

**COMPARISON OF SCHEDULING USING CPM AND PDM
METHODS IN THE RECONSTRUCTION PROJECT OF JALAN
BUMI MAKMUR – PULAU SARI, BUMI MAKMUR DISTRICT,
TANAH LAUT REGENCY, SOUTH KALIMANTAN**

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ABSTRACT

Construction projects in their implementation require the success of management because they are very important for the project. For a smooth work process, effective management is needed to manage project scheduling from start to finish. Therefore, in the Bumi Makmur – Pulau Sari Road Reconstruction project, scheduling will be made using diagrams with PDM, CPM, and modified CPM.

The *Precedence Diagram Method* (PDM) scheduling method in the construction industry is scheduling that can be done with several dependencies where there is an *overlapping relationship*. While the *Critical Path Method* (CPM) method, which is the dependence of *finish to start* work, then in this study will be modified, namely a work item is divided into several segments of work activities.

The results obtained from the research conducted on the scheduling of this project for the PDM method of the project can be carried out in 136 days. Meanwhile, the CPM method of the project can be done in 225 days and for the CPM method of project modification it can be done in 145 days. The three methods have critical paths, in PDM all activities have a critical path and only have 1 critical path, while in the CPM method without modification there is 1 critical path, and in modified CPM there are 2 critical paths.

Kata kunci: *Critical Path Method* (CPM), *Precedence Diagram Method* (PDM)

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Keywords: *Critical Path Method (CPM), Precedence Diagram Method (PDM)*

1. INTRODUCTION

Scheduling in understanding construction projects is a tool used to identify the activities needed to complete a project within a certain period of time. Every activity must be carried out so that the project can be completed according to the deadline that has been set.

A project consists of a series of interrelated activity activities, so the project completion time is determined by a critical trajectory also known as *a critical path*. This track is the longest track in completing activities.

The Bumi Makmur – Pulau Sari Road Reconstruction Project only uses a scheduling method in the form of *a bar chart-S curve*, thus in this final project, project scheduling will be made using the PDM and CPM methods. Furthermore, in this final project, modified CPM scheduling will also be carried out, namely a job is divided into several segments of work activities, a work can be started without having to wait for the previous work to be completed.

2. THEORETICAL FOUNDATIONS

According to Husen (2008), scheduling is a process of scheduling time that exists to carry out a work item with the aim of completing a project in order to achieve maximum results.

According to Safitri (2019), CPM or (*Critical Path Method*) is a method of scheduling and controlling organizational resources. The purpose of the CPM scheduling method is to identify critical paths from the beginning to the end of the project, because if there is a delay in the execution of this path, it leads to a delay in the total duration of the project.

According to Safitri (2019) How to determine the critical trajectory in CPM is carried out as follows.

1. Calculation from the future

$ES_j = \max (ES_i + D_i)$, for all (i,j) activities described

ES_i = earliest start time (*erliest start*)

D_{ij} = duration of activity from event i to j. For ES_a to start is always worth zero.

2. Calculation from the back

LC_a = is at least $LC - D$, for all (i,j) activities described.

C_i = final time to complete

According to Safitri (2019) PDM is a scheduling method that justifies overlapping relationships, where a can be started even though the previous work is one hundred percent complete.

The calculation of PDM is also based on:

1. Relationship of finish to *finish activities*

a. Forward Calculation :

$$EF_j = EF_i + FF_{ij} \text{ (7), } ES_j = EF_j - D_i$$

b. Countdown :

$$LF_i = LF_j - FF_{ij} \text{ (9), } LS_i = LF_i - D_j$$

2. Relationship of finish to *start activities*

a. Forward Calculation :

$$ES_j = EF_i + FS_{ij} \text{ (11), } EF_j = ES_j + D_j$$

b. Countdown :

$$LF_j = LS_i - FS_{ab} \text{ (13), } LS_i = LF_i - D_j$$

3. Relationship of start to *start activities*

a. Forward Calculation :

$$ES_j = ES_i + SS_{ij} \text{ (15), } EF_j = EF_j + D_j$$

b. Countdown :

$$LS_i = LS_j - SS_{ij} \text{ (17), } LF_i = LS_j + D_i \text{ (18)}$$

4. Relationship between start to *finish activities*

a. Forward Calculation :

$$EF_j = ES_i + SF_{ij} \text{ (19), } ES_i = EF_j - D_i$$

b. Countdown :

c. $LS_i = LF_j - SF_{ij} \text{ (21), } LF_i = LS_i + D_i$

3. METHOD

The Bumi Makmur – Sari Island Road Reconstruction Project is located in Bumi Makmur District, Tanah Laut Regency, South Kalimantan Province. In this road project, it is carried out along 21 km.

Preparation is carried out before the research to find and study previous literature sources related to the research topic. Primary data collection from field executive interviews, secondary data obtained from related contractor archives.

Create a *work breakdown structure* (WBS) to continue, determine the dependency relationship of work items, and then process project scheduling using the modified CPM method. Then the scheduling of the CPM method without modification was also made and the scheduling of the PDM method was also made. Next, look for the critical trajectory and duration of the project.

