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Research Paper

Optimization of Bridge Project Acceleration Using Crashing Method

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ABSTRACT: *The Malang regency government through the Public Works Department of Bina Marga every year gets priority in allocating budget for handling road and bridge infrastructure. The Kedungpedaringan Kepanjen area is a priority of the Malang regency government in the development of bridge infrastructure, because the road that crosses the bridge is the main access to the kepanjen ring which is very important as the main support in economic and social activities of the community. Bridge Construction is urgently needed, considering the existing condition of the landslide disaster occurred on the east side of the bridge and hindered the accessibility of the community because the volume of vehicles passing is very dense. In this study using Crashing method as an effort to accelerate the implementation of bridge construction. The results showed the duration of time required for the completion of the Mlaten bridge construction project can be accelerated on the work of Stiffner (120.14) which is on a critical trajectory from the original time of 8 weeks to 6 weeks and the need for additional labor as many as 8 people with details of 1 Foreman, 3 Blacksmiths and 4 workers. The need for additional construction costs required IDR. 163.786.179,19.*

KEYWORDS: *Crashing, Bridge, Acceleration*

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I. INTRODUCTION

The Government of Malang regency through the Public Works Department of Bina Marga annually gets priority in allocating the budget for the handling of road and bridge infrastructure in Malang regency. Kedungpedaringan Kepanjen area is a priority of Malang regency government in Bridge Construction, because the road that crosses the bridge is the main access of lingkar Kepanjen which is very important as the main support in economic and social activities of the community.

With the availability of good bridge infrastructure, it will support the smooth transportation, distribution and mobilization of goods and services which are important factors in improving the community's economy. This is in accordance with law No.38 on roads “ " roads as infrastructure for the distribution of goods and services are the lifeblood of society, nation, and state” [1].

To complete the work of the bridge infrastructure handling project has a certain planning and scheduling in the implementation of the project as a deadline. However, not infrequently the planning and implementation schedule that has been prepared is not in accordance with the work in the field, resulting in changes in various components of the project work, including in terms of project costs that have been planned will experience changes in cost overruns [2].

Crashing method is a way to estimate the variable cost in determining the maximum duration reduction with the most economical cost of activities that are still possible to be reduced [3]. Crashing is done so that the work is completed by cross-exchanging time and cost by increasing the number of work shifts, the number of working hours, the number of workers, the amount of material availability and the use of more productive equipment and faster installation methods as components of direct cost costs. The method is done by way of improved scheduling using network planning that is on a critical trajectory. The consequences of crashing are increasing direct costs such as the cost of workers ' wages and the addition of tools [4]. Crashing is a systematic and analytical process in a project that is centered on activities that are on a critical path. Crashing method is one of the right ways to speed up the duration of the project, the crashing process itself is a process of reducing or reducing the duration of a job that will affect the completion time of the project.

II. RESEARCH LOCATION

This research was conducted in Kedung Pendaringan Village, Kepanjen District, Malang regency. The object of research is a bridge that experienced a landslide disaster on the east side due to hydrometrological disasters. The location of the study is shown in Figure 1.

