Identification of Critical Path Changes and Concurrent Delays Using EDAM Method for Building Project

Zetta Rasullia Kamandang
Department of Civil Engineering, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Indonesia

Email: zerasullia.ts@upnjatim.ac.id

Abstract

Achieving a project whose punctually in completion date and duration is one of the main purposes of the project planning. However, avoiding the issue of the delay is hard to do. Delays itself commonly divided into three types, EN, EC and NE delays that represent the contribution of each project parties. Furthermore, the concurrent delay is at different levels that often use as a tool against each other parties. In term of preventing the time-frame problems, the critical path method (CPM) is widely applied. In the delay analysis technique, the EDAM method employs CPM to identify the critical path changes and the occurred concurrent delays. Implementing a six-floor building as-planned schedule and its delays information as a case study, this research results show that the critical path of the building has changed eight times and the concurrent delay occurred on the first change with six days of delays. By identifying the critical path change, project parties are expected to be able to prevent continuously delays by escalating the work progress. Furthermore, the information about concurrent delays would be essential in avoiding disputes regarding this issue. Project parties would be aware of their contribution to critical path changes by knowing their caused delay in that time period.

Keywords: *Concurrent delay, Construction project, Critical path, EDAM method.*

1. Introduction

In the construction industry, performance or quality, resources and time are strongly connected in order to achieve punctual project completion. But generally, the lack of resources or unmanageable problems in the field could lead the completion into delay. Delay itself commonly described as an unanticipated extension to the final time period that was planned and/or the circumstances which lengthen the duration of an activity without influencing the planned final project duration [1]. Since the construction industry involves parties, the delay types also represent them. Excusable non-compensable delays (EN) are delays beyond parties control. Adverse weather, God acts, force majeure, unforeseen site conditions and material shortages are the examples of EN [2][3]. Excusable compensable delays (EC) are delays caused by the owner or his/her representatives including inability in providing site access, changes of orders, incomplete planned drawings/specifications and differing site conditions [4]. Meanwhile, Non-excusable delays (NE) are usually due to the fault of the contractors. The situation when two or more delays occur at the same time and able to affect the project completion date is known as concurrent delay [4]. Analyzing concurrent delay has to consider all aspects of the delay in the project [5]. Besides that, that delay has its own difficulty since it is used by both owner and contractor to against each other. The concurrent delays will be used to protect owners' interest in obtaining liquidated damages and will be used by contractors to waive their inexcusable delays and avoid damage entitlement [2].

