

**SCHEDULING ANALYSIS OF PLAN, REALISATION, AND ESTIMATION
BY USING *PRECEDENCE DIAGRAM METHOD* (PDM)
(CASE STUDY : CONSTRUCTION DEVELOPMENT PROJECT
MULTI-PURPOSE SPORTS HALL PHASE IV
IN KATINGAN REGENCY)**

Dhika Fitrianita Putri¹, Endah Widiastuti², Humaira Afrila², Gawit Hidayat²
Civil Engineering Study Program, Lambung Mangkurat University
Jl. Jenderal Achmad Yani Km 35.5 Banjarbaru, South Kalimantan – 70714
E-mail: ¹dhikafitrianitaputri14@gmail.com, ²endah.widiastuti@ulm.ac.id,
²humaira.afrila@ulm.ac.id, ²gawit.hidayat@ulm.ac.id

ABSTRACT

In its implementation, starting from planning, scheduling implementation, to supervision and implementation of controls properly, construction projects have a complicated and dependent series at each stage. In the process of Construction of Phase IV Multipurpose Sports Building located in Katingan Regency, there were delays due to several obstacles. This is related to time management, thus affecting the delay in project completion. This study aims to analyse the difference in the period of delay that occurs based on the scheduling plan, realisation, and estimation with the help of Microsoft Project 2021, as well as identifying the critical and non-critical path of work on the three schedules. In this study, the quantitative analysis method, where data collection was carried out by interviewing and distributing questionnaires to several respondents from Supervisory Consultants and distribution of questionnaires to several respondents from the Supervisory Consultant and Implementing Contractor with a total of 6 respondents.

Based on the results of PDM analysis with the help of Microsoft Project 2021, a comparison of the total duration of work based on plan, realisation and estimation scheduling was obtained, namely in the plan scheduling for 272 days, realisation scheduling for 249 days, and estimation scheduling for 267 days.

Based on the three schedules, the work with the most critical status is obtained in Preparatory Work, Concrete Structures, Doors and Windows, Electrical and Electrical, and Procurement of Equipment Etc. And from the results of the questionnaire recapitulation, it is concluded that the influencing factors in the construction process of this project are unstable weather, material supply mobilisation process, and lack of manpower.

Keywords : *Critical and Non-Critical Path, Microsoft Project 2021, Rescheduling, Precedence Diagram Method (PDM)*

1. INTRODUCTION

In the development and progress of an area, there are certain factors that contribute to the success that drives growth in the region. The form of effort that can be made in supporting the development of an area's progress is by carrying out development in various sectors, one of which is in the field of sports, namely by building public facilities in the form of multipurpose sports buildings.

The multipurpose sports hall is a building that is used by the public for various purposes with the presence of stands and large capacity.

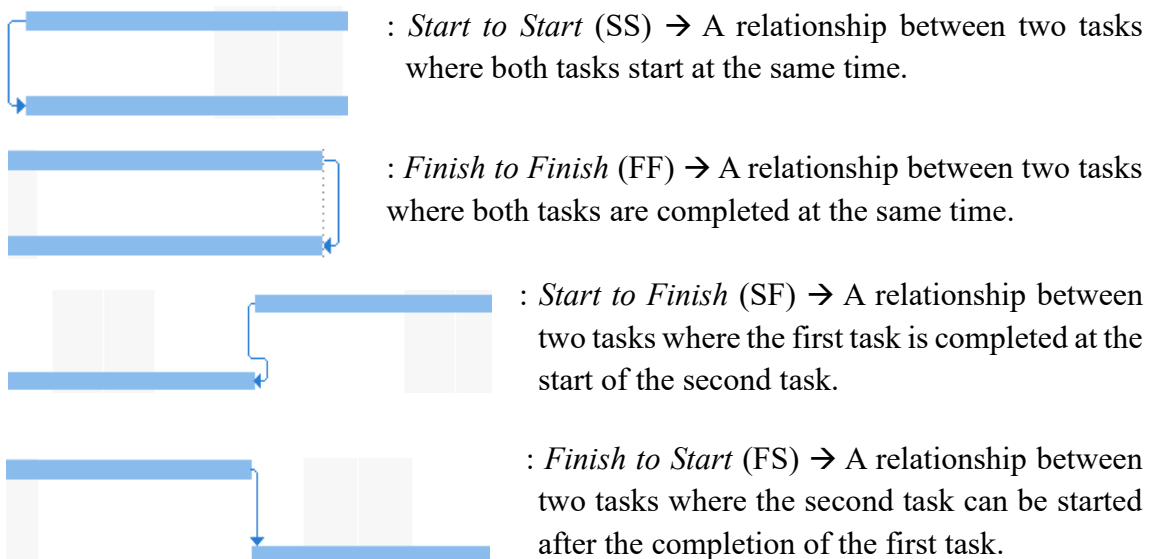
In the construction process, this multipurpose sports building experienced several obstacles related to delays in the material supply mobilisation process, unstable weather, and a lack of skilled workers, which had the potential to delay the project completion time. Based on these conditions, it is necessary to evaluate the scheduling plan against the realisation and estimation, so that the duration/delay can be organised and the work done more efficiently.

