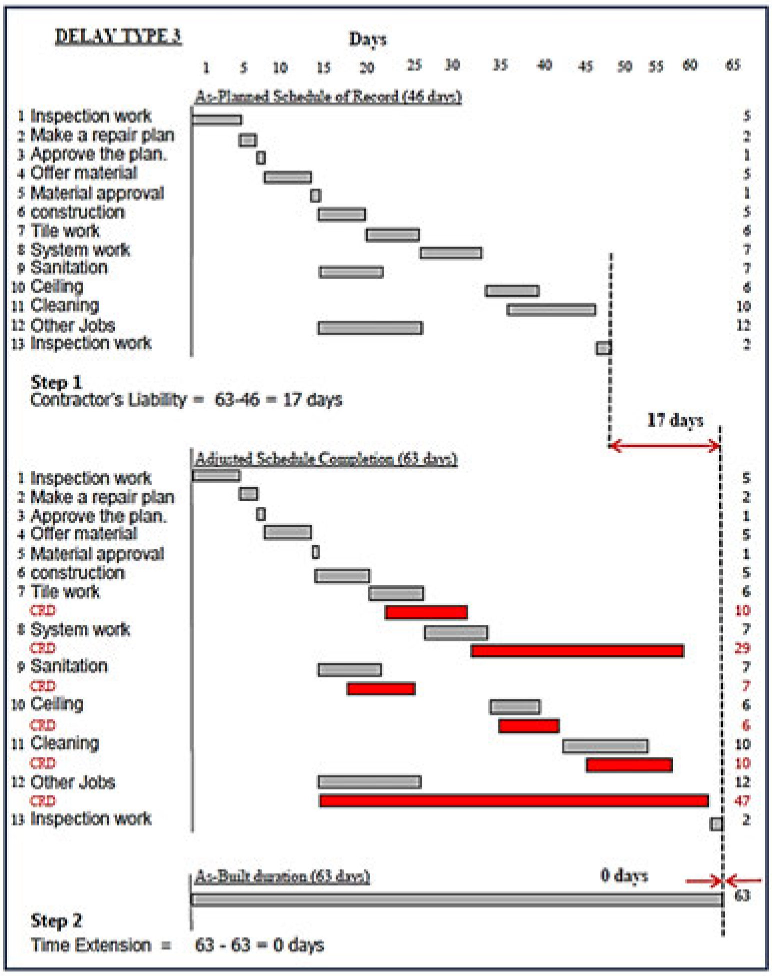


Figure 4: Adjusted As-Planned CPM Approach.

4.3 ADJUSTED AS-PLANNED CPM APPROACH

The Adjusted as-planned CPM approach is obtained by inserting all the CRD into the As-planned schedule resulting in the Adjusted schedule completion as shown in Figure 4. It should be noted that the Adjusted schedule completion ignores the ORD and the ED. The As-built duration is taken from the project completion. The Contractor's Responsibility is determined by subtracting the Adjusted schedule completion by the As-planned schedule. Time extension is then calculated by subtracting the Adjusted schedule completion from the As-built duration.

As a result, after inserting all the CRD into the As-planned schedule, an Adjusted schedule completion duration is 63 days. The modified time or the contractor is liable for his own delays is 63 – 46 = 17 days, which is the difference between the As-planned schedule duration (46 days) and the Adjusted schedule completion duration (63 days). To determine the time extension, the Adjusted schedule completion duration (63 days) is then subtracted from the As-built duration (63 days). Then the time extension = 63 – 63 = 0 days. The total of 0 days indicates that the ORD and the ED are not liable for their own delays. The difference between the As-built duration and the Adjusted schedule completion is 0, which indicate that the total period of time that the work is not completed as planned causing by the contractor responsibility.

