p–ISSN: 2723 – 6609 e-ISSN: 2745-5254
Vol. 6, No. 1, January 2025 http://jist.publikasiindonesia.id/

Project Planning Analysis with the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT): Study on the Development of Facilities and Infrastructure of SMK Negeri 1 Garut (DOOM)

Arif Kuswanto[1], Olivia Tahira Shalshabila[2]*
Universitas Telkom, Indonesia
Email: arifkuswanto@telkomuniversity.ac.id[1], oliviatahira@telkomuniversity.ac.id[2]*

*Correspondence

Keywords: CPM, PERT, project management.

ABSTRACT

Success in implementing a project often hinges on thorough planning and effective control. This study examines the infrastructure development project at SMK Negeri 1 Garut (DOOM), applying the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) to estimate project completion time, costs, probability, and potential planning alternatives. The goal is to achieve maximum efficiency and project success. The research began by determining the activities, their sequence, and duration using the PERT and CPM methods, with POM QM as the data processing tool. Based on the PERT method, the estimated project duration is 128 days with a 50% probability. The critical path, identified through the CPM method, includes activities B through P and predicts a project time of 116 days with a 0.13% probability. Additionally, Crashing the project reduces the time to 97 days, with a minuscule probability of 3.095359E-15. The probability of meeting the contract deadline of 126 days is 31%. To achieve a 95% probability, the project time extends to 130 days with an acceleration cost of IDR 2,575,898,910.73. The study suggests that when making addendums, companies should not only focus on cost changes but also consider adjustments to project timelines to meet the expected deadlines. It is recommended that companies incorporate CPM and PERT as alternative planning methods to select the most optimal cost-effective approach for project acceleration, thereby minimizing the risk of financial losses.

Introduction

Currently, the Indonesian government pays great attention to various infrastructure developments. Infrastructure development is a driving tool for the economy in a country and provides an important function as a reference for the economic growth of a country at the national and regional levels. Infrastructure development, certainly provides many benefits, such as being able to reduce unemployment, and poverty and improve people's welfare. With the many benefits provided by infrastructure development, the government is committed to continuing to improve the establishment of infrastructure (KPUPR, 2012).

Indonesia is a country that has a high growth rate every year (Asyrofi & Arumsari, 2023). In 2022, Indonesia's economic growth will reach 5.31%. According to (Central Statistics Agency, 2023) there is significant growth in various industrial sectors in Indonesia. Indonesia's economic growth is also caused by one of the business fields that contributes, namely the Construction sector. The role of the construction sector is related to the absorption of labor, capital investment, and the number of infrastructure and development projects, even the construction sector can be a facilitator that can move and grow goods and services, and the equitable distribution of various developments in all sectors is also supported by the construction sector (Statistik, 2014).

Referring to the economic growth data for 2020, 2021, & 2022, shows that the number of development projects implemented in Indonesia will help improve economic progress in various sectors (Iwano et al., 2016). The development of infrastructure projects is included in various fields, such as school facilities that support education. It is stated in Article 24 of Government Regulation Number 19 of 2005 that every educational institution is required to have adequate facilities, including learning support media, books, and other learning resources. In addition to these facilities, educational institutions must also provide physical facilities that include various types of rooms (classrooms, administration, teachers, libraries), sports facilities, places of worship, and various other facilities that facilitate a structured and sustainable learning process (Government of Indonesia, 2005)

In achieving the vision and mission of the West Java Provincial Education Office, the construction of Facilities and Infrastructure of SMK Negeri 1 Garut, Garut Regency is carried out to meet the learning needs of quality students and create an improvement in the quality of education. Therefore, the construction of facilities and infrastructure of SMK Negeri 1 Garut Regency is one of the important steps in achieving the vision and mission of the West Java Provincial Education Office to provide access to quality education (West Java Provincial Education Office, 2023). So the Infrastructure Development project, SMK Negeri 1 Garut (DOOM) was carried out, while DOOM is the name for the roof frame that has a wide span.

Based on the results of the auction that has been carried out, the contractor who won the project of Facility Development, Prasarana SMK Negeri 1 Garut (DOOM) is the CV company. PRATAMA SAKTI INTERNUSA, with a project value of IDR 2,319,999,530.12 (two billion three hundred nineteen million five hundred and thirty rupiah). A company is a unit of production activities that processes economic resources to provide goods and services for consumers to obtain profits and satisfy consumer needs (Kuswanto & Qonita, 2024). In this era of globalization, competition between companies in an industry is getting tighter. The company is required to provide the best service to its consumers and business partners (Wahjono et al., 2016). CV. PRATAMA SAKTI INTERNUSA is a company located in the city of Bandung that is engaged in specialist services such as landscape/planting, building maintenance, steel work and its installation, and various other specialist projects.