2. THEORETICAL BASIS

Scheduling

In a construction project work, project scheduling is needed which is useful to show when a job will start in a systematic and orderly sequence.

In this research, the scheduling that will be discussed consists of scheduling plans, realisations, and estimates, with a constraint that aims to show the dependence between the relationship between one job and another.



Precedence Diagram Method (PDM)

One of the methods in project scheduling is the *Precedence Diagram Method* (PDM) or priority diagram method, which is a work network method with a critical path, which is a series of jobs with the longest total duration and the fastest completion time duration, where the work on the critical path must not be late / delayed in its implementation.

In addition, the PDM method is known for constraints that connect two nodes (nodes are generally rectangular), consisting of start = (S) and finish = (F), with arrows as a guide to the relationship between related work, by connecting the previous node to the next node.

Critical and Non-Critical Path

Some conditions in determining the critical path with the PDM method are if it fulfils one of the following condition :

1. The early start time must be identical to the late start time, $ES = LS$.
2. Initial finish time must be identical to final finish time, $EF = LF$.
3. The difference between the final completion time and the initial start time is equal to the time duration of the work, $LF - ES = D$.
4. Total *float*, $LF - EF = LS - ES = 0$.

Microsoft Project

Microsoft Project is *software* in project administration that is used to support and assist the process of planning, managing and reporting data, supervising, organising, controlling time, and scheduling a project, especially construction projects, so as to produce accurate data.

In the PDM method, some basic terminology is used, namely :