From the As-planned schedule, the critical path is Activities 1- 8, 10-11, and 13. After inserting all the CRD into the As-planned schedule, the critical path is changed in an Adjusted schedule completion duration to be Activities 1- 8 and 10-13. The delays caused by the contractor's activities impacting the critical path start from the Activity 7 (Tile work). The changes of durations for the most delayed activities are not much difference, except the Activities 8 and 12. The Activity 8 (System work) includes the inspection and repair of the electrical, the air conditioning, the ventilation, and the fire extinguisher installation systems. Most materials are shortage and their prices are rise up affecting by floods. Moreover, the Activity 10 (Ceiling) can start and finish before the completion of the Activity 8 (System work), because flooding rises high enough to enter an electrical outlet, but it is not reach the ceiling position. System works of the Activity 8 concern about the walls rather than the ceilings. The Activity 12 (Other Jobs) includes the Computer system, the CCTV system, the experiment tool and instruments, the safety deposit box, and the steel fire exit doors. Delays cause by the Activity 12 (Other Jobs) is not only the shortage of materials but also some specific requirements based on the particular items. New versions of the Computer system, the CCTV system need to be compatible with the existing system. In addition, users from different departments demand for some extra additional and several requirements. Most requirements concern with the better specification, i.e., higher resolution, additional positions, view angle, and cover distance, under the insufficient financial support condition. A negotiation is needed. Different parties discuss their problems and requirements trying to reach a solution. This situation impacts on the decision making resulting in the longer duration.

4.4 ADJUSTED AS-BUILT CPM APPROACH

The Adjusted as-built CPM approach starts by determining the whole events of the As-planed duration and the Adjusted completion duration as shown in Figure 5. The Adjusted completion duration is taken from the As-built duration of the Adjusted as-planned CPM approach, as shown in Figure 4. The following Adjusted as-built schedule duration is obtained by inserting the durations of the Owner Responsible Delay (ORD) and the Excusable Delay (ED) into the as-planned schedule.

The analysis was considered twice – the first step is the Contractor's Responsibility, which is determined by subtracting the Adjusted completion duration by the As-planned duration. The second step is the time extension, which is then calculated by subtracting the Adjusted as-built duration by the Adjusted completion duration.

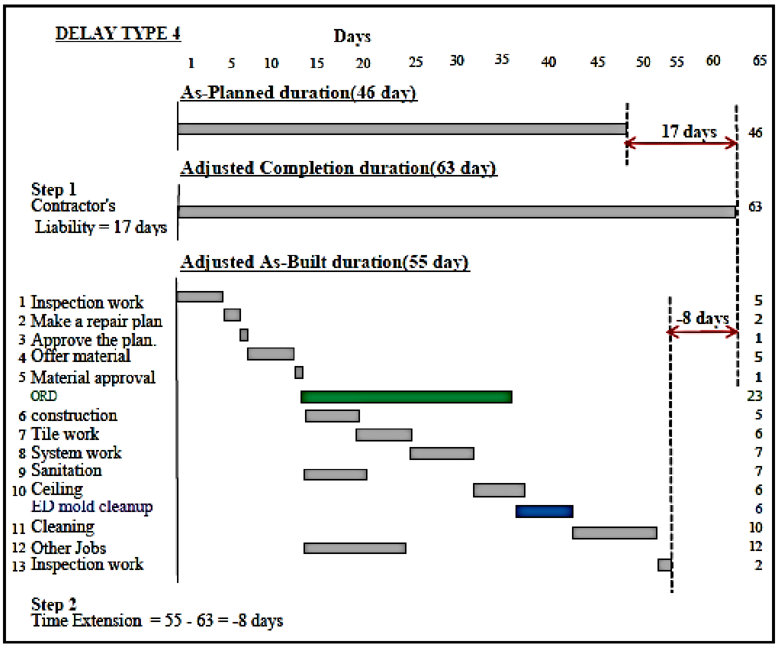


Figure 5: Adjusted As-Built CPM Approach.

In this study, for the early step, the difference between the As-planned duration (x = 46 days) and the Adjusted completion duration (y = 63 days) is the Contractor's responsibility, y – x = 63 – 46 = 17 days. Then, in the second step, insert ORD and ED into the As-planned schedule resulting in an Adjusted as-built schedule duration. The Adjusted as-built duration is 55 days (z = 55 days). To determine the time extension, the Adjusted as-built schedule duration (z = 55 days) is then subtracted by the Adjusted completion duration (63 days). The time extension is z – y = 55 – 63 = -8 days.

It is noted that, in this study, the contractor' responsibility alone for the delay of the Adjusted completion duration is 63 days. The penalties shall be applied to the contractor that causes these delays (17 days). However, the duration of the Adjusted as-built causing by the unavoidable situations due to the responsibility of the ORD and the ED is 55. The time extension is reduced or negative (z – y = 55 – 63 = -8 days). Therefore, the time that the contractor must compensate for the delay caused by the failure to complete the plan or the contractor responsibility is 8 days.