Since its establishment in 2016 until now, CV. PRATAMA SAKTI INTERNUSA has various experiences in the implementation of its specialist services. Based on the experience of my CV portfolio. PRATAMA SAKTI INTERNUSA, the company has a lot of experience in the field of building maintenance and architecture landscape so that in the implementation of the Facilities Development project, SMK Negeri 1 Garut (DOOM) Infrastructure, requires more careful planning to achieve maximum and efficient results. The various plans include financing planning, project schedule planning, and quality planning. These three things are parameters that can be used as a reference and target in the project process.

Success or failure in implementing a project, often occurs due to a lack of planning and ineffective control in the implementation process, resulting in inefficient results (Bomantara, 2024). Therefore, the importance of planning in a project is needed to achieve success in a project. Project planning has several methods, including the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT). With the application of CPM and PERT in the planning of Facility Development, SMK Negeri 1 Garut (DOOM) Infrastructure, can produce an estimate of the project completion time, probability, and several planning alternatives that can be carried out to produce maximum and efficient results for project success.

Method

The research uses a quantitative method, which is an empirical approach where the data collected is in the form of numbers (Hrp & Anas, 2024). The study involves the application of project management planning techniques with the Critical Path Method (CPM) and Program Evaluation and Review (PERT) techniques, which are based on data collected from observations. The object of this research is the facility construction project at SMK Negeri 1 Garut (DOOM).

Data Source

Data sources are various information obtained by researchers to answer questions asked during the research process.

Primary Data

Primary data can be obtained using various techniques such as observation, interviews, questionnaires, and other methods. Therefore, this primary data needs to be obtained further to produce meaning (Simanjuntak & Manurung, 2024). The primary data carried out were in the form of data from the CV PRATAMA SAKTI INTERNUSA company, interviews, observation data on the construction of facilities, infrastructure of SMK Negeri 1 Garut, and field observation data.

Secondary Data

Secondary data is data that is collected indirectly and obtained from other sources that collect data, reducing the need for researchers to compile or explain the data (Simanjuntak & Manurung, 2024). In this study, various literature, reference books, previous research, national and international journals, articles, and information sources

were used Online relevant to the research topic, focusing on project management and planning methods such as CPM and PERT.

Results and Discussion

Description of Research Data

The description of research data is the process of presenting data about the project that is used as research material so that with these data, alternative project planning will be obtained using the CPM and PERT methods.

Project Schedule

As for finding out the scheduling of the construction project of Facilities, and Infrastructure of SMK Negeri 1 Garut (DOOM), interviews were conducted, and the opening documents from the contractor, namely CV PRATAMA SAKTI INTERNUSA and also the planning consultant. Based on the schedule, the duration of the completion of the construction project of SMK Negeri 1 Garut (DOOM) Infrastructure is 18 weeks or 126 days. The following is the schedule for the Infrastructure Development Project of SMK Negeri 1 Garut (DOOM).

Based on the schedule above, the duration of the completion of the Facilities, Infrastructure Project of SMK Negeri 1 Garut (DOOM) is 18 weeks or 126 days which began in August and ended in December (Putra & Fauji, 2023).

Cost Budget Plan (RAB) and Addendum

Based on Contract No. 2501/KU.11.08/PSMK on August 10, 2023, the construction project of Facilities, Infrastructure of SMK Negeri 1 Garut has a contract value of Rp. 2,319,999,530,12.During the project, several unexpected obstacles in the field required additional costs and the need to make an addendum with approval owner and planning consultants. Addendum is a term that refers to the addition of information, documents, or modifications in a pre-existing agreement, contract, document, or manuscript. Generally, the term addendum is used to describe changes or additions made after the original document has been approved or signed (Verianty, 2023). The total value of the Facilities and Infrastructure Development Project, SMK Negeri 1 Garut (DOOM) Contract No. Addendum 2719/KU.11.08/PSMK dated August 22, 2023, the contract value changed to IDR 2,575,178,910.73.

List of Development Activities

In the Facility Development Project, SMK Negeri 1 Garut (DOOM) Infrastructure there are stages/activities A-B-C-D-E-F-G-H-I-J-K-L-M-N-O-P-Q which are based on project documents. There is a predecessor that is, the relationship between one activity and another, each activity has a predecessor by the relationship of their activities. Then there is the duration of each work activity, which is obtained from the calculation of weighting based on the project schedule.

