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Development Project Evaluation Tebangi Besar–Kayu Agung Lampung Toll Road

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ABSTRACT

Project management is a process of activities to manage organizational resources owned by the company to achieve certain goals. The Terbangi Besar-Kayu Agung Lampung toll road construction project is a project that must be completed in a short time. This study has a purpose to evaluate the performance of the construction project of the Terbangi Besar-Kayu Agung Lampung toll road using the PERT and CPM methods with a toll road length of 189.2 km (117.6 miles). Based on the results obtained by using these two methods, the project completion time which was originally 238 days can be completed in just 119. There are several alternative proposals. The alternative proposal by adding work shifts that have crashed 32 times has an optimal cost of IDR 39,154,229,627.03 and an optimal time of 119 days. While the alternative of increasing the capacity of the equipment produces an optimal time of 189 days and an optimal cost of IDR 39,205,747,076.44 with the crashing process reaching 12 times of crashing. The Toll Road Development Project Planning is scheduled to have a normal time to work for 238 days at a total cost of IDR 39,349,097,164.38.

Keywords: Project management, critical path method, network diagram, crash program, project evaluation, review technique

Introduction

Projects that are following the planned objectives, the project must be processed with good professional and weighty management. Therefore, in starting and completing a project it is necessary to plan, organize, direct, coordinate, and supervise as best as possible. Good planning is required in development, among others by considering time and cost-efficient, and good quality.

The construction project of Tebangi Besar-Kayu Agung Lampung Toll Road is a project that must be completed with the shortest possible time and by utilizing the existing resources as much as possible. This study aims to evaluate the performance of the construction project of Terbangi Besar-Kayu Agung Lampung toll road with a toll road length of 189.2 km (117.6 miles).

In this study, CPM and PERT methods were chosen because in some studies this method proved to be applicable in some scheduling cases. CPM and PERT methods are widely used in previous studies and have been shown to provide optimal results. The CPM and PERT methods to schedule home development projects, Yuniarti and Djonaedi (2020) which use methods to streamline the production process, Setiawati (2017) and Ba'Its et al. (2020) which use both methods in scheduling construction projects.

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Study Literature

Project management

Suharto said that project management (2017) is a series of planning, organizing, leading, and controlling processes both in terms of activities and resources of the project in achieving certain project objectives.

Critical path method

According to Banjarnahor and Pristiwanto (2018), CPM critical path method (CPM) is a project management model that prioritizes cost as an object that is analyzed. CPM is a network analysis that seeks to optimize the total cost of a project through a reduction in the total completion time of the project. Using the CPM method can also save time in completing different stages of a project.

Duration of activities

The duration of an activity in a network method is the length of time it takes to perform an activity from start to finish. The period is generally expressed by the hour, day, or week. Duration calculation in the CPM method is used to estimate the completion time of the activity, namely using a single duration estimate.

Critical path

Render and Jay argues that (Ilhami et al., 2019) the critical path is a series of activities of a project that cannot be delayed in its implementation time which shows interconnected relationships with each other.

Activity schedule

According to Ihwanuddin (2018) to know the critical path then we will calculate the two start and end times for each activity. Several criteria need to be calculated, namely:

a. Earliest start (ES), i.e. the previous time an activity can be started, assuming all predecessors are completed.
b. Earliest finish (EF), i.e. the previous time an activity can be completed.
c. The last start (LS), which is the last time an activity can be started so as not to delay the completion time of the entire project.
d. The last finish (LF), i.e. the last time an activity can be completed so that there is no need to delay the overall completion time of a project.

Project Evaluation and Review Technique (PERT)

According to Levin and Krikpatrick, PERT is a method that aims to reduce delays, as well as disruptions and production conflicts, coordinate and synchronize as part of an entire work and also in accelerating the completion of a project (Utomo et al., 2020). According to Heizer the CPM (Critical Path method) method is a critical path method developed in the 1950s to make it easier for managers to schedule, monitor, and control large and complex projects (Hermawan, 2017). The PERT and CPM equations both measure the completion time of a project and recognize critical paths and slack.

Activity on node

One of the project's working networks is the AON network or activity on node (AON) In the AON approach, a circle or node indicates an activity, while an arrow identifies the relationship between several activities and the order of those activities. Activity is the work required in completing a project. Travel points as markers of an event beginning and end on one or more activities. To identify travel points and activities can use a network to make it easier to understand and add other information such as order and duration.