This approach takes into account the contractor's responsibility delays comparing with the responsibility of the Owner Responsible Delay (ORD) and the Excusable Delay (ED). The delay caused by the fault of the owner, or the ORD, is the Activity 5 (Material approval). Delay by Material approval includes the shortage and delay in materials supply and their prices are rise up affecting by the floods. Some materials are not available, such as the patterns of floor tiles, the computer system, and the CCTV system that are compatible with the remaining ones. The new or equivalent type of material is in order and more time is needed to receive a new permit approval. Material approval may need to wait for testing or specific evaluation of the product. In addition, as mention in the previous Adjusted as-planned CPM approach, a negotiation is needed when the users from different departments demand for different better specification, some extra additional and other several requirements. Under the insufficient financial support condition, this impacts on the decision making resulting in the longer duration.

The delay caused by an unexpected event or the Excusable Delay (ED), is mold cleanup in the Activity 10 (Ceiling work). This includes the replacement of the unexpected corrosion of the galvanized steel light walls and steel doors. As a result, the workload had increased because of the need to clean the mold and to a rusted steel frame with a new one.

The Adjusted as-built duration (55 days) is influenced by the delay causing by ED (6 days) rather than the delay causing by ORD (23 days). The delay caused by the owner in the Activity 5 (Material approval) is, however, no significant impacts in the project scheduling duration due to the subsequent Activity 6 (Construction work) can be done before for the completion of the owner approval. The Construction work, in this study, is the structural works dealing with the damaged wall and floor system. In contrast, the Activity 11 (Cleaning) needs to wait until the completion of the delay caused by the unexpected event in the Activity 10 (Mold cleanup).

4.5 COLLAPSED AS-BUILT SCHEDULE (BUT-FOR) APPROACH

In the collapsed as-built schedule (but-for) approach, the word "but-for" is represented the removing only the ORD in the beginning, and then removing both ORD and the ED from the as-built schedule. The technique is performed in multiple steps as follows (Figure 6).

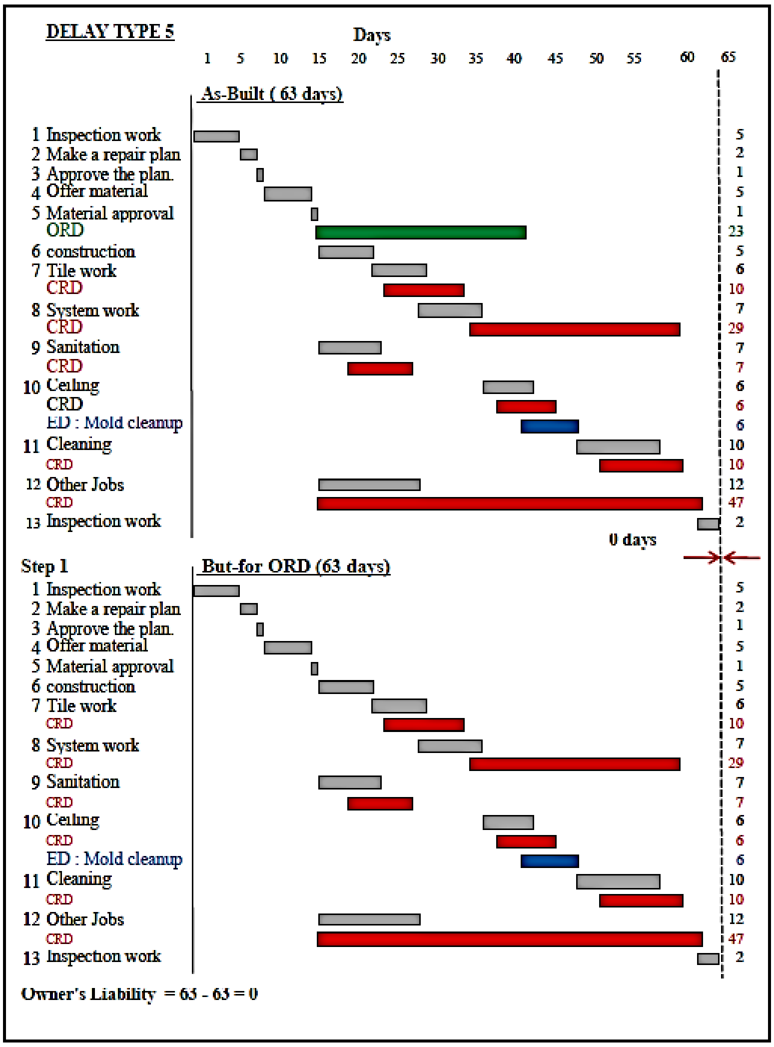
1. Create an As-built schedule. In this study, the As-built duration is x = 63 days.
2. Step 1, remove the ORD from the As-built schedule causing the But-for ORD schedule. The owner responsibility is then obtained by subtracting the As-built duration (x = 63 days) by the But-for ORD duration (y = 63 days). Then the owner responsibility is x – y = 63 – 63 = 0 days.
3. Step 2, remove ORD and ED from the As-built schedule causing the But-for ORD & ED schedule. The time extension is then obtained by subtracting the But-for ORD & ED duration (z = 63 days) by the But-for ORD duration (y = 63 days). Then the time extension is z – y = 63 - 63 = 0 days.
4. Step 3, in conclusion, the contractor's responsibility is obtained by using the relationship:

