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Analysis of Time Comparison and Costs of Implementing Road Implementation with Time Cost Trade-Off Method

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Abstract

Project for the construction of the Gunungsari Banjar Sugihan - Kandangan diversion channel, Surabaya, in the implementation of this project there was a delay in how many works. One way to anticipate this delay is by accelerating it using the Time Cost Tread Off method, through alternative working hours (overtime) and additional labor. The method is used so that the project can run smoothly and so that the project can be accelerated in completion. Time-Cost Trade-Off analysis, better known as TCTO. jobs included in the critical cross and jobs that are not allowed to delay are as follows: Urugan Sirtu (solid), Lean concrete fc 10 Mpa work, Rigid pavement fc 30 Mpa work finishing growing, iron beginning work.

Keywords: *Construction, Comparison, Road Implementation, Time-Cost Trade-Off Analysis.*

1. Introduction

In a study on the Gunungsari Banjar Sugihan - Kandangan Surabaya diversion channel project, the author will discuss the plan to calculate the duration of the work so that it can minimize the things that will happen due to heavy traffic, as well as technical and non-technical constraints that affect the smooth operation of the project [1] [2].
Projects can be defined as activities that take place within a limited period by allocating certain resources and are intended to produce products or deliverables whose quality criteria have been clearly outlined [3].
From the background above, the author wants to apply an effective time calculation method so that the Gunungsari Banjar Sugihan - Kandangan diversion channel Development Project can be completed within a predetermined time, and can function optimally according to what has been planned using Time Cost Trade-Off Analysis, or better known as TCTO [4] [5] [6].

Problem Formulation :
1. How to determine a job that uses the Time-Cost Trade-Off method?
2. How does the change in the amount of time and cost of project work implementation after additional working hours (overtime)?
3. How does the change in the amount of time and cost of implementing project work after the addition of workers?
4. How to determine the most effective method for the project?

2. Literature Review

Accelerating the project completion time is an attempt to complete the project earlier than the completion time under normal circumstances. There are times when the project schedule must be accelerated with various considerations from the project owner [5]. That the maximum acceleration duration is limited by the project area or work location, there are four factors that can be optimized to carry out the acceleration of activity, namely increasing the number of workers, overtime schedule, use of heavy equipment, and changing construction methods in the field [7].
There are several alternatives to optimize the time and cost of project completion that can be done like this Implementation of Additional Working Hours (Overtime): Implementation of Additional Workforce, Shorten Project Completion Time [8].
Time cost trade-off is an analysis method that will be used to speed up the project completion time by using a schedule compression method in order to get a more profitable project in terms of time and cost [9] [10]. Aim to get a project of an acceptable duration and minimize project costs [11].
From the description above, the procedures for shortening time and costs are also detailed as follows:
a. Calculating the completion time of the project, identifying floats, and determining the critical path by using the scheduling method that will be used.

b. Determine the normal cost of each inactivity.
c. Determine the accelerated costs of each in the activity.
d. Calculating the cost slope of each component in the activity.
e. Speed up the time of activities starting from the point of view of critical cross-cutting activities that have a low cost slope.
f. Calculation of direct costs and costs that are not directly on the project.
g. Add up direct costs and indirect costs to find costs before the time that you want to be wanted.
h. Check the total cost graph to reach the optimum timeframe, which is the project completion period with the lowest cost.

3. Method

At the time of conducting this research there were preparations to deepen the knowledge that was related to the topic of this research as well as things that would be done in the preparation stage, namely literature study on problems related to the time cost trade off method, Determining what is needed in the data., Looking for agencies that will be used as sources [10].
Secondary data is used as a source of data in conducting research. Data obtained from secondary data sources are the Budget Plan (RAB), Scheduling (Time Schedule) [12].

