

# Evaluation of Fabrication Concrete Wave Breaker Project Scheduling with the Critical Chain Project Management Method

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**Abstract**—The project is successful if the implementation of project activities goes according to the allotted time. The problem of execution in the field is complicated to achieve appropriate actions following predetermined targets. This study aims to evaluate the delay in project activities that occur in the fabrication of concrete wave breakers. This study uses the critical chain project management method in analyzing essential activities that require attention. Based on data processing, critical paths that occur in concrete wave breaker fabrication activities include Engineering Verification, Purchasing Materials, Formwork Fabrication, Rebar fabrication, pouring concrete, mobilization concrete, closeout document. The improvement of the work system by using the critical chain project management was able to maximize the activity time to 53 days from its original duration of 64 days. Critical chain project management application is consistently able to reduce jobs that do not have added value that can hinder or prolong the project.

**Keywords:** *critical chain project management, critical paths, fabrication of concrete wave breakers*

## I. INTRODUCTION

Scheduling in projects is a crucial component in carrying out project activities on time. Failure in the schedule will have an impact on increasing the duration of operations and decreasing quality [1]. The increase in the period can have a final effect, which causes the project costs to rise from the initial estimate. Likewise, the fabrication of the concrete wave breaker project has the same problem in streamlining the project schedule to fit the planned time.

Critical Chain Project Management (CCPM) is a project scheduling management that takes into account the availability of resources [2]. CPM is a development of the Evaluation and Review Technique (PERT) method, which focuses on the critical path. That focus results in several problems, such as multitasking. CCPM provides buffer time to anticipate unplanned project delays [3,4]. CCPM focuses on handling uncertainties and variations in project activities

[5], estimating work duration [6], eliminating multitasking [7], and minimizing resource conflicts [8,9].

CCPM pays attention to uncertainty in the project [7,10,11] and the availability of resources in determining buffer time in the face of risk [12]. Buffer time in project activities consists of project buffer (critical activity safety time) and feeding buffer to anticipate delays in non-critical projects [13]. Most studies directly apply the cut & paste method in determining the optimal duration of the activity. This research combines the cut & paste method and the opinion of the project responsible for getting the acceleration of project activities according to field conditions. This study aims to evaluate the concrete wave breaker project activities in getting the ideal project duration. The duration of the new project is expected to be able to make the scheme effective by the planned time.

## II. METHOD

This study analyzes concrete wave breaker fabrication activities in the Banten area. This study uses quantitative data that is the duration of project activities contained in the initial Gant chart. Evaluation of the project activity schedule is carried out with CPPM and interviews with the project leader to get the ideal duration of the concrete wave breaker activities.

This research phase refers to the research of Jo, Lee, & Pyo [14] without including material risk management with resource buffer. The CCPM step used in this study is to analyze the project schedule, create CCPM activities. Making CCPM activities, make a project buffer time, and zone buffer identification. The stages in CCPM activities include implementation schedule, determination of critical chain, and non-critical chain activities and application of the cut & paste method.

Activities in the project consist of the critical chain and non-critical chain activities based on the value of slack time on the project. If the project's float / slack time value is zero or none, the project activities include critical path activities.

For project activities that have float / slack time values, these activities do not include the critical chain.

The leading edge of the cut & paste method can be done using a probability of 50% [15–18], 30% [4], 20%, and 10% [19,20] reduced by the time of activities. This research uses the cut & paste method with a probability of 30% by the results of the experience of the company planning can be done, and the results are by the target. In this stage, the result of applying the cut & paste method is the new schedule of the semi-gantry crane structure project by using the CCPM method.

In making the project buffer time, the authors look for project buffers and project buffer feeding by calculations using the Root Square Error Method (RSEM). Zone Buffer identification is the level of buffer usage. In determining the zone buffer, the authors use the zone buffer indicator that serves to control the zone buffer so that the company can take actions that are useful in project activities.

$$2\sigma = 2x \sqrt{\left(\frac{S1-A1}{2}\right)^2 + \left(\frac{S2-A2}{2}\right)^2 + \dots + \left(\frac{Sn-An}{2}\right)^2} \quad (1)$$

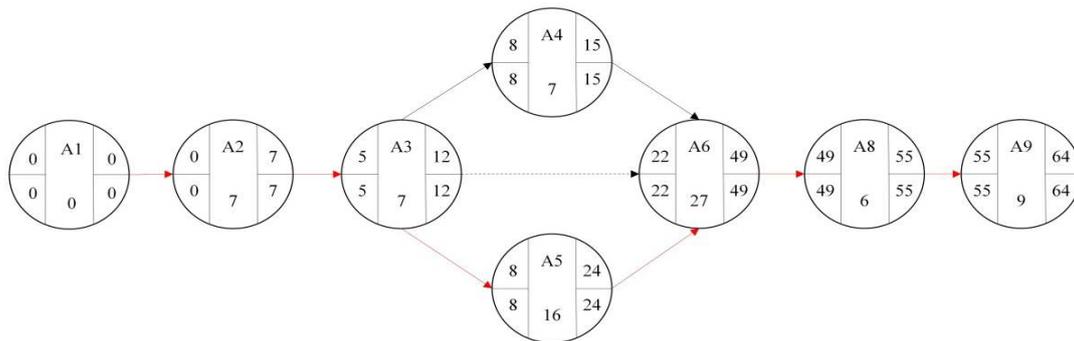


Fig.1. Network initial condition diagram

After getting critical and non-critical activities, the next step is to use the cut & paste method application. Of the several possible uses of probability, this study uses a 30% probability. This 30% probability is used based on interviews with the person in charge of the project from the evaluation of the previous project work planned by the company planning party. In the process of applying the cut & paste method, the standard time time of project activities is reduced by a 30% probability.