4. RESULTS AND DISCUSSION

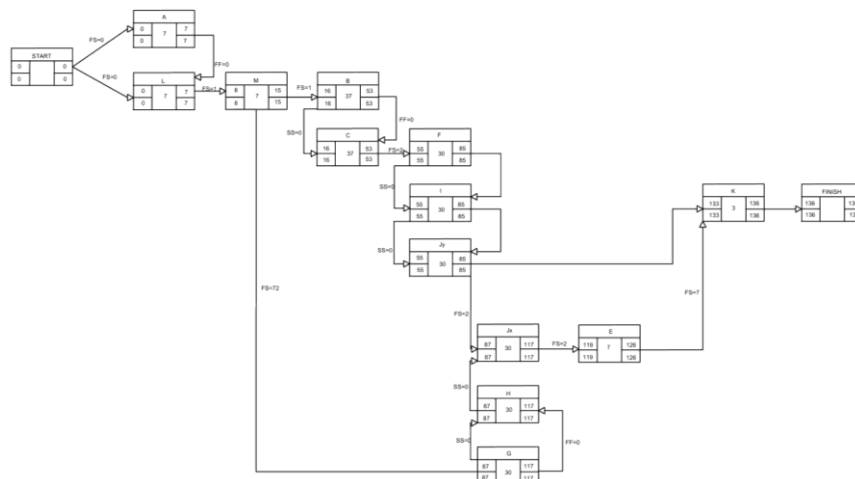
The case study in this study will be completed within 150 working days. Then the work item code is created and the relationship between jobs can be analyzed

Table 1. Work Item Codes and PDM method dependencies

No.	Job Description	Code	Duration (Day)	Keter hanger	Could strain	Slack Time
III	Earthworks and Geosynthetics					
1.	Granular Pavement Excavation	A	7	L	SS	0
2.	Road Body Preparation	B	7	M	FS	1
				C	FF	0
V	Grained Pavement and Cement Concrete Pavement					
1.	Class A Aggregate Foundation Layer	C	37	B	SS	0
3.	Grade S Aggregate Foundation Layer	And	7	Jx	FS	2
WE	Asphalt Pavement					

No.	Job Description	Code	Duration (Day)	Keter hanger	Could strain	Slack Time
1.	Adhesive Absorbent Layer – Liquid Asphalt	F	30	C	FS	2
2.	Adhesive Layer – Liquid Asphalt/Emulsion	G	30	M	FS	73
				H	FF	0
3.	Lataston Lapis Off (HRS-WC)	H	30	G	SS	0
4.	Lataston Lapis Fondasi (HRS-Base)	I	30	F	SS	0
5.	Anti-Peel Material	You	30	I	SS	0
				K	FS	0
		Jx	30	H	SS	0
IX	Day Jobs and Miscellaneous Jobs					
1.	Thermoplastic Road Markings	K	3	And	FS	7
X	Performance Maintenance Jobs					
1.	Grade A Aggregate Foundation Layer Repair	L	7	A	SS	0
2.	Hot Asphalt Mix Repair	M	7	L	FS	1

Next, calculations were made for PDM scheduling. After completing all the calculations. Create PDM Work diagrams



Picture 1. PDM Keja Network Diagram

Calculations were carried out manually, forward and countdown counts so that the critical path obtained in PDM scheduling had 1 activity path with a total duration of 136 days and work activities: A, L, M, B, C, F, I, JX, G, H, Jy, E, K. and *lag time* as many as 15 days.

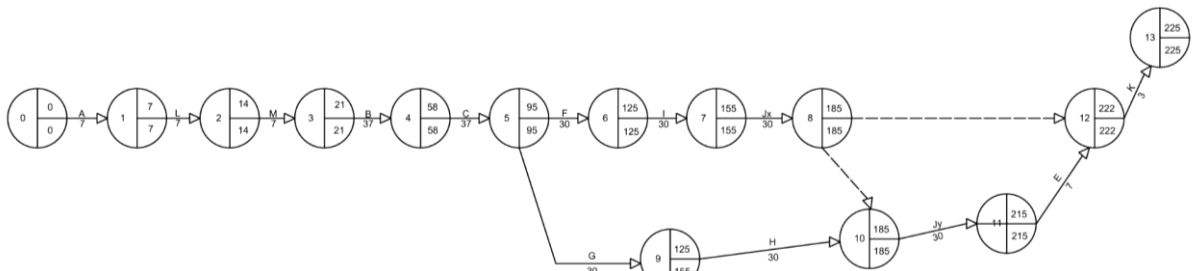
A work item code was also created and an analysis of the relationship between jobs was carried out on the CPM method without modification, the following can be seen in

Table 2. Job item codes and CPM method dependencies without modification

No.	Job Description	Code	Duration (Day)	Predecessors	Successors
III	Earthworks and Geosynthetics				
1.	Granular Pavement Excavation	A	7	-	L
2.	Road Body Preparation	B	37	M	C
V	Grained Pavement and Cement Concrete Pavement				
1.	Class A Aggregate Foundation Layer	C	37	B	F
3.	Grade S Aggregate Foundation Layer	And	7	You	K
WE	Asphalt Pavement				
1.	Adhesive Absorbent Layer – Liquid Asphalt	F	30	C	F
2.	Adhesive Layer – Liquid Asphalt/Emulsion	G	30	C	H
3.	Lataston Lapis Off (HRS-WC)	H	30	G	You