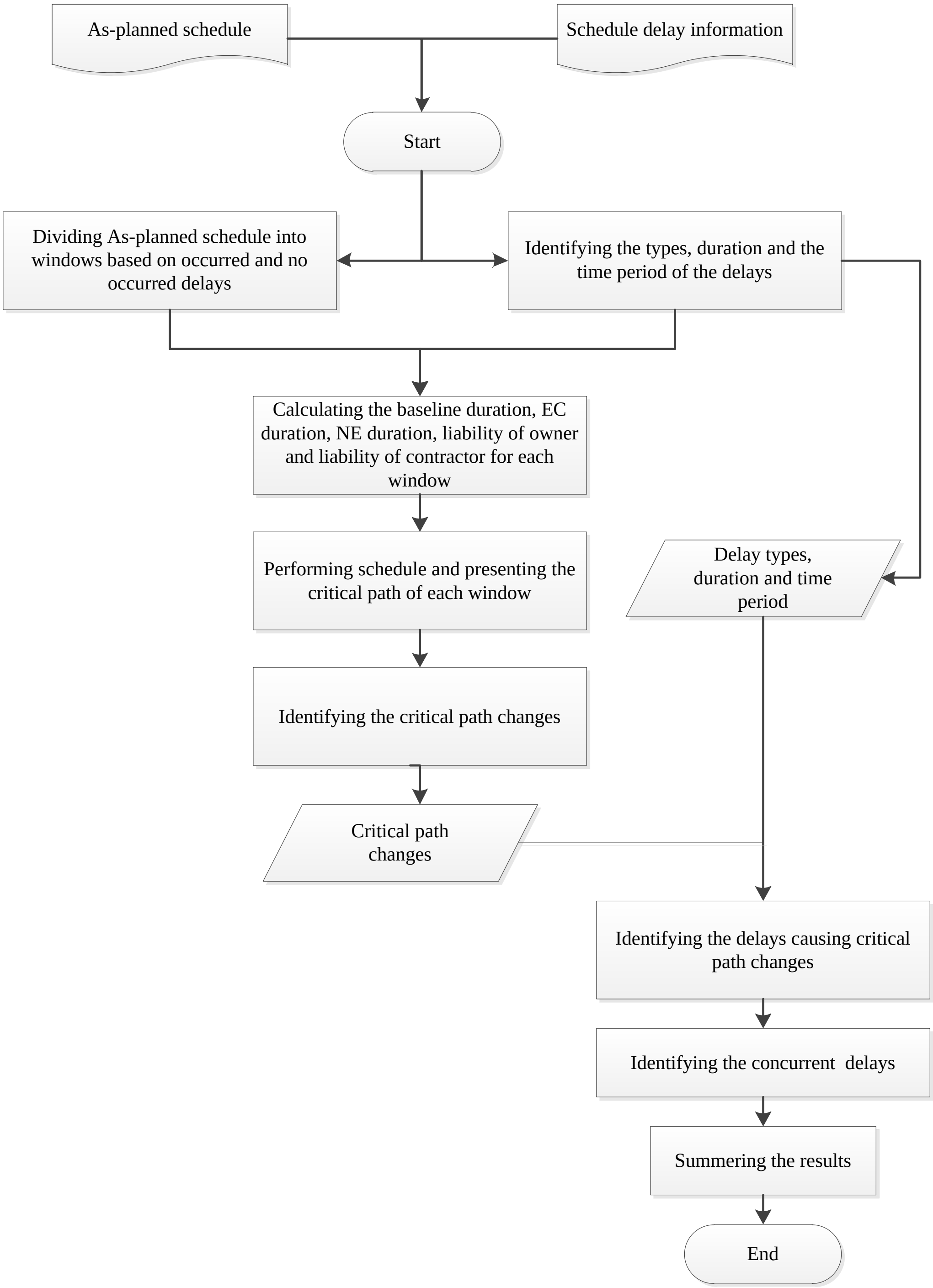

Figure 1. Flowchart of the research

Critical path method (CPM) is one of highly effective methods as a project management tool for planning and scheduling. CPM is a step-by-step project management technique for process planning that defines critical and non-critical tasks with the goal of preventing time-frame problems and process barriers [6]. To demonstrate cause and effect relationships of time-related disputes in construction projects, schedule delay analysis is commonly conducted [7]. In terms of delay analysis, the CPM is also implemented as a method. One of the delay analysis techniques that employ CPM is EDAM method. The effect-based delay analysis method (EDAM method) is a systematic analysis method based on existing windows-based delay analysis methods and specified delay impacts by considering the effects of delays on the critical path [8]. By performing EDAM method, the critical path changes and concurrent delays are able to be identified.

2. Research Methodology

This study started by preparing an as-planned schedule of a completed case study project as a baseline of delay analysis and its delays information including the start, finish, and types. The schedule later is divided into several windows based on the occurred or not occurred delays. In this study, a week-by-week analysis is executed due to the weekly progress report that gathered from the project site. Since the EDAM method provides equations to calculate delay impaction (6-the), the equations are applied for each window and each activity to calculate the baseline duration, EC duration, NE duration, delay liability for the owner and delay liability for the contractor. Moreover, a critical path method (CPM) also has to be performed for each window. The result later will be used to identify the critical activities and their changes. After that, the concurrent delays identification can be done by observing the occurred delays at the same time when critical path change. The concurrent delays exist when the critical path change happened with more than one type of delay occurred. Figure 1 presents the methodology flowchart of this research.

Table 1. Example of a week-by-week calculation recapitulation.