Program Evaluation and Review Technique (PERT)

The calculation Program Evaluation and Review Technique (PERT), is divided into 3 parts, namely estimation of 3 types of time duration, Standard and Variance Deviation, and Probability.

Estimation of 3 Types of Time Duration

In the PERT method, 3 time estimates are used, namely the most optimistic time (a), the most likely time (m), and the most pessimistic time (b). In determining the estimated implementation time, it was carried out by interviewing several experts (estimators) concerned with the construction project of Facilities, and infrastructure SMK Negeri 1 Garut (DOOM). The interviews were conducted with work supervisor consultants (A), contractors (B), and field supervisors (C) where these experts have experience in various previous projects so that a rational and accountable time estimate can be obtained. Time estimators have various considerations in determining the estimate due to various factors that cannot be ascertained and have many uncertainties that occur so the PERT method is used to determine the implementation time and probability of completion in a project. From the results of the data from interviews conducted with the work supervisor consultant (A), contractor (B), and field supervisor (C), then the average calculation is carried out by taking the middle value with the following formula:

$$X = \frac{N}{n}$$

Table 1
PERT Calculation Results for the Infrastructure Development Project of SMK Negeri 1 Garut (DOOM)

Kode	Job Description	A			M			B			A	M	B	Te	V
		A	B	C	A	B	C	A	B	C					
a	Preparatory Work	8	7	7	9	10	10	14	12	14	7,3	9,6	13,3	9,8	1
b	Construction Work Safety Management System	5	4	6	6	5	7	8	7	10	5	6	8,3	6,2	0,3
c	Earthworks	7	8	8	9	14	10	14	16	16	7,6	11	15,3	11,1	1,6
d	Local Plate Foundations	3	3	2	4	5	6	8	8	8	2,6	5	8	5,1	0,7

Kode	Job Descrip- tion	A			M			B			A	M	B	Te	V
		A	B	C	A	B	C	A	B	C					
e	Pedestal Column	1	1	2	4	5	5	7	8	10	1,3	4,6	8,3	4,7	1,3
f	Sloof	2	2	2	4	5	5	8	8	10	2	4,6	8,6	4,8	1,2
g	Beton Fc'	1	1	1	2	2	3	6	8	7	1	2,3	7	2,8	1
h	Doom Pillar Work	7	10	10	11	12	12	14	14	14	9	11,6	14	11,6	0,6
i	Pipe Beam Work	6	7	6	8	10	8	12	12	10	6,3	8,6	11,3	8,7	0,6
j	Doom Frame Work X Direction	10	6	6	14	10	12	18	14	18	7,3	12	16,6	12	2,4
k	Doom Direction Y Frame Work	10	8	11	14	10	12	18	14	18	9,6	12	16,6	12,3	1,3
l	Gordeng Work	4	4	5	5	6	6	8	10	10	4,3	5,6	9,3	6,05	0,6
m	Doom Roofing Work	12	13	13	14	15	15	16	18	20	12,6	14,6	18	14,8	0,7
n	Frame Assembly/Installation Work	4	3	3	5	4	4	7	7	8	3,3	4,3	7,3	4,6	0,4
o	Electrical Mechanical Jobs	1	1	1	2	4	1	4	7	4	1	2,3	5	2,5	0,4
p	Architectural Work	14	16	16	22	20	20	25	22	24	15,3	20,6	23,6	20,2	1,9

Kode	Job Descrip- tion	A			M			B			A	M	B	Te	V
		A	B	C	A	B	C	A	B	C					
q	Plumbing Work	1	1	1	2	3	3	4	7	6	1	2,6	5,6	2,8	0,6
Total (Critical Activities)														**128**	**15,7**

Standard and Variant Deviation

Based on the table above, the probability of the project planning time can be calculated as in the calculation below.

1. Standard Deviation(s)

S2 $= \sqrt{V}$

$= \sqrt{15{,}79}$

$= 3.9$

Probability Based on the PERT Method

The probability value is obtained after the calculation of the variant and standard deviation on the critical path. Furthermore, calculations are carried out with a value of T(d) or the target time for project completion based on PERT, which is 128 days

Z $= \frac{T(d)-Te}{S}$

$= \frac{128-128}{3{,}97}$

$= 0$

Based on the Z table of Normal Distribution, the probability of time-based on the PERT method planning is 0.5 or if used as a percentage, is 50%, which means that the opportunity for the project to be implemented according to the 128-day plan is 50%.