No.	Job Description	Code	Duration (Day)	Predecessors	Successors
4.	Lataston Lapis Fondasi (HRS-Base)	I	30	F	F
5.	Anti-Peel Material	Jx	30	I	I
		You	30	H	And
IX	Day Jobs and Miscellaneous Jobs				
1.	Thermoplastic Road Markings	K	3	And	-
X	Performance Maintenance Jobs				
1.	Grade A Aggregate Foundation Layer Repair	L	7	A	M
2.	Hot Asphalt Mix Repair	M	7	L	B

After completing all the calculations. Create CPM Work charts without Modification



Picture 2. Unmodified CPM Network Diagram

Calculations are carried out manually for forward and countdown counts so that the critical path obtained in CPM scheduling without modification is 1 activity path with a total duration of 225 days and work activities: A, L, M, B, C, F, I, JX, JY, E, K

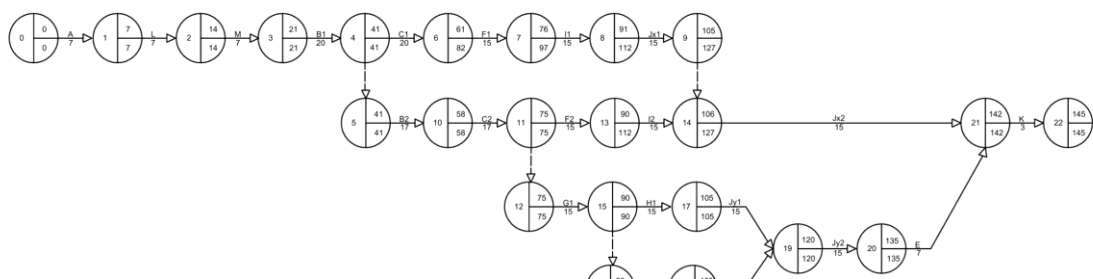
A work item code was also created and an analysis of the relationship between jobs was carried out on the CPM method without modification, the following can be seen in

Table 3. Job item codes and CPM dependency modifiers

No.	Job Description	Code	Duration (Day)	Predecessors	Successors
III	Earthworks, Geosynthetics				
1.	Granular Pavement Excavation	A	7	-	L
2.	Road Body Preparation	B1	37	M	B2
		B2		B1	C1
V	Granular Pavement, Cement Concrete Pavement				
1.	Class A Aggregate Foundation Layer	C1	20	B2	F1
		C2	17	Jx1	F2
3.	Grade S Aggregate Foundation Layer	And	7	Jy2	K
WE	Asphalt Pavement				
1.	Adhesive Absorbent Layer – Liquid Asphalt	F1	15	C1	I1
		F2	15	C2	G1
2.	Adhesive Layer – Liquid Asphalt/Emulsion	G1	15	F2	I2
		G2	15	H1	Jy1
3.	Lataston Lapis Off (HRS-WC)	H1	15	Jx2	G2
		H2	15	Jy1	Jy2
4.	Lataston Lapis Fondasi (HRS-Base)	I1	15	F1	Jx1
		I2	15	G1	Jx2
5.	Anti-Peel Material	Jx1	15	I1	C2
		Jx2	15	I2	Jx2
		Jy1	15	G2	H2
		Jy2	15	H2	And
IX	Daily Jobs, Miscellaneous Jobs				
1.	Thermoplastic Road Markings	K	3	And	-
X	Performance Maintenance Jobs				
1.	Grade A Aggregate Foundation Layer Repair	L	7	A	M
2.	Hot Asphalt Mix Repair	M	7	L	B1

After completing all the calculations. Create a Modified CPM Work chart as follows

Picture 3



Picture 3. Modified CPM Network Diagram

Calculations are carried out manually, forward and countdown counts so that the critical paths obtained in the scheduling of modified PDM have 2 activity paths, the first work activity path: A, L, M, B1, B2, C2, G1, H1Jy1, Jy2, E, K and the second work activity path: A, L, M, B1B2, C2, G1, G2, H2, Jy2, E, K with a total duration of 145 days each

5. CONCLUSION

The scheduling analysis uses the PDM method as a result of the total project duration which is for 136 days, the CPM method without modification of the total project duration for 225 days. And using the CPM method with a modification of the total duration of the project for 145 days. By making a comparison between scheduling using the PDM method) and the CPM method, the project duration comparison modification is smaller. so that efficient scheduling uses the PDM method because it has a shorter total duration.

Scheduling using the PDM method in this final project has a critical path in all activities. Meanwhile, the critical path obtained uses the CPM method without modification, namely all activities except (G1). And the critical path uses the modified CPM method, namely activities A, L, M, B1, B2, C2, G1, G2, H1,H2, Jy1,Jy2, S E, K.

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