Research Methods

The methods used in this study are the Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT). The steps are as follows:

Data collection that includes work data:

a. land clearing
b. demolition of land
c. drainage
d. aggregate foundation
e. hardening, structure
f. lighting

The percentage relationship of work achieved with the working time monitored through S-Curve. Define the process of processing data in the field by the purpose and decision-making needs. Does the predecessor match the curve S otherwise Return to the curve S, if yes proceed to the next process.

Calculation of time and cost under normal conditions and in crash conditions. Normal time is the time required by a project in carrying out a series of activities until completion without considering the normal cost resources and direct costs incurred during the completion of project activities by normal time. Crash time is the shortest time in completing a project technically well, in this case, is the resource is not as a cost barrier in accelerating the completion time has no effect on the resource.

At this stage will be conducted analysis and discussion on calculations using pert and CPM methods. Conclude research that has been done and provide advice for further research

Result and Discussion

Data collection

The data obtained are as follows:

Table 1. Project work and volume details

No	Describe Jobs	Servings of Japek Zona 2	
		Price (Rp)	Weight (%)
1.	Public	13,596,307,337.06	1,95730
2.	Workplace cleaning	5,137,688,014.87	0,73960
3.	Demolition	44,094,902.56	0,00630
4.	Land Works	294,690,805,337.29	1,22890
5.	Excavation Structure	4,831,819,855.80	0,69560
6.	Drainase	9,062,475,210.91	1,30460
7.	Subgrade	1,042,730,267.50	0,15010
8.	Aggregate Foundation Layer	28,903,814,279.97	4,16100
9.	Pavement	133,713,596,132.98	19,24940
10.	Concrete Structure	145,043,811,427.89	20,83100
11.	Other jobs	53,171,178,970.51	7,65450
12.	Lighting, Traffic lights & Electric pek	2,796,984,179.25	0,40270

Source: Data processing

Determining critical paths

In Table II, there can be some critical paths on this project that if there is a delay in activity in the path, it will cause the project to become more as well as completion.

Table 2. Critical paths

Code activity	duration (day)	EET		LET		Total Float	Infor-mation
		EETi	EETj	LETi	LETj		
A	B	C	D	E	F	G = F-C-B	H
A1	46	0	40	0	86	46	
B1	56	0	48	0	84	20	
B2	56	0	48	0	84	20	
C1	**124**	**0**	**124**	**0**	**124**	**0**	**Critical**
C2	**124**	**0**	**124**	**0**	**124**	**0**	**Critical**
C3	84	56	140	84	238	98	
C4	84	56	140	84	238	98	
D1	56	0	56	0	112	56	
D2	56	0	56	0	112	56	
D3	56	0	56	0	112	56	
D4	56	0	56	0	112	56	
D5	28	56	84	84	112	28	
E1	133	0	133	0	238	105	
E2	133	0	133	0	238	105	
E3	133	0	133	0	238	49	
E4	56	133	189	238	238	49	
E5	56	133	189	238	238	49	
E6	56	133	189	238	238	49	
E7	56	133	189	238	238	49	
E8	56	133	189	238	238	49	
E9	56	133	189	238	238	49	
E10	56	133	189	238	238	49	
E11	56	133	189	238	238	49	
E12	56	133	189	238	238	49	
E13	56	133	189	238	238	49	
F1	126	56	182	84	238	56	
G1	126	84	210	84	238	28	
G2	126	84	210	112	238	28	
H1	56	133	189	238	238	49	
H2	56	133	189	0	238	49	
H3	56	133	189	84	238	49	
H4	56	133	189	0	238	49	
H5	56	133	189	84	238	49	
H6	**126**	**112**	**238**	**112**	**238**	**0**	**Critical**
H7	**126**	**112**	**238**	**112**	**238**	**0**	**Critical**

Accelerated activity calculation

Table III follows is the result of the calculation of accelerated activities (Crash Program). It can be seen in the table that the shortest total duration is 119 days while the longest is 238 days.