(As-plane) + (Contractor's responsibility) + (Owner's responsibility) + (Extension) = (As-built)

46 + Contractor's responsibility + 0 + 0 = 63

Thus, contractor's responsibility = 17.

The responsibility of the contractor is 17 days, which is the time to calculate for contractor's late payment penalty for the delay caused by the failure to complete the plan.



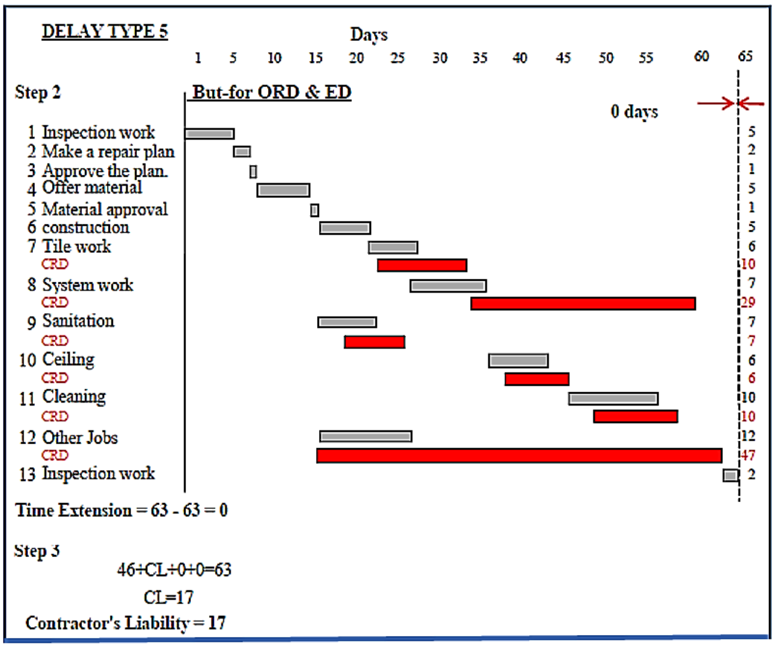


Figure 6: Collapsed As-Built Schedule (But-for) Approach.

From the As-built schedule, the changes of durations for the most delayed activities are not much difference, except the Activities 5 (Materials approval), Activity 8 (System work) and Activity 12 (Other Jobs). The critical path of the As-built schedule seems to be the Activities 1- 8, 10-11, and

13. However, this critical path is dominated by the longest duration of delay in Activity 12 (Other Jobs). As mention in the Adjusted as-planned CPM approach, the Activity 8 (System work) includes the inspection and repair of the electrical, the air conditioning, the ventilation, and the fire extinguisher installation systems. The Activity 12 (Other Jobs) includes the Computer system, the CCTV system, the experiment tool and instruments, the safety deposit box, and the steel fire exit doors. From the Adjusted as-built CPM approach, the Activities 5 (Materials approval) concerns about the shortage and delay in materials supply including the demand of the users from different departments for different better specification, some extra additional and other several requirements.

After remove the ORD from the As-built schedule, the obtained But-for ORD schedule duration is not changed (63 days). It implies that the delay caused by the owner in the Activity 5 (Material approval) is not significant impacts in the project scheduling duration due to the subsequent Activities can be done before for the completion of the owner approval.

In the But-for ORD&ED schedule duration, after remove the ED, the Activity 11(cleaning) can move forward which seems to shorten the critical path of the project. However, this moving forward does not provide a benefit to the whole project duration since it is dominated by the longer duration of the delays of Activity 8 (System work) and Activity 12 (Other Jobs).