Critical Path Method (CPM)

In the calculation Critical path method (CPM), is divided into 3 parts, namely Network Planning, Critical activity, and Crashing Project (project acceleration).

Network Planning

The work network is the process of planning activities of the Facilities and infrastructure of the SMK Negeri 1 Garut (DOOM) construction project which starts from activity A to activity Q. The total duration of the development project is 126 days or 18 weeks. The following is a picture of the network of activities for the construction of facilities, and infrastructure of SMK Negeri 1 Garut (DOOM).

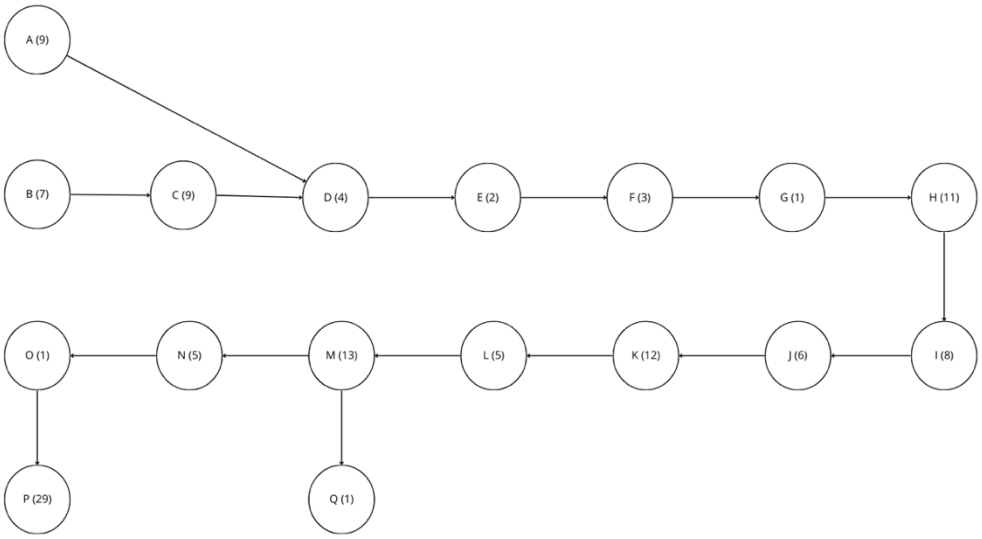

Figure 1
Activity Network

Critical Path

In the diagram of the work network of the Facility Development Project, Prasarana SMK Negeri 1 Garut (DOOM) there are several paths of activities/activities carried out, as follows.

The Facilities Development Project, SMK Negeri 1 Garut (DOOM) Infrastructure is known to have 4 activity paths. The critical path in the development project is on the B - C - D - E - F - G - H - I - J - K - L - M - N - O - P which is the longest of the four activity lines.

Table 2
Results of CPM Calculation for the Facilities Development Project, Infrastructure of SMK Negeri 1 Garut (DOOM)

Code	Job description	Predece -Ssor	Duration (Days)	E s	Ls	Ef	Lf	Tf	Informa-Tion
A	Preparatory Work	-	9	0	7	9	16	7	Non-Critical
B	Construction Work Safety Management System	-	7	0	0	7	7	0	Critical
C	Earthworks	B	9	7	7	16	16	0	Critical
D	Local Plate Foundations	A, C	4	16	16	20	20	0	Critical
E	Pedestal Column	D	2	20	20	22	22	0	Critical
F	Sloof	E	3	22	22	25	25	0	Critical
G	Beton Fc'	F	1	25	25	26	26	0	Critical

H	Doom Pillar Work	G	11	26	26	37	37	0	Critical
I	Pipe Beam Work	H	8	37	37	45	45	0	Critical
J	Doom Frame Work X Direction	I	6	45	45	51	51	0	Critical
K	Doom Direction Y Frame Work	J	12	51	51	63	63	0	Critical
L	Gordeng Work	K	5	63	63	68	68	0	Critical
M	Doom Roofing Work	L	13	68	68	81	81	0	Critical
N	Frame Assembly/Installation Work	M	5	81	81	86	86	0	Critical
O	Electrical Mechanical Jobs	N	1	86	86	87	87	0	Critical
P	Architectural Work	O	29	87	87	116	116	0	Critical
Q	Plumbing Work	M	1	81	115	82	116	34	Non-Critical