Table 3. Crash program

Code Activity	Normal		Crash		workforce		Total Duration
	m3/day	Duration (day)	m3/day	Duration (day)	Shift 1	Shift 2	
C1	1135.07	112	2270.14	56	4	4	238
C2	42.97	112	85.95	56	3	3	210
B2	10.71	56	21.43	28	4	4	210
G2	46.21	126	92.43	63	5	5	210
G1	38.76	126	77.52	63	5	5	189
E4	2.11	56	4.21	28	5	5	189
E7	0.04	56	0.07	28	4	4	189
E8	0.04	56	0.07	28	4	4	189
E9	0.13	56	0.25	28	4	4	189
E10	0.04	56	0.07	28	4	4	189
H1	429.52	56	859.04	28	4	4	189
H2	104.45	56	208.89	28	4	4	189
E11	2.7	56	5.39	28	4	4	189
E12	30.89	56	61.79	28	4	4	189
E13	17.86	56	35.71	28	4	4	189
H3	61.98	56	123.96	28	5	5	189
H4	14.48	56	28.96	28	5	5	189
H5	4.77	56	9.54	28	2	2	189
E1	7.52	133	15.04	67	5	5	189
E2	1.84	133	3.68	67	5	5	189
E3	0.3	133	0.6	67	5	5	182
F1	506.63	126	1013.25	63	3	3	182
H6	43.98	126	87.97	63	10	10	182
H7	15.54	126	31.07	63	8	8	147
B1	12.2	56	24.39	28	6	6	133
A1	1319.6	42	2639.19	21	4	4	123
E6	0.13	56	0.26	28	9	9	123
E5	1.57	56	3.14	28	9	9	119
D1	17.86	56	35.71	28	2	2	119
D2	4.38	56	8.75	28	4	4	119
D3	0.71	56	1.43	28	4	4	119
D5	9.75	28	19.5	14	5	5	119

Cost slope

Cost slope or an accelerated activity and total direct and indirect costs. The following are the results of the total cost of activities that have shortened the duration with alternative shift work.

Table 4. Cost slope

Phase	Duration	Cost slope (IDR/day)	Tot. Float (Day)	ldditional Cost (Rp)	Direct Cost (IDR)	Indirect Cost(Rp)	Total cost (IDR)
Usual	238				35,133,122,468	4,215,974,696	39,349,097,164
C1	238	55,956,763	56	3,133,578,757	38,266,701,225	4,215,974,696	42,482,675,921
C2	210	55,977,763	56	3,134,754,757	38,267,877,225	4,133,308,525	42,401,185,751
B2	210	12,325,431	28	345,112,077	35,478,234,546	4,133,308,525	39,611,543,071
G2	210	32,093,474	63	2,021,888,872	37,155,011,340	4,133,308,525	41,288,319,865
G1	189	5,460,633	63	2,021,888,872	35,155,011,340	4,071,308,897	41,226,320,238
E4	189	5,460,633	28	152,897,746	35,286,020,215	4,071,308,897	39,357,329,112
E7	189	5,460,633	28	152,897,746	35,286,020,215	4,071,308,897	39,357,329,112
E8	189	5,460,633	28	152,897,746	35,286,020,215	4,071,308,897	39,357,329,112
E9	189	5,460,633	28	152,897,746	35,286,020,215	4,071,308,897	39,357,329,112
E10	189	5,460,633	28	152,897,746	35,286,020,215	4,071,308,897	39,357,329,112
H1	189	7,706,450	28	215,780,604	35,348,903,072	4,071,308,897	39,420,211,970
H2	189	7,706,450	28	215,780,604	35,348,903,072	4,071,308,897	39,420,211,970
E11	189	521,318	28	14,596,904	35,147,719,372	4,071,308,897	39,219,028,269
E12	189	521,318	28	14,596,904	35,147,719,372	4,071,308,897	39,219,028,269
E13	189	521,318	28	14,596,904	35,147,719,372	4,071,308,897	39,219,028,269
H3	189	124,730,069	28	3,492,441,958	38,625,564,427	4,071,308,897	42,696,873,324
H4	189	124,730,069	28	3,492,441,958	38,625,564,427	4,071,308,897	42,696,873,324
H5	189	124,730,069	28	3,492,441,958	38,625,564,427	4,071,308,897	42,696,873,324
E1	189	5,543,370	66	365,862,465	35,498,984,934	4,071,308,897	39,570,293,831
E2	189	5,543,370	66	365,862,465	35,498,984,934	4,071,308,897	39,570,293,831
E3	182	2,771,685	66	182,931,232	35,316,053,701	4,050,642,355	39,570,293,831
F1	182	18,901,298	63	1,190,781,816	36,323,904,284	4,050,642,355	40,374,546,639
H6	182	125,054,787	63	7,878,451,595	43,011,574,064	4,050,642,355	47,062,216,419
H7	147	4,840,742	63	304,966,786	35,438,089,255	3,947,309,642	39,385,398,897
B1	133	6,969,001	28	195,132,045	35,328,254,513	3,905,976,556	39,234,231,070
A1	123	10,350,541	21	217,361,364	35,350,483,832	3,876,452,924	39,226,936,757
E6	123	5,515,986	28	154,447,631	35,287,570,099	3,876,452,924	39,164,023,023
E5	119	5,587,988	28	154,463,687	35,289,586,155	3,864,643,471	39,154,229,627
D1	119	11,914,672	28	333,610,839	35,466,733,307	3,864,643,471	39,331,376,779

The table obtained from crashing produced an optimal cost of 39,154,229,627.03 with an optimal time of 119 days. Cost slope per day was 5,587,988, additional cost was 154,463,687, direct cost was 35,289,586,155, and indirect cost was 3,864,643,471. Indirect costs are costs related to administrative and supervisory coordination tasks while direct Biya is the cost associated with the wages of equipment materials.