It is noted that delay causing by the Owner (ORD) and ED had no influence on request for extension in this case because of the longer duration of the delays of Activity 8 (System work) and Activity 12 (Other Jobs), similar to the Adjusted As-Planned CPM Approach.

5. COMPARISON OF METHODS

The results from each schedule impact analysis technique are summarized in Figure 7. The owner responsibility, contractor responsibility, and time extension for delays are shown in the column 1, 2, and 3, respectively. Objective of each technique is to determine the time extension implying the award of contractor.

	Owner's responsibility	Contractor's responsibility	Time Extension
1 Global Impact Approach	*	*	29
2 Net Impact Approach	*	*	17
3 Adjusted As-Planned CPM Approach	*	17	0
4 Adjusted As-Built CPM Approach	*	17	-8
5 Collapsed As-Built Schedule (But-for)	0	17	0

Figure 7: Results from each impact analysis Techniques.

The actual project completed is 17 days later than the as-plan schedule. However, time extensions of each schedule impact analysis technique were -8, 0, 0, 17, and 29 days. The time extensions represent the different results obtained from applying these different techniques.

Time extension obtained by the Global Impact Approach is 29 days, which is unacceptable. This technique calculates the time extension by summing the delays of ORD and ED without considering their overlapping period. For the Net Impact Approach, the time extension of the whole project is 17 days. However, the net time is just the difference between the as-planned and as-built durations. Time extension for both approaches ignored all details of each delay.

The time extension of the Adjusted as-planned CPM approach considers mainly on the result obtained by all contractor delays (CRD). The Collapsed as-built (but-for) approach, however, considers all delays causing by the three parties (ORD, CRD, and ED). Both approaches provide the same results, which are 0 day. The contractor could not get benefit of the time extension due to many long delays of six activities of the contractor. This implied that the whole project did not response to the delay activities of the owner (ORD) and unexpected ED events.

The Adjusted as-built CPM approach obtains the Adjusted completion duration found from the Adjusted schedule completion of the Adjusted as-planned CPM approach. Time extension was -8 days, which obtained from the difference between the Adjusted as-built and the Adjusted completion duration. The time extension is decreased or negative because the delay duration causing by contractor (CRD) or contractor responsibility is larger than parts of the owner (ORD) and unexpected Excusable Delay (ED). In fact, this responsibility due to the contractor alone, the contractor needs to pay penalties to the employer.

The different schedule impact analysis approaches provided the different results of time extension were -8, 0, 0, 17, and 29 days. The time delays caused by the owners (ORD) and unexpected events (ED) had very little impact on the project comparing with the delay duration causing by contractor (CRD).

Fortunately, the Thai Government realizes the difficulty and problems causing by the irregular condition which has a huge impact on the construction process in a wide variety of dimensions. The flood mitigation obtains from the tendering approach. The construction contract allows the construction period to be extended since it is an indirect delay duration caused by the contractor's fault. Moreover, the majority parts of repair cost for the buildings in this case study are obtained from compensation for losses or damages resulting by the annual indemnity insurance of the institution. Some additional parts are received from the Flood Mitigation Assistance grant supplied by the Government.

6. CONCLUSION

The scheduling for repair a set of nine-flood-affected buildings was selected as the representative of the building repair of the Higher Educational Government Sector causing by the 2011-irregular flood crisis. Five approaches of the retrospective technique have been used to analyze the impact of these delays on the schedule. The actual project completed is 17 days later than the as-plan schedule. However, time extensions of each schedule impact analysis technique were -8, 0, 0, 17, and 29 days. The time extensions represent the different results obtained from applying these different techniques. Time extensions of 17 and 29 days were obtained from the Global Impact Approach and the Net Impact Approach, which ignored all details of each delay. For the remainder approaches considered more details of each delay, time extensions of 0, -8, and 0 days were obtained from the Adjusted As-Planned CPM Approach, the Adjusted As-Built CPM Approach, and the Collapsed As-Built Schedule (But-for) Approach, respectively. The negative time delays caused by the contractor (CRD) had significant impact on the repair project. The Owner ORD and ED had no influence on request for extension in this case because of the longer durations of the delays of System work and Other Jobs. For the last three approaches, although they provided the different time extensions, they obtained the same contractor's responsibility, which was 17 days. The unexpected situation discovered in this area was the mold, which grew on the back of many pieces of gypsum board walls and ceilings. This required the replacement.

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