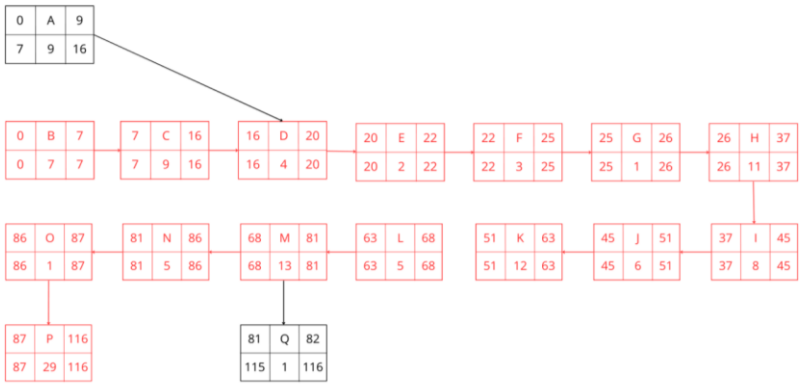

Figure 2
Critical Activities of the Facilities Development Project, Infrastructure of SMK Negeri 1 Garut (DOOM)

Costs and Probabilities Based on the CPM Method

The CPM method results in a project duration time of 116 days, which is faster than the duration of the project contract construction of facilities, and infrastructure of SMK Negeri 1 Garut (DOOM) so that the cost generated remains the same, which is Rp2,575,178,910.73 because there is no need to accelerate the project. The probability is

carried out by calculating the value of T(d) or the target time for project completion based on the CPM method, which is 116 days, as follows.

$$Z = \frac{T(d) - Te}{S}$$
$$= \frac{116 - 128}{3{,}97}$$
$$= -3{,}018986$$

Based on the Z table of Normal Distribution, the probability of time in accordance with the planning of the CPM method is 0.0013 or if used as a percentage, it is 0.13%, which means that the opportunity for the project to be implemented according to the planning for 116 days is 0.13%.

Crashing Project

Crashing Project is a way that can be done to cut the time of each critical activity so that a Crashing Project can be used as an alternative if the project does not run according to the predetermined time target. The way that can be done in accelerating the project in this method is by increasing the cost of additional workers and tools needed. Method Crashing Project can help contractors avoid penalties if the project does not run according to the specified contract time, the penalty figures given, especially in the government project for the construction of facilities and infrastructure of SMK Negeri 1 Garut (DOOM) are as follows.

Penalty = x Project Contract Value $\frac{1}{1000}$

= x 2,575,178,910.73$\frac{1}{1000}$

= IDR 2,575,178.91/day

To perform the Crashing Project as well as provide an alternative to accelerate each critical activity, then the opening of the self-estimated price document (HPS) and interviews with planning consultants are carried out to determine the price of each activity that can be accelerated. Here are the alternatives for each of the project's activities.

Table 3
Types and Prices of Adding Components in Crashing Project Facilities Development Project, Infrastructure of SMK Negeri 1 Garut (DOOM)

Code	Activity-Bag Type	Type Of Add-On	Unit	Unit Price	Quantity	Total Price	Quantity/Day	Duration (Days)		
								No-Rm-Al	Acceleration (Max)	To-Tal Duration
A	Preparatory Work	Workers/Helpers	Org	90.000	2	180.000	180.000	9	3	6

Code	Activity-Bag Type	Type Of Add-On	Unit	Unit Price	Quantity	Total Price	Quantity/Day	Duration (Days)		
								No-Rm-Al	Acceleration (Max)	To-Tal Duration
B	Construction Work Safety Management System	Workers/Helpers	Org	90.000	2	180.000	180.000	7	2	5
C	Earthworks	Digger	Org	120.000	4	480.000	480.000	9	1	8
D	Local Plate Foundations	Workers/Helpers	Org	90.000	2	180.000	180.000	4	1	3
E	Pedestal Column	Workers/Helpers	Org	90.000	2	180.000	180.000	2	1	1
F	Sloof	Blacksmith	Org	120.000	4	480.000	480.000	3	1	2
G	Beton Fc'	-	-	-	-	0	0	1	0	1
H	Doom Pillar Work	Crane	Hour	750.000	6	4.500.000	4.860.000	11	2	9
		Workers/Helpers Org		90.000	4	360.000				
I	Pipe Beam Work	Crane	Hour	750.000	4	3.000.000	3.240.000	8	1	7
		Electric Welder	Org	120.000	2	240.000				
J	Doom Frame Work X Direction	Crane	Hour	750.000	6	4.500.000	5.220.000	6	1	5