Cost and optimal time comparison analysis

Following the initial planning of the Toll Road Construction project that took 248 days with a total cost of IDR 39,349,097,164.38, which was a direct cost of IDR 35,133,122,468.20 and indirect costs of IDR 4,215,974,696.18. After crashing with two alternatives, it is obtained a shorter duration and a more affordable cost than before.

Table 5. Cost & time comparison

Activity	Time (day)	Price (IDR)
Normal	238	39,349,097,164
Alternative shift work	119	39,154,229,627
Alternative tool capacity addition	189	39,205,747,076

Conclusion

Following the analysis and processing of the data above, the following conclusions can be drawn:

1. Following the calculation of pert and CPM the project where the completion can be scheduled for 119 days from the predetermined time of 238 days so that it is more efficient 119 days earlier than scheduled. Then more effective 50% of the set time
2. Alternative addition of work shifts that have been crashed as much as 32 times has an optimal cost of IDR 39,154,229,627.03 and an optimal time for 119 days. However, the alternative addition of tool capacity resulted in an optimal time of 189 days and an optimal cost of IDR 39,205,747,076.44 with a crashing process that reached 12 times crashing. Of the two optimum conditions, the most optimal cost and time are chosen for the Toll Road Construction Project project by using acceleration with alternative shift workers whose productivity is twice the normal productivity.
3. Toll Road Construction Project Planning was originally scheduled to have a normal working time of 238 days with a total cost of IDR 39,349,097,164.38. The time and cost of the project decreased after the acceleration with the method of time-cost trade-off, acceleration carried out using the two alternatives is done until it reaches the critical path saturated. The first alternative is the addition of work shifts by generating a final total cost of IDR 39,154,229,627.03 with a project completion time of 119 days. Compared to normal conditions, the alternative saves time for 119 days with a difference of IDR 194,867,537.35. However, for alternative capacity addition, the tool has a time difference of 49 days by saving costs of IDR 143,350,087.94.

References

Ba'Its, H. A., Puspita, I. A., & Bay, A. F. (2020). Combination of Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM) for project schedule development. *International Journal of Integrated Engineering, 12*(3), 68-75.

Banjarnahor, W. W., & Pristiwanto, P. (2018). Analisis pelaksanaan proyek perumahan dengan metode CPM (Critical Path Method) Dan Pert (Project Evaluation and Review Technique) (Studi Kasus Proyek Perumahan Citra Turi). *Pelita Informatika: Informasi dan Informatika, 6*(3), 363-368.

Hermawan, H. (2017). Analisis network planning dengan CPM (Critical Path Method) dalam rangka efisiensi waktu dan biaya proyek pembuatan kandang ayam koloni karya remaja. *Matriks Teknik Sipil, 1*(4), 408-416. Doi: https://doi.org/10.20961/mateksi.v1i4.37494

Ihwanuddin, M. N. (2018). Analisa penjadwalan proyek pipa carbon dengan metode fuzzy logic application for schedulling. *MATRIK (Manajemen dan Teknik Industri-Produksi), 17*(2), 29-42.

Ilhami, R., Utama, L., & Khaidir, I. (2019). Perancanaan penjadwalan waktu dengan metoded jalur kritis (Critical path method) Studi Kasus RSUD DR. Rasidin Padang. Abstract of Undergraduate Research, Faculty of Civil and Planning Engineering, *Bung Hatta University, 2*(2), 1-5.

Setiawati, S. (2017). Penerapan metode CPM Dan PERT pada penjadwalan proyek konstruksi (Studi kasus: Rehabilitasi/perbaikan dan peningkatan infrastruktur irigasi daerah Lintas Kabupaten/Kota DI Pekan Dolok*). Jurnal Teknik Sipil USU, 6*(1), 1-5.

Utomo, G., Hendriyani, I., & Aida, S. N. (2020). Evaluasi pelaksanaan proyek drainase dengan metode CPM Dan PERT. *Media Ilmiah Teknik Sipil, 9*(1), 44-52

Yuniarti, E., & Djonaedi, E. (2020). Optimizing Production Time in Book Printing using PERT/CPM. *In Proceedings of the 8th Annual Southeast Asian International Seminar (ASAIS 2019),* 102-107