Based on the cut & paste method table after the duration of project activities is obtained (Table 2), the researcher conducts a discussion with the person in charge of the project. This discussion was held to find the optimal duration between the proposed reduction in the period of project activities using the cut & paste method and the actual work on the project in

### III. RESULT

Concrete wave breaker is included in concrete with unique specifications because it uses type-5 cement, type 5 cement differs from cement in the market, because type 5 cement has the highest resistance in acidic water compared to other types of cement. Casting work (Pouring Concrete) is the main activity of this concrete wave breaker fabrication project. In concrete fabrication consists of reinforced bars, formwork, and casting practice. Concrete maintenance is the last activity carried out in concrete wave breaker fabrication activities, and the control carried out in concrete maintenance must be routine to be able to identify the damage and failure of the construction that occurred.

Fabrication of the concrete wave breaker project initially requires a work duration of 64 days consisting of the engineering verification stage, purchasing material, formwork fabrication, rebar fabrication, pouring concrete, mobilization, and closeout documents (Figure 1). The initial step in the CCPM process is to analyze all activities to determine critical and non-critical activities. Based on the calculation process using slack, the results of the critical chain are verification, purchasing material, rebar fabrication, pouring concrete, mobilization, and closeout documents. The stages of formwork fabrication are non-critical chain activities (Table 1).

the field. After conducting discussions with the person in charge of the project, I experienced a reduction in the duration of project activities, namely activities with codes A5 (rebar fabrication) and A6 (pouring concrete).

To maintain the possibility that is not desirable, the project buffer and feeding buffer are determined. This buffer time zone is useful for keeping project activities by the desired plan. Based on the division of critical and non-critical activities, the project buffer obtains ten days (table 4) and 0 days for feeding buffer. There is no time added to the feeding buffer because the pessimistic duration and optimistic duration have the same value in fabrication formwork activities.

**TABLE 1. CRITICAL CHAIN DETERMINATION**

Activity Code	Activity	Node	Duration	Forward Pass		Backward Pass		Slack	Remark
	Fabrication Concrete Wave Breaker			ES	EF	LS	LF	LS-ES LF-EF	
A1	Start	-	0	0	0	0	0	0	Critical
A2	Engineering Verification	A1	7	0	7	0	7	0	Critical
A3	Purchasing Material	A2	7	5	12	5	12	0	Critical
A4	Fabrication Formwork	A3	7	8	15	15	22	7	Non Critical
A5	Fabrication Rebar	A3	16	8	24	8	24	0	Critical
A6	Pouring Concrete	A4, A5	27	22	49	22	49	0	Critical
A7	Mobilization Concrete	A6	6	49	55	49	55	0	Critical
A8	Close Out Document	A7	9	55	64	55	64	0	Critical

**TABLE 2. CUT & PASTE METHOD**

Activity Code	Activity	Node	Duration	30%(A)	Duration Cut & Paste
A1	Start	-	0	0	0
A2	Engineering Verification	A1	7	2.1	4.9
A3	Purchasing Material	A2	7	2.1	4.9
A4	Fabrication Formwork	A3	7	2.1	4.9
A5	Fabrication Rebar	A3	16	4.8	11.2
A6	Pouring Concrete	A4, A5	27	8.1	18.9
A7	Mobilization Concrete	A6	6	1.8	4.2
A8	Close Out Document	A7	9	2.7	6.3
Final Duration					55.3 = 56

**TABLE 3. RESULTS OF DISCUSSIONS WITH THE PERSON IN CHARGE OF THE PROJECT**

Activity Code	Activity	Node	Early Duration	Discussion Duration
A1	Start	-	0	0
A2	Engineering Verification	A1	7	7
A3	Purchasing Material	A2	7	7
A4	Fabrication Formwork	A3	7	7
A5	Fabrication Rebar	A3	16	10
A6	Pouring Concrete	A4, A5	27	20
A7	Mobilization Concrete	A6	6	6
A8	Close Out Document	A7	9	9

**TABLE 4. PROJECT BUFFER**

Activity Code	Activity	Node	Pessimistic Duration (S)	Optimistic Duration (A)	S - A	S - A/2	(S - A/2) <sup>2</sup>
A1	Start	-	0	0	0	0	0
A2	Engineering Verification	A1	7	7	0	0	0
A3	Purchasing Material	A2	7	7	0	0	0
A4	Fabrication Formwork	A3	16	10	6	3	9
A5	Fabrication Rebar	A3	27	20	7	3.5	12.25
A6	Pouring Concrete	A4, A5	6	6	0	0	0
A7	Mobilization Concrete	A6	9	9	0	0	0
A8	Close Out Document	A7	0	0	0	0	0
Total							21,25
Project buffer							10

The zone buffer time indicators for the project buffer are 0 to 3 days (there is no action to be done), 4 to 6 days (planning preventative measures), and 7 to 10 days (implement precautions). Some suggestions to prevent excessive use of buffer time are to add project workers and overtime to several project activities. Another alternative is to add concrete drying methods, increase the amount of formwork, and eliminate multitasking activities that cause project workers not to finish their work immediately.

#### IV. CONCLUSIONS

The use of the Critical Chain Project Management Method application can shorten the duration of the Fabrication Concrete Wave Breaker project from 64 days to 53 days. Reduction of time on fabrication activities for 16 days for fabrication of rebar to 10 days by adding overtime and adding employees. Pouring concrete activities with a period of 27 days to 20 days by using a retarder method to speed up specific arrangements so that after three days, the concrete can be mobilized and increase the amount of formwork so that each pouring process can add 2m<sup>3</sup> of concrete. This research can be continued in lean project management to get more efficient work.

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