Code	Activity-Bag Type	Type Of Add-On	Unit	Unit Price	Quantity	Total Price	Quantity/Day	Duration (Days)		
								No-Rm-Al	Acceleration (Max)	To-Tal Duration
		Electric Welder	Org	120.000	6	720.000				
K	Doom Direction Y Frame Work	Crane	Hour	750.000	4	3.000.000	3.720.000	12	1	11
		Electric Welder	Org	120.000	6	720.000				
L	Gordeng Work	Workers/Helpers	Org	90.000	4	360.000	360.000	5	1	4
M	Doom Roofing Work	Blacksmith	Org	120.000	3	360.000	360.000	13	2	11
N	Frame Assembly/Installation Work	Electric Welder	Org	120.000	4	480.000	480.000	5	1	4
O	Electrical Mechanical Jobs	-	-	-	-	0	0	1	0	1
P	Architectural Work	Painter	Org	120.000	2	240.000	240.000	29	4	25
Q	Plumbing Work	-	-	-	-	0	0	1	0	1

Based on Table, there is an increase in the quantity of workers/handymen and heavy equipment used to accelerate the project in each critical activity so as to produce the amount of price required for each activity.

Table 4
Comparison of Crashing Project Costs and Fines in the Facilities Development Project, Infrastructure of SMK Negeri 1 Garut (DOOM)

Acceleration Duration	Acceleration				Amount Of Acceleration Fee	Amount Of Fine
	Code	Price/ Day	Quanti-Ty	Total		
1	B(1)	180.000,00	1	180.000	180.000	2.575.179
2	B(2)	180.000,00	2	360.000	360.000	5.150.358
3	B(2) + D(1)	180.000,00	3	540.000	540.000	7.725.537
4	B(2) + D(1) + E(1)	180.000,00	4	720.000	720.000	10.300.716
5	B(2) + D(1) + E(1)	180.000,00	4	720.000	960.000	12.875.895
	P(1)	240.000,00	1	240.000		
6	B(2) + D(1) + E(1)	180.000,00	4	720.000	1.200.000	15.451.073
	P(2)	240.000,00	2	480.000		
7	B(2) + D(1) + E(1)	180.000,00	4	720.000	1.440.000	18.026.252
	P(3)	240.000,00	3	720.000		
8	B(2) + D(1) + E(1)	180.000,00	4	720.000	1.680.000	20.601.431
	P(4)	240.000,00	4	960.000		
9	B(2) + D(1) + E(1)	180.000,00	4	720.000	2.040.000	23.176.610

Acceleration Duration	Acceleration				Amount Of Acceleration Fee	Amount Of Fine
	Code	Price/ Day	Quanti-Ty	Total		
	P(4)	240.000,00	4	960.000		
	L(1)	360.000,00	1	360.000		
10	B(2) + D(1) + E(1)	180.000,00	4	720.000	2.400.000	25.751.789
	P(4)	240.000,00	4	960.000		
	L(1) + M(1)	360.000,00	2	720.000		
11	B(2) + D(1) + E(1)	180.000,00	4	720.000	2.760.000	28.326.968
	P(4)	240.000,00	4	960.000		
	L(1) + M(2)	360.000,00	3	1.080.000		
12	B(2) + D(1) + E(1)	180.000,00	4	720.000	3.240.000	30.902.147
	P(4)	240.000,00	4	960.000		
	L(1) + M(2)	360.000,00	3	1.080.000		
	C(1)	480.000,00	1	480.000		
13	B(2) + D(1) + E(1)	180.000,00	4	720.000	3.720.000	33.477.326
	P(4)	240.000,00	4	960.000		
	L(1) + M(2)	360.000,00	3	1.080.000		
	C(1) + F(1)	480.000,00	2	960.000		

Acceleration Duration	Acceleration				Amount Of Acceleration Fee	Amount Of Fine
	Code	Price/ Day	Quanti-Ty	Total		
14	B(2) + D(1) + E(1)	180.000,00	4	720.000	4.200.000	36.052.505
	P(4)	240.000,00	4	960.000		
	L(1) + M(2)	360.000,00	3	1.080.000		
	C(1) + F(1) + N(1)	480.000,00	3	1.440.000		
15	B(2) + D(1) + E(1)	180.000,00	4	720.000	7.440.000	38.627.684
	P(4)	240.000,00	4	960.000		
	L(1) + M(2)	360.000,00	3	1.080.000		
	C(1) + F(1) + N(1)	480.000,00	3	1.440.000		
	I(1)	3.240.000,00	1	3.240.000		
16	B(2) + D(1) + E(1)	180.000,00	4	720.000	11.160.000	41.202.863
	P(4)	240.000,00	4	960.000		
	L(1) + M(2)	360.000,00	3	1.080.000		
	C(1) + F(1) + N(1)	480.000,00	3	1.440.000		