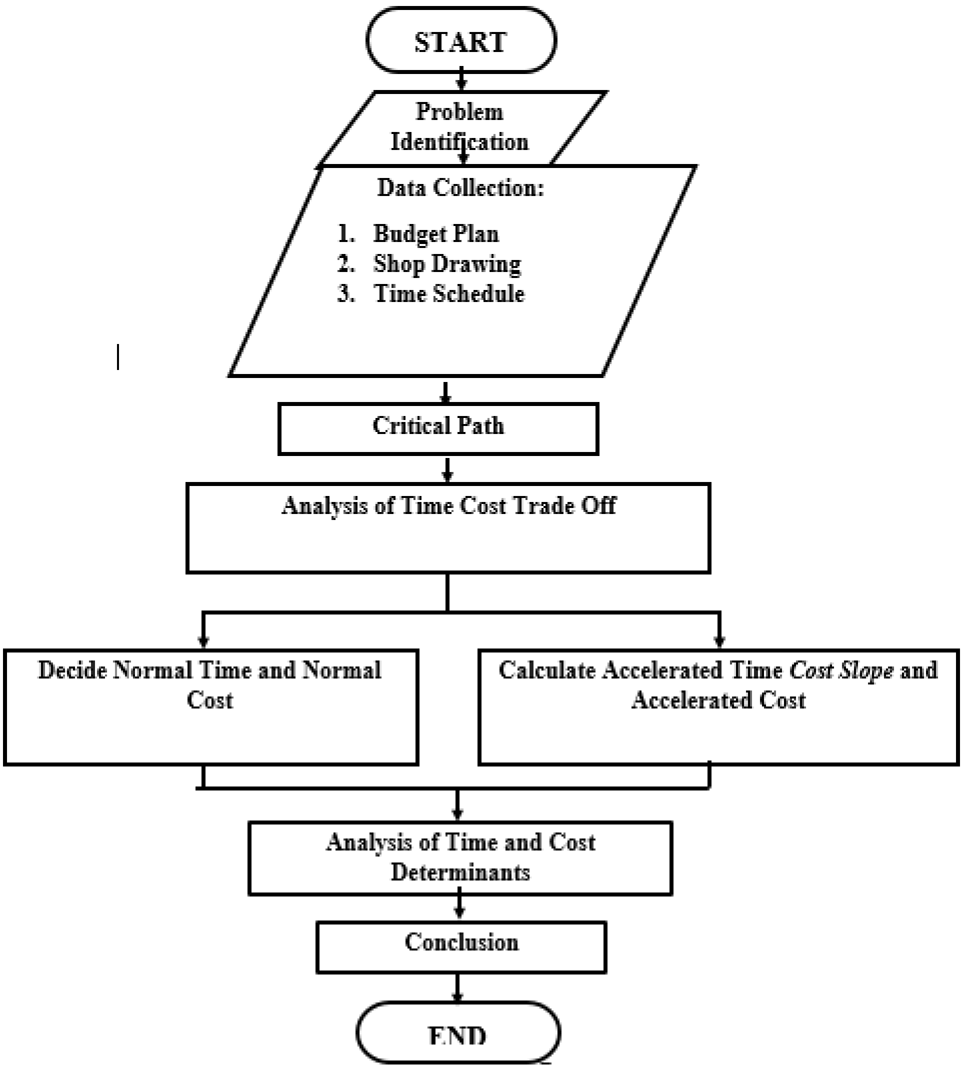

Fig 1. Research Flowchart

4. Results and Discussion

The project which is made into a typical study in this research is the Gunungsari Banjar Sugihan - Kandangan diversion channel development project, Surabaya, which is a channel construction project in Surabaya, East Java. With the existence of this road project, it is a means of supporting the activities of the surrounding community and general public road users to improve the smooth flow of traffic, goods, and services [13].
From the project data obtained, there are 4 jobs with critical crossings that will be analyzed in this study, namely Urugan Sirtu (solid) work, Lean Concrete Concrete fc 10 Mpa, Rigid Pavement fc 30 Mpa Finishing Grooving, and Iron Begisting work using two the alternative implementation is to increase working hours (overtime) and additional workforce and analyzed using the time and cost exchange method (Time Cost Trade-Off) [14] [15].
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Before calculating the Crash Duration and Crash Cost, a Crashing plan or acceleration plan is carried out, especially for jobs that are on critical trajectories, namely Sirtu Urugan Work (solid), Lean Concrete Work for fc 10 Mpa, Rigid Pavement fc work 30 Mpa Finishing Grooving and Work Iron Begisting. Crashing plans or acceleration plans are carried out based on resource requirements for each work whose duration can be accelerated. But it can also be based on the length of duration and the volume of work. This acceleration is sought for the most optimum in terms of cost and time because it needs to be combined between accelerating in terms of human resources by adding labor and increasing work hours (overtime). This acceleration should be done on a critical trajectory so that it can reduce the total project duration. The assumptions used to simplify the acceleration process are additional workforce, additional working hours (overtime)

Determine the Crash Duration

the time needed to complete the work after the optimum addition of working hours (overtime), namely the Crash Duration. Before calculating the Crash Duration, you need to look for daily productivity, hourly productivity, and daily productivity after the Crash (acceleration). Productivity is defined as the ratio between output and input or the ratio between production output and total resources used. Post-Crash daily productivity is the ability to complete a certain volume of work each day after acceleration.