Table 1. Basic Terminology in PDM Method

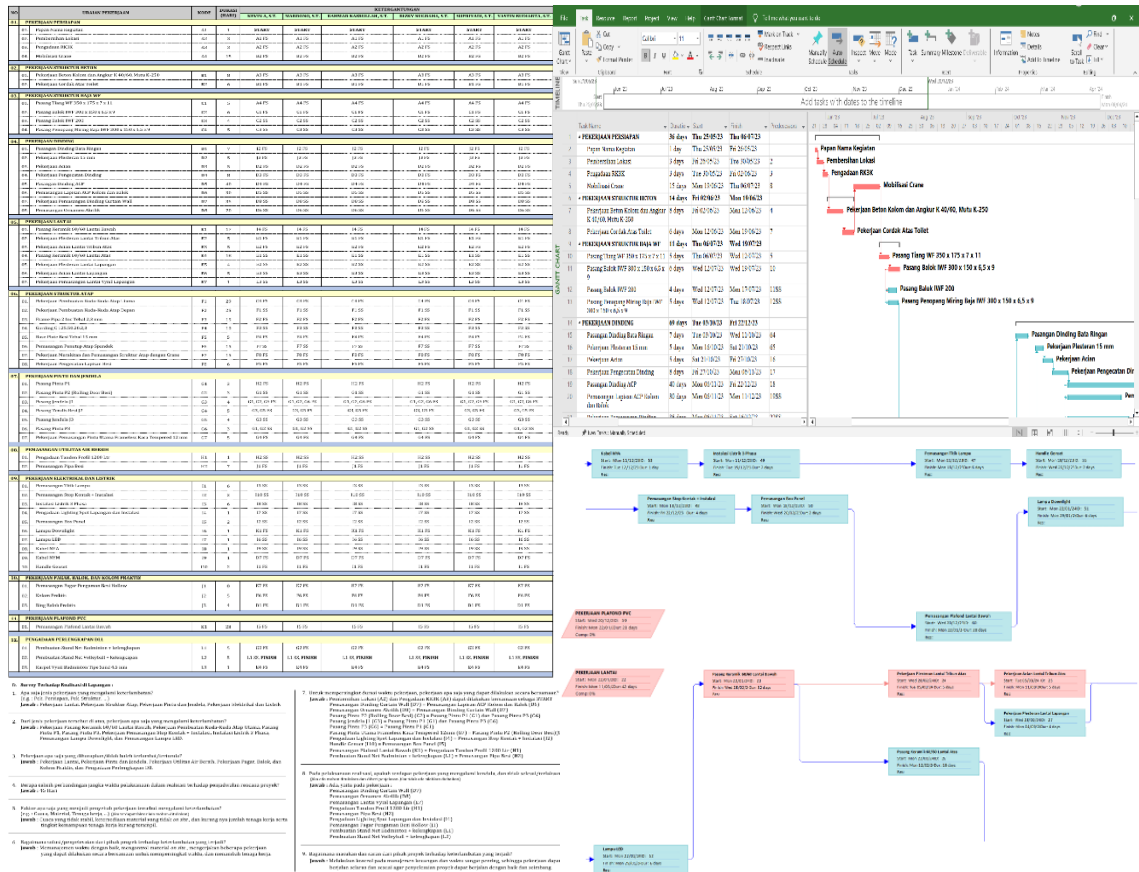
SYMBOLS		ACTIVITY CODE				
		ES	TYPE OF ACTIVITY	EF		
		LS		LF		
		DURATION				
DESCRIPTION		PDM Method NODE/Symbol			(Arrow) – Non - Critical	(Arrow) - Critical
TERMINOLOGY		ES (Early Start)	EF (Early Finish)	LS (Late Start)	LF (Late Finish)	D (Duration)
DESCRIPTION		Earliest start time	Earliest finish time	Latest time activity started	Latest time the activity was completed	Time period required
FORWARD CALCULATION		1.	$ES_j = ES_i + SS_{ij}$ or $ES_j = EF_i + FS_{ij}$			
		2.	$EF_j = ES_i + SF_{ij}$ or $EF_j = EF_i + FF_{ij}$ or $ES_j + D_j$			
		If FS_{ij} or SS_{ij} does not exist and the activity is non-splittable then $ES_j = EF_j - D_j$				
BACKWARD CALCULATION		1.	$LS_i = LS_j - SS_{ij}$ or $LS_i = LF_j - SF_{ij}$ or $LF_i - D_i$ $LF_i = LF_j - FF_{ij}$			
		2.	$LF_i = LS_j - FS_{ij}$			
		If FF_{ij} or FS_{ij} does not exist and activity is non-splittable then $LF_i = LS_i + D_i$				
Float	Total Float	$LF - EF = LS - ES$				
		The time available for an activity to be delayed without affecting the overall project completion.				
	Free Float	Minimum $ES_j - ES_i - D$				
		Time that is allowed to be delayed or late, as it does not affect the delay of the next activity.				
Lag		The lead time of a period of activity J to activity I that has already started, occurs in the relationship SS and SF				
Lead		The time that precedes a period of activity J after activity I starts before activity I is completed occurs in the relationship FS and FF.				

3. RESEARCH METHODOLOGY

This research was conducted on the Phase IV Multipurpose Sports Building construction project, with quantitative methods, obtained from primary and secondary data. Where primary data is obtained by distributing questionnaires to several respondents from supervisory consultants and implementing contractors, while secondary data is

provided directly by the supervisory consultant, as well as some missing data that was completed by conducting interviews.