Acceleration Duration	Acceleration				Amount Of Acceleration Fee	Amount Of Fine
	Code	Price/ Day	Quanti-Ty	Total		
	I(1)	3.240.000,00	1	3.240.000		
	K(1)	3.720.000,00	1	3.720.000		
17	B(2) + D(1) + E(1)	180.000,00	4	720.000	16.020.000	43.778.041
	P(4)	240.000,00	4	960.000		
	L(1) + M(2)	360.000,00	3	1.080.000		
	C(1) + F(1) + N(1)	480.000,00	3	1.440.000		
	I(1)	3.240.000,00	1	3.240.000		
	K(1)	3.720.000,00	1	3.720.000		
	H(1)	4.860.000,00	1	4.860.000		
18	B(2) + D(1) + E(1)	180.000,00	4	720.000	20.880.000	46.353.220
	P(4)	240.000,00	4	960.000		
	L(1) + M(2)	360.000,00	3	1.080.000		
	C(1) + F(1) + N(1)	480.000,00	3	1.440.000		
	I(1)	3.240.000,00	1	3.240.000		

Acceleration Duration	Acceleration				Amount Of Acceleration Fee	Amount Of Fine
	Code	Price/ Day	Quanti-Ty	Total		
19	K(1)	3.720.000,00	1	3.720.000	26.100.000	48.928.399
	H(2)	4.860.000,00	2	9.720.000		
	B(2) + D(1) + E(1)	180.000,00	4	720.000		
	P(4)	240.000,00	4	960.000		
	L(1) + M(2)	360.000,00	3	1.080.000		
	C(1) + F(1) + N(1)	480.000,00	3	1.440.000		
	I(1)	3.240.000,00	1	3.240.000		
	K(1)	3.720.000,00	1	3.720.000		
	H(2)	4.860.000,00	2	9.720.000		
	J(1)	5.220.000,00	1	5.220.000		

Based on table above, the comparison of project acceleration costs is cheaper than the cost of the project's daily fines, then the critical path of the alternative calculation Crashing Project remains the same, i.e. in the activity B - C - D - E - F - G - H - I - J - K - L - M - N - O - P. So the optimal cost of the construction project of Facilities, Infrastructure of SMK Negeri 1 Garut (DOOM) if you want to be accelerated, the alternative that can be used is by Crashing Project/project acceleration.

Costs and Probabilities Based on the Project Crashing Method

Crashing Project is an acceleration of the results of the CPM method calculation so that it results in the project duration time as follows.

Crashing Project = CPM Duration – Maximum Acceleration Duration
= 116 – 19
= 97 Days

The duration is faster than the duration on the project contract construction of facilities, infrastructure of SMK Negeri 1 Garut (DOOM) so that the cost generated remains the same, which is Rp2,575,178,910.73 because there is no need to accelerate the project. Probability is done by calculating the value of T(d) or the project completion time target based on Crashing Project namely 97 days, as follows.

$$Z = \frac{T(d)-Te}{S}$$
$$= \frac{97-128}{3{,}97}$$
$$= -7{,}8$$

So probability of time according to Crashing Project which is as large as 3.095359E-15 This means that the project opportunity can be implemented according to the 97-day plan of 0.00000000000000003%.

Time, Cost, and Probability Based on Employment Contract

Project timing construction of facilities, infrastructure of SMK Negeri 1 Garut (DOOM) based on a work contract of 126 days at a cost of IDR 2,575,178,910.73. The following is the probability with the calculation of the value of T(d) or the target time for completing the project based on the work contract, which is 126 days, as follows.

$$Z = \frac{T(d)-Te}{S}$$
$$= \frac{126-128}{3{,}97}$$
$$= -0.503 \text{ (direct table calculation)}$$

Referring to the table above, the probability of time according to the planning that has been carried out is 0.3085 or if it is used as a percentage, which is 31%, which means that the chance of the project being implemented according to the plan for 126 days is 31%.