Task Name	Window / Week														
	38 / 42					**39 / 43**					**40 / 44**				
Finishing Work	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Ground Floor	225		232		7	232		239		7	239				
1^{ST} Floor	176		183		7	183		190		7	190				
2^{ND} Floor	154		161		7	161		168		7	168				
3^{RD} Floor	161		168		7	168		175		7	175				
4^{TH} Floor	154		161		7	161		168		7	168				
5^{TH} Floor	154		161		7	161		168		7	168				
6^{TH} Floor	168		175		7	175		182		7	182				
Dak Floor	181					181					181				

A	Dur_i^{Base}	Project Duration
B	Dur_i^{Own}	Impacted project duration caused by owner's liabilities
C	Dur_i^{Con}	Impacted project duration caused by contractor's liabilities
D	$Duty_i^{Own}$	Owner's delay liability
E	$Duty_i^{Con}$	Contractor's delay liability (A, B, C, D , E in day)

3. Results and Discussion

This study applies a six-floor building project as a case study with 47 weeks of as-planned duration. Consisting of four project works which are main building works, façade works, supporting buildings works and landscape works, the project is scheduled to finish at September 16, but with several days of delay, the project was completed on October 23, 2016. As stated at the research methodology that the as-planned schedule will be divided into several windows based on the delays so that the 47 weeks later is presented into 43 windows.

Table 2. Critical path changes.

No.	Window	Week	Critical Activities		Duration (day)	Project Total Duration (day)
1	26	30	Structure	Foundation	14	300
				Semi Basement	28	
				1st Floor	35	
				2nd Floor	21	
				3rd Floor	25	
				4th Floor	14	
				5th Floor	21	
				6th Floor	70	
				Dak Floor	98	
			Architecture	Dak Floor	98	
			Finishing	Dak Floor	167	
2	29	33	Structure	Foundation	14	308
				Semi Basement	28	
				1st Floor	35	
				2nd Floor	21	
				3rd Floor	25	
				4th Floor	14	
				5th Floor	21	
				6th Floor	70	
			Landscape	Hardscape	171	
				Softscape	98	
3	34	38	Structure	Dak Floor	147	307
			Architecture	Dak Floor	105	
			Finishing	Dak Floor	174	
4	38	42	Structure	Dak Floor	154	315
			Architecture	Dak Floor	105	
			Finishing	Dak Floor	181	
			Supporting Building	Power House		
5	39	43	Supporting Building	Power House	294	320
			Façade Work	Alumunium Composite	192	
6	41	45	Façade Work	Alumunium Composite	192	322
			Supporting Building	Power House	301	
7	42	46	Supporting Building	Power House	301	322
				Post & ATM Building	210	
			Finishing Work	Ground Floor	249	
				3rd Floor	189	
				6th Floor	189	
8	43	47	Finishing Work	Ground Floor	249	322
				1st Floor	211	
				2nd Floor	190	
				3rd Floor	189	
				4th Floor	189	
				5th Floor	189	
				6th Floor	189	

	Supporting Building	Power House	301
		Post & ATM Building	210
	Landscape	Softscape Work	112

It is because the delays have occurred every week on week 6 – 47 and leaving week 1 – 5 as one window with no delay occurred. After that, a week-by-week analysis is executed in equations form for obtaining the liability of owner and contractor. Table 1 represents the example of a week-by-week calculation recapitulation of finishing works on window 38 – 40 or week 42 – 44. The table shows the calculation of EDAM method equations with only NE delays occurred. Performing the schedule and presenting the critical path of each window is the next step in order to identify the CP changes. Based on the CPM results, on window 26 or at week 30 the first critical path change is identified. The project duration has extended six days from its as-planned duration, 294 days. It indicates that the first affected delay to the total project duration has happened on week 30. Later, eight critical path changes have been identified in this case study as presented in Table 2.

In order to identify the concurrent delay, the analysis starts from the first identified critical path changes. When the critical path has changed and affected the total duration, the acceleration or delay has happened on the project. Based on the previous calculation, the duration at week 30 is six days longer than its as-planned, so the delay has occurred. The delay information showed that on week 30, both owner and contractor caused delays at structure, architecture, and finishing of main building works and it indicates the position of first concurrent delay. On the second critical path change, the total project duration is 308 days and eight days longer than its first with only contractor caused the delay. The third critical path change is on window 34 or at week 38 with 307 days of total project duration and seven days of acceleration at landscape works. For the rest windows, only the NE delays that occurred, therefore, the concurrent delay only happens one time on week 30.

4. Conclusion

EDAM method is a schedule delay technique that able to identify the critical path change and concurrent delay. Based on the results, the critical path has changed eight times and the concurrent delay occurred on the first change with six days of delays. By identifying the critical path change, project parties are expected to be able to prevent continuously delays by escalating the work progress. Furthermore, the information about concurrent delays would be essential in avoiding disputes regarding this issue. Project parties would be aware of their contribution to critical path changes by knowing their caused delay in that time period.

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