4. RESULTS AND DISCUSSION



Relationship of Dependency

The dependency relationship in this study is based on the scheduling plan, which is obtained from the recapitulation of the questionnaires that have been distributed. However, there are changes in the constraints on the realisation and estimation scheduling, because in the realisation scheduling there are several jobs that are not carried out. While in the estimation scheduling there are several jobs that are expected / should not be late / delayed, so that constraint changes are made based on the results of the recapitulation of questionnaires related to work that can be done simultaneously, as well as references from previous research journals with similar methods.

The following is a table of constraint changes in the realised and estimated scheduling against the planned scheduling listed in Table 2.

Table 2. Constraint Changes in Scheduling Plan, Realisation, and Estimation

No.	Kode	Perubahan Hubungan Ketergantungan		
		Rencana	Realisasi	Estimasi
1.				
2.	A2	A1 FS = 0		START
3.	A3	A2 FS = 0		START
4.				
5.	B1	A3 FS = 0		A1, A2, A3 FS = 0
6.				
7.	C2	C1 FS = 0	C1 SS = 0	
8.	C3	C2 SS = 0	C2 FS = 0	
9.	C4	C3 SS = 0	C3 FS = 0	
10.				
11.	D6	D5 SS = 0		D5 FS = 0
12.	D7	D8 SS = 0		D6, D8 SS = 0
13.				
14.	E1	I4 FS = 0	I7 SS = 0	D8 FS = 0
15.	E7	E6 FS = 0, L3 SS = 0		L3 SS = 0
16.				
17.	G1	H1 FS = 0	L3 SS = 0	E1, E4 FS = 0
18.	G2	G1 SS = 0		G1, G6 SS = 0
19.	G6	G1, G2 SS = 0		G1 SS = 0
20.	G7	G4 FS = 0	G4 FS = 0, FINISH	G4 FS = 0, I10 SS = 0
21.				
22.	I1	I3 SS = 0		I8 FS = 0
23.	I2	I10 SS = 0		I1 FS = 0
24.	I3	I8 SS = 0		I2 FS = 0
25.	I4	I7 SS = 0		I2 SS = 0
26.	I5	I2 SS = 0		I3 FS = 0
27.	I6	K1 FS = 0		K1, L2 FS = 0, FINISH
28.	I7	I6 SS = 0		K1, L2 FS = 0, FINISH
29.	I8	I9 SS = 0		I3 FS = 0
30.	I9	D7 FS = 0	D6 FS = 0	
31.	I10	I1 FS = 0		I4 FS = 0, I5 SS = 0
32.				
33.	K1	I5 FS = 0		H1 SS = 0
34.				
35.	L1	G2 FS = 0		H2 SS = 0
36.	L2	L1 SS = 0, FINISH		L1 SS = 0
37.	L3	E4 FS = 0	E4, E6 FS = 0	E6 FS = 0

Critical and Non-Critical Path

Critical and non-critical path in this study are determined based on whether or not they meet the predetermined conditions, after forward and backward calculations are carried out.

The following is a table of critical and non-critical path in the scheduling plan, realisation and estimation listed in Table 3.

Table 3. Critical and non-Critical Path On Scheduling Plan, Realisation, and Estimation