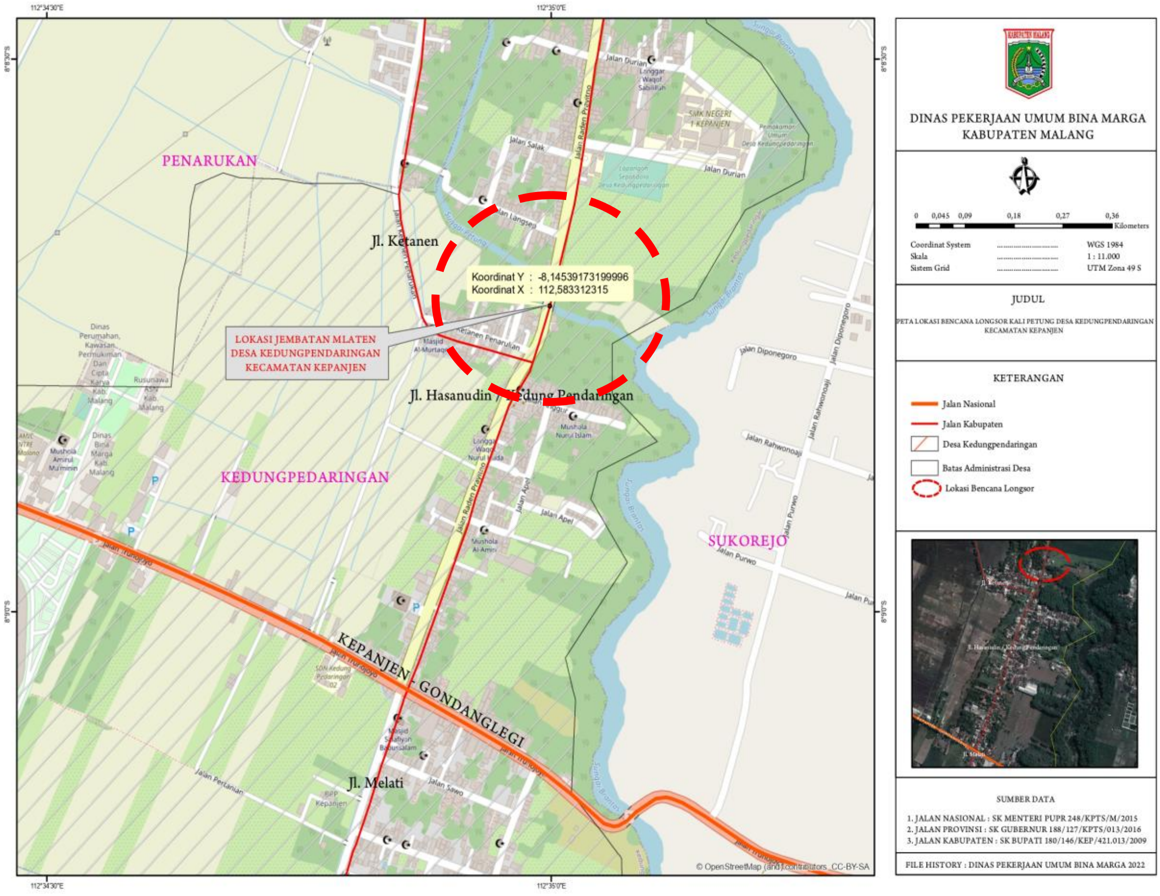

Figure 1: Bridge Location

III. RESULTS OF RESEARCH AND DISCUSSION

Acceleration of the Mlaten Kedungpedaringan Bridge project was carried out by Crashing method. In the process, this method describes the parts of the work in the project and rearranges it by inputting project data into the Microsoft Project program to get the critical path of the project in accordance with the dependency logic so that afterwards a working network can be created for this project.

The calculation uses data on time and cost of each of the parts of the activities that have been arranged according to the order of the process that can be from the Department of Public Works Bina Marga Malang. The Total completion of the project according to the contract for 140 calendar days whose work starts on August 3 - December 20, 2022 with the total cost of project work is IDR. 1,693,383,000.00.

In this subchapter will be presented data and tabulated calculations of job identification analysis, calculations are carried out with the help of Microsoft Excel and Microsoft Project 2000 programs. The duration of each work is obtained from the plan s Curve Mlaten bridge construction with rician work items as follows:

DIVISION 1. GENERAL

- Mobilization

DIVISION 2. CONSTRUCTION SAFETY MANAGEMENT SYSTEM (SMKK)

- Manufacturing procedure and work instruction
- Banner (Banner)
- APD, among others :
- Topi pelindung (Safety Helmet)

- Pelindung mata (Goggles, Spectacles)
- Sarung tangan (Safety Gloves)
- Rompi keselamatan (Safety Vest)
- Respiratory and mouth protection (mask, respirator mask)
- Full body Harness
- Asuransi(Construction All Risk/ CAR)
- Traffic control officer
- P3k equipment
- Cost of infectious outbreak health protocols (eg hand washing, swabs, vitamins during the covid-19 pandemic)
- Signposts
- Warning signs
- Information signs / Project signage
- Traffic cone
- Lights / temporary lighting equipment (rental)
- Environmentalists
- K3 Flag