Time and Cost, for 95% Probability

As for If the project completion time goal construction of facilities, infrastructure of SMK Negeri 1 Garut (DOOM) for probability 95%, then it is known that the Z value is 1.65 so the calculation of T(d) is as follows.

$$T(d) = + \frac{S}{Z} Te$$
$$= + \frac{3{,}97}{1{,}65}\ 128$$
$$= 130 \text{ Days}$$

To achieve a probability of 95% of the duration of the project The construction of Facilities, Infrastructure of SMK Negeri 1 Garut (DOOM) takes 130 days which duration is 4 days longer than the work contract, so as an alternative acceleration the project cost can be calculated as follows.

95% probability cost = Normal project cost + Acceleration cost

= 2.575.178.910,73 + 720.000

= 2,575,898,910.73

With this calculation, the project cost construction of Facilities, Infrastructure of SMK Negeri 1 Garut (DOOM) for a probability of 95% worth Rp2,575,898,910.73.

Conclusion

Based on the analysis of project planning using the Critical Path Method (CPM) and Program Evaluation Review Technique (PERT), the following conclusions can be drawn: The facility construction project for SMK Negeri 1 Garut (DOOM) is estimated to take 128 days with a 50% probability using the PERT method. The critical path for the project is identified along the activity sequence B - C - D - E - F - G - H - I - J - K - L - M - N - O - P, which represents the longest duration path. Using the CPM method, the project duration is calculated to be 116 days with a total cost of IDR 2,575,178,910.73 and a 0.13% probability. After project time crashing, the duration is reduced to 97 days with the same cost and an extremely low probability of completion at 0.00000000000000000003%. According to the contract terms, the project is expected to last 126 days at a cost of IDR 2,575,178,910.73 with a 31% probability. Lastly, with a 95% probability, the project duration is estimated at 130 days, requiring a total accelerated cost of IDR 2,575,898,910.73.

Bibliography

Asyrofi, H. R., & Arumsari, P. (2023). Comparative analysis of CPM, PDM and PERT method on the duration of bridge work (Case study: Gelam Bridge Project). *IOP Conference Series: Earth and Environmental Science*, *1169*(1), 12011.

Bomantara, G. K. (2024). *Analisis Pengendalian Risiko Keterlambatan Penyelesaian Proyek Pada Pembangunan Blud Rumah Sakit Umum Daerah Kabupaten Pacitan*. Universitas Islam Indonesia.

Hrp, W. A. A., & Anas, N. (2024). The Effect of Sicabox Media on Students' Scientific Thinking Ability on the Material of the Properties of Light in MI. *Didaktika: Jurnal Kependidikan*, *13*(2), 2709–2716.

Iwano, E. R. M., Tjakra, J., & Pratasis, P. A. K. (2016). Penerapan Metode CPM pada Proyek Konstruksi (Studi Kasus Pembangunan Gedung Baru Kompleks Eben Haezar Manado)(Application of the CPM Method in Construction Projects (Case Study of the Construction of a New Building at the Eben Haezar Manado Complex). *J. Sipil Statik*, *4*(9), 551–558.

Kuswanto, A., & Qonita, A. (2024). Team Problem-Solving with Agile Business Process to Improve Employee Performance Using NVIVO Analysis at PT XYZ. *Journal of Advances in Accounting, Economics, and Management*, *2*(1), 16.

Putra, A. A. M., & Fauji, D. A. S. (2023). Application Of Project Management By Cv Duta Jaya Tehnic Kediri Using Cpm-Pert Method In Deep Well Drilling Project. *Proceeding International Conference on Economy, Management, and Business (Volume 1, 2023)*, *1*(1), 165–174.

Simanjuntak, E., & Manurung, H. R. (2024). Factors Related To The Utilization Of Health Services In The Sinunukan Health Center In Mandailing Natal District Of 2023: Factors Related To The Utilization Of Health Services In The Sinunukan Health Center In Mandailing Natal District Of 2023. *Mitra Husada Health Internasional Conference (MIHHICo)*, *4*(1), 535–541.

Statistik, B. P. (2014). Statistik Indonesia 2014, Statistical Yearbook of Indonesia 2014. *BPS Statistic Indonesia*.

Verianty, W. A. (2023). OPM adalah Organisasi Papua Merdeka, Pelajari sejarah Terbentuknya. *Retrieved from Liputan*, *6*.

Wahjono, S. I., Marina, A., Perumal, S. D. A., & Wardhana, A. (2016). The impact of performance appraisal on job satisfaction with quality of supervisor-employee as a moderating variable at state owned company. *International Journal of Advanced Scientific Research & Development*, *3*(4), 224.