No.	Uraian Pekerjaan	Kode	Status		
			Rencana	Realisasi	Estimasi
I. PEKERJAAN PERSIAPAN					
01.	Papan Nama Kegiatan	A1	Kritis	Kritis	Kritis
02.	Pembersihan Lokasi	A2	Kritis	Kritis	Kritis
03.	Pengadaan RK3K	A3	Kritis	Kritis	Kritis
04.	Mobilisasi Crane	A4	Kritis	Kritis	Kritis
II. PEKERJAAN STRUKTUR BETON					
01.	Pekerjaan Beton Kolom dan Angkur K 40/60, Mutu K-250	B1	Kritis	Kritis	Kritis
02.	Pekerjaan Cordak Atas Toilet	B2	Kritis	Kritis	Kritis
III. PEKERJAAN STRUKTUR BAJA WF					
01.	Pasang Tiang WF 350 x 175 x 7 x 11	C1	Kritis	Kritis	Kritis
02.	Pasang Balok IWF 300 x 150 x 6,5 x 9	C2	Kritis	Tidak	Kritis
V. PEKERJAAN LANTAI					
01.	Pasang Keramik 60/60 Lantai Bawah	E1	Tidak	Kritis	Tidak
02.	Pekerjaan Plesteran Lantai Tribun Atas	E2	Tidak	Kritis	Tidak
03.	Pekerjaan Acian Lantai Tribun Atas	E3	Tidak	Kritis	Tidak
04.	Pasang Keramik 60/60 Lantai Atas	E4	Kritis	Tidak	Tidak
06.	Pekerjaan Acian Lantai Lapangan	E6	Tidak	Kritis	Tidak
07.	Pekerjaan Pemasangan Lantai Vinyl Lapangan	E7	Kritis	Tidak Ada Pekerjaan	Tidak
VII. PEKERJAAN PINTU DAN JENDELA					
01.	Pasang Pintu P1	G1	Kritis	Kritis	Tidak
02.	Pasang Pintu P2 (Rolling Door Besi)	G2	Kritis	Tidak	Tidak
03.	Pasang Jendela J1	G3	Kritis	Kritis	Tidak
04.	Pasang Teralis Besi J2	G4	Kritis	Kritis	Tidak
05.	Pasang Jendela J3	G5	Kritis	Kritis	Tidak
06.	Pasang Pintu P3	G6	Kritis	Kritis	Tidak
07.	Pekerjaan Pemasangan Pintu Utama Frameless Kaca Tempered 12 mm	G7	Kritis	Kritis	Tidak
VIII. PEMASANGAN UTILITAS AIR BERSIH					
02.	Pemasangan Pipa Besi	H2	Kritis	Tidak Ada Pekerjaan	Tidak
IX. PEKERJAAN ELEKTRIKAL DAN LISTRIK					
01.	Pemasangan Titik Lampu	I1	Tidak	Tidak	Kritis
02.	Pemasangan Stop Kontak + Instalasi	I2	Tidak	Tidak	Kritis
03.	Instalasi Listrik 3 Fasa	I3	Tidak	Tidak	Kritis
05.	Pemasangan Box Panel	I5	Tidak	Tidak	Kritis
06.	Lampu Downlight	I6	Tidak	Tidak	Kritis
07.	Lampu LED	I7	Tidak	Tidak	Kritis
08.	Kabel NYA	I8	Tidak	Tidak	Kritis
X. PEKERJAAN PAGAR, BALOK, DAN KOLOM PRAKTIS					
01.	Pemasangan Pagar Pengaman Besi Hollow	J1	Kritis	Tidak Ada Pekerjaan	Tidak
XI. PEKERJAAN PLAFOND PVC					
01.	Pemasangan Plafond Lantai Bawah	K1	Tidak	Tidak	Kritis
XII. PENGADAAN PERLENGKAPAN DLL					
01.	Pembuatan Stand Net Badminton + kelengkapan	L1	Kritis	Tidak Ada Pekerjaan	Tidak
02.	Pembuatan Stand Net Volleyball + kelengkapan	L2	Kritis	Tidak Ada Pekerjaan	Tidak
03.	Karpet Vinyl Badminton Tipe Sand 4.5 mm	L3	Kritis	Tidak	Tidak

5. CONCLUSIONS

After inputting the duration and constraints in *Microsoft Project 2021*, a comparison of the total duration of work between the scheduling plan, realisation, and estimation is obtained, namely :

➤ Scheduling Plan :

- Critical Path Duration Total : 272 Day
- Description : As a basis and reference in research.

➤ Scheduling Realisation :

- Critical Path Duration Total : 249 Day
- Description : < Plan Duration

Due to some work that was not carried out, as well as changes in the duration of some work, so that the duration of work is less than (faster) than the planned duration.

➤ **Scheduling Estimation :**

- Critical Path Duration Total : 267 Day
- Description : < Plan Duration

Due to the use of different constraints, which are obtained based on journal references with similar methods, as well as the results of the recapitulation of questionnaire surveys related to work that can be done simultaneously, thus shortening the duration of work on the critical path, which is less than (faster) than the planned duration.

*) Duration difference less than (faster) refers to the plan scheduling duration.

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