DIVISION 3. DRAINAGE

- Manual excavation for drainage ditches and drains

DIVISION 4. EARTHWORKS AND GEOSYNTHETICS

- Common Minerals
- Sirtu

DIVISION 6. GRAINED PAVEMENT

- Cement Concrete Pavement

DIVISION 7. ASPHALT PAVEMENT

- Adhesive Layer-Liquid Bitumen/Emulsion
- Laston Lapis Aus (AC-WC)

DIVISION 8. STRUCTURE

- Concrete structure, fc ' 25 Mpa without reference
- Concrete, fc ' 15 Mpa without reference
- Plain Reinforcement Steel-BjTP 280
- Baja Tulangan Sirip BjTS 420A
- Preparation of structural steel Grade 250 (melting strength 250 MPa) - WF 800.300.14.26
- Diaphragm (iron elbow 100.100.10)
- Plat Elastomeric (tebal 18 mm)
- Connecting plate (18 mm thick)
- Stiffner (120.14)
- Boult & Nut (Baut & Mur)
- Installation Of Structural Steel
- Transportation of bridge materials provided by service users
- Concrete drill pole, diameter 400 mm
- Masonry
- Expansion Joint Tipe Baja Bersudut 90 X 90 X 6 mm
- Steel Coated Synthetic Rubber Elastomeric Anvil Size 450 Mm x 400 Mm x 45 Mm
- Backrest (Railing)
- Bridge Nameplate (Inscription)
- 75 Mm diameter steel drainage pipe
- Concrete Formwork for structures
- Scaffolding

DIVISION 9. BRIDGE REHABILITATION

- SMAW welding on Grade 30 steel

- Painting of steel structures in dry areas 80 microns thick

DIVISION 10. DAILY JOBS & MISCELLANEOUS JOBS

- Peg Director
- Painting

The results of Network Planning can be seen in Figure 2.

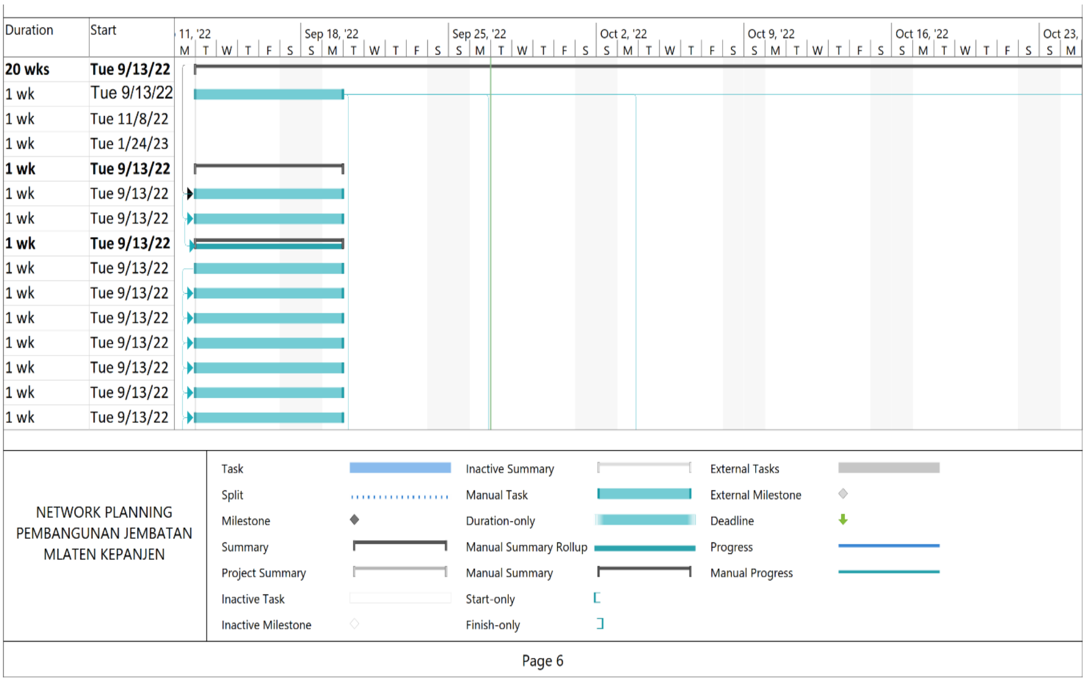

Figure 2: Network Planning

The critical path of the processed Microsoft Project software can be presented in Figure 3.