This is calculated based on the alternative acceleration used, including increasing the optimum working hours (overtime). The addition of working hours (overtime) results in an increase in work productivity so that the time needed to complete the work becomes faster than before

Determining Normal Cost (Normal Cost)

The costs needed to complete the work within the normal time period. Here are some of the steps:

a. Determine the unit price of workers' wages
b. Calculating Normal Cost of Hourly Work
c. Calculating Normal Cost of work per day
d. Calculating Normal Cost

Determine Cost Acceleration (Crash Cost)

Crash costs are incurred after acceleration is carried out which is the total direct cost to complete the work. Where these costs are calculated from the sum of direct costs and total overtime costs of workers. Automatically, with this acceleration, the value of direct costs for each work item will be greater than the previous direct costs.

a. Calculating overtime pay
In calculating overtime wages according to (Decree of the Minister of Manpower and Transmigration of the Republic of Indonesia Number Kep.102 / MEN / VI / 2004) articles 3.7 and article 11, for overtime working hours it is 1.5 (one and a half) times one hour's wages. Whereas each hour of overtime work is 2 (two) times one hour's wages.

b. Calculate the crash cost of workers per day
The crash cost of workers per day can be obtained by adding the normal cost of workers per day with the cost of overtime per day.

c. Calculating crash costs
Crash cost can be obtained by multiplying the Crash cost of workers per day by the crash duration.

Determine the Cost Slope

Cost Slope is a direct cost increment to speed up the activity of a one-time unit. The added cost is directly proportional to the value of the Crash cost. The greater the Crash cost and vice versa. The planned duration also affects the value of this acceleration cost.

Time-Cost Trade-Off (TCTO) Exchange Methods

After obtaining the value of the cost slope (additional costs due to acceleration) of each work activity, the next step is to analyze the time and cost exchange using the time-cost trade-off method. This analysis is carried out by means of compression (emphasis) on activities that are on the critical path. From the several stages of compression, the shortest time of the total cost will be sought. The following will describe the process of calculating the compression stage with the alternative of increasing work hours (overtime) and the addition of optimum labor with maximum crashing duration and minimal crashing duration.

Tabel 1. Additional Working Hours (Overtime)

Num	Accelerated Work	Volume	Normal Duration	Accelerated Duration	Normal Cost	Accelerated Cost
			(d)	(h / d)	(IDR)	(IDR)
1	Sirtu backfill (solid)	5072.43 m3	41	3 h + 41 d	193.060.308,00	122.571.984,00
2	Lean Concrete fc 10 Mpa	308.89 m3	41	3 h + 41 d	63.211.110,40	42.441.150,50
3	Rigid Pavement fc 30 Mpa Finishing Grooving	926.68 m3	41	3 h + 41 d	30.156.890,70	21.821.542,10
4	Steel Form	61.5 m1	34	3 h + 34 d	49.674.293,80	33.946.133,10

Tabel 2. Additional Workforce

Num	Accelerated Work	Volume	Normal Duration	Accelerate Duration	Normal Cost	Accelerated Cost
			(d)	(d)	(IDR)	(IDR)
1	Sirtu backfill (solid)	5072.43 m3	41	38	4.705.250,00	4.980.750,00
2	Lean Concrete fc 10 Mpa	308.89 m3	41	38	1.804.750,00	1.942.500,00
3	Rigid Pavement fc 30 Mpa Finishing Grooving	926.68 m3	41	38	978.250,00	1.116.000,00
4	Steel Form	61.5 m1	34	31	1.669.250,00	1.809.250,00

5. Conclusion

Based on the results of the analysis of the discussion, the suggestions that can be given from this study are as follows. For further research, it is recommended that additional working hours (overtime) can be compared between 1 hour, 2 hours and 3 hours to get efficient time and cost. Meanwhile, the addition of manpower can be compared between 1 day, 2 days and 3 days assuming acceleration time to get efficient time and cost.

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