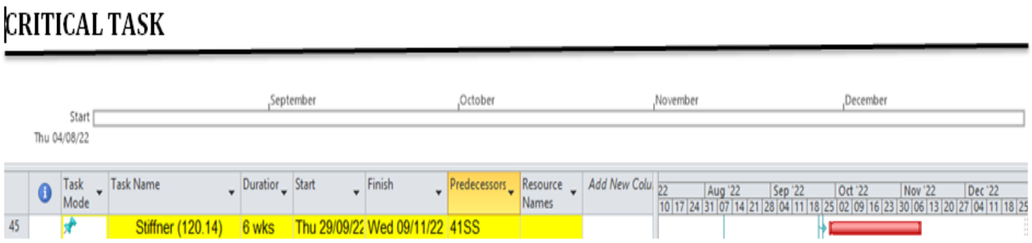

Figure 3: Critical Path

After the analysis of scheduling and critical path, the next step is to calculate the needs of the number of workers on the critical trajectory. The results of the calculation of Labor needs in Stiffner's work are shown in Table 1.

No.	Types Of Work	Man Power			Description
		Foreman	Blakckmith	Employees	
1	Stifner (120.14)	0.02959387	5.918775	7.8917	-
	Rounded to	***1***	***6***	***8***	

Table 1: Total Labor Requirement On Stiffner Jobs (120.14)

In Table 1 indicates that the need for the number of workers for Stiffner work items that are on a critical trajectory is 15 people, with details of 1 Foreman, 6 Blacksmiths and 8 workers. After getting the amount of

Labor needed on Stifner's job (120.14), duration acceleration is done using crashing method. The process of duration acceleration in this study was done by emphasizing the duration of activities on a critical trajectory with the addition of Labor. The decision to do crashing must consider the cost slope that occurs. The value of cost slope shows the increase in cost per day of each activity. The calculation is done by taking into account the addition of Labor. The results of the calculation of additional labor can be described in Table 2.

Man Power	Normal (persons)	40% Increase (persons)
Foreman	1	0.4 ≈ 1
Blacksmith	6	2.4 ≈ 3
Employees	8	3.2 ≈ 4

Table 2: Increase In Total Man Power At Stiffner Jobs (120.14)

Based on Table 2 shows that after the addition of Labor by 40%, get the number of labor needs for the acceleration of project implementation as many as 8 people with the details of the addition of the foreman needed 1 person, 3 people & workers 4 people in full shown in Table 3.

No.	Types Of Work	Man Power			Total Man Power	The Addition 40%			Total Man Power 40%
		Foreman	Blacksmith	Emplo yess		Foreman	Blacksmith	Employess	
1	Stifner (121.40)	1	6	8	15	1	2	3	6

Table 3: Details Of Adding Labour To Stiffner Jobs (120.14)

After calculating the addition of Labor, the next step is to calculate the productivity of the work as follows:
Productivity calculation for Stifner jobs (120.14)

Normal Productivity (Pn)

$$= \frac{Volume}{Duration}$$

$$= \frac{789{,}17\ kg}{8\ weeks} = 98{,}64625$$

From the calculation of productivity for work Stifner (120.14) obtained normal productivity (Pn), namely 98,64.
Produktivity Crashing

$$= \frac{Pn\ x\ (Total\ man\ power + Total\ Man\ Power\ 40\%)}{Duration}$$

$$= \frac{98.64625\ x\ (15 + 8)}{15}$$

$$= 151.2575833$$

Until crashing productivity obtained amounting to 151.2575833. The next step is to calculate the crash duration value. Calculation of crash duration is by dividing the volume of work with crashing productivity.

$$\text{Cd} = \frac{\text{Volume}}{(\text{produktivitas } crashing\,)}$$

$$\text{Cd} = \frac{789.17\ \text{kg}}{151.2575833}$$

= 5.2173913 ≈ 6 weeks

A period of time shortened from 8 weeks to 6 weeks is the shortest time to complete a job that is technically still possible. Recapitulation of normal duration with duration after crashing is presented in Table 4 recapitulation of normal duration with duration after crashing.

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No.	Types Of Work	Duration (weeks)	
		Normal	Crash
1	Stifner (120.14)	8	5.2173913 ≈ 6

Table 4: Recapitulation of Normal duration with duration after Crashing

Based on Table 4 obtained the duration of the crashing results that were originally at normal times for 8 weeks, can be accelerated to 6 weeks. Next, we will calculate the crash cost. To search amount of value crash cost then it takes a new coefficient value (OH) after the crash methoding.

Coeficient (OH) crash
= OH x (amount of additional labor)/amount of Labor)

Foreman Crash Coefficient = 1 x (1/2) = 0.5
Blacksmith Crash coefficient = 6 x (3/9) = 2.0
Worker Crash coefficient = 8 x (4/12) = 2.67
Total Crash Cost
Foreman = 0.5 x 145,000. 00 x 789.17
Blacksmith = 2.0 x 127,000. 00 x 789.17
Worker = 2.67 x 101,000. 00 x 789.17
Total = 57,214,825.00 + 200,449,180 + Rp212,549,787
= Rp 470,213,791.67

As for biaya for time shortened (Crash cost) amounting to IDR 470,213,791.67. these costs are total cost direct for finishing jobs with kurun time shortest. The next step is to calculate the cost slope.

Cost slope = (crash cost-normal cost)/(normal duration-crash duration)
= (470,213,791.67 - 14,462,399.43) / (8 - 5.714286)
= 455,751,392.24 / 2.782608696
= 163,785,656.59

After the comparison between difference cost for implement jobs normal dan jobs yang accelerated as well as difference time, find the cost slope RP. 163,785,656.59. The recapitulation of crash cost from normal cost for Stiffner job type (120.14) is shown in Table 5.

No.	Types Of Work	Crash Cost (IDR)	Normal Cost (IDR)	Cost Slope (IDR)
1	Stifner (120.14)	455,751,392.24	14,462,399.43	163,785,656.59

Table 5: Rekapitulation Crash Cost and Normal Cost untuk for Stiffner job type (120.14)

In Table 5 it can be seen that the results of Crash Cost IDR 455,751,392.24 serta Cost Slope IDR 163,785,656.59 dari Normal Cost IDR 14,462,399.43 for Stifner type work on Mlaten Bridge. Comparison of time and cost of crashing results in Stiffner's work is shown in Table 6.

Comparison of time before and after Crashing (weeks)	Cost (IDR)
8	1,693,383,000.00
6	1,857,169,179.19
Additional Cost	163.786.179,19

Table 6: Comparison of time and cost of Crasing results on Stiffner work (120.14)

Based on Table 6 shows that the results of the analysis of crasing method can accelerate the work time from 8 weeks to 6 weeks. As for the costs required the greater the additional cost of Rp. 163.786.179,19. The cost of accelerating the completion of the Mlaten Kedungpedaringan Kepanjen Bridge project on Stifner's work after Crashing, the resulting optimization time is shorter but requires greater implementation costs, this does not make the contractor's cost loss. To be able to complete the work of the bridge infrastructure handling project has a certain planning and scheduling in the implementation of the project as a deadline. In essence, there is a relationship between duration and cost, that is, if the project is carried out slowly, the cost is relatively low. If the project is carried out normally, the cost is relatively normal, while if the project is accelerated the cost will be expensive [2].

IV. CONCLUSION

Efforts to accelerate the implementation of the bridge construction project is necessary, given the current conditions of landslides on the east side of the bridge. Based on the analysis of the calculation of the acceleration of the Mlaten bridge construction project by using the Crashing method, the duration of the time needed to accelerate the work is on the work of Stiffner (120.14) which is on a critical trajectory which was originally 8 weeks to 6 weeks and requires additional labor of 8 people with additional details of 1 Foreman, 3 blacksmiths, and 4 employees. The additional costs required by IDR 163.786.179,19.

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