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ANALYSIS OF COST CALCULATION IN THE CONSTRUCTION PROJECT OF KAPAS – GLENDENG 8 BRIDGE IN BOJONEGORO DISTRICT DUE TO TIME ACCELERATION USING THE CRASHING METHOD WITH ALTERNATIVE ADDITION OF WORKING HOURS

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Abstract

Infrastructure development plays a very important role as capital in efforts to stimulate increased economic productivity, both at the national and regional levels, as well as reducing unemployment, alleviating people from poverty and of course improving the standard of living of the community at large. Delays in completing a project are a problem that often arises and can have an impact on the entire work, especially with time delays resulting in increased costs which can be detrimental to many parties. This delay also occurred in the Kapas-Glendeng 8 bridge construction project, Bojonegoro Regency. In anticipation of these delays, it is necessary to accelerate time and costs. In this research the author uses the crashing method with the alternative of increasing working hours. The crashing method is a way of estimating cost variables to determine the maximum and most economical reduction in the duration of an activity that is still possible to reduce. The research results showed that the total time and cost of the project required after crashing was 174 calendar days with a cost under accelerated conditions of Rp. 2,555,189,555.98 with a difference of 6 calendar days from the normal duration of 180 calendar days and a fee under normal conditions of Rp. 2,548,581,990.63.

Keywords: *Time and Cost Analysis, Crashing Method, Additional Working Hours*

1. INTRODUCTION

Massive and equitable infrastructure development in all corners of the country over the past 5 (Five) years has become the foundation for Indonesia's future progress. Infrastructure development is very important especially for Indonesia, an archipelago with unique geographical conditions in it so that efforts to improve connectivity between regions and efforts to make equity by prioritizing development in regions and villages continue to be improved. Infrastructure development plays a very important role as capital in an effort to spur increased economic productivity, both at the national and regional levels, as well as to reduce unemployment (KEMENPERIN, 2003), alleviate people from poverty and of course improve the standard of living of the community at large. Therefore, the government is committed to continuously improving infrastructure development, because the availability of reliable infrastructure is very important to support economic growth and growth in the business world.

Generally, infrastructure refers to the physical development of public facilities, such as roads, ports, schools, hospitals, waste treatment, clean water, airports, and many more. One of the successes of development in a region is the availability of good infrastructure in the form of transportation facilities and infrastructure. The development of transportation facilities and infrastructure in the form of roads and bridges is still a top

priority program that is sustainable and sustainable by the current government. Speaking of infrastructure, the government is currently aggressively building a series of road and bridge infrastructure throughout Indonesia. If previously only centered on the island of Java, it is now launching a prestigious project of the cross-Papua road. In addition to Papua, the government is also building various other highway projects on other islands. On the island of Kalimantan, the government is building a toll road for the 99 km Balikpapan to Samarinda route. The toll road for the Balikpapan to Samarinda route is 99 km long. On the island of Sulawesi, a toll road is being built on the 39 km route from Manado to Bitung. On both islands, preservation is being carried out to ensure the condition of the infrastructure.

In Indonesia today, 90% of logistics distribution shipments utilize land routes and only 10% use sea facilities while in other countries the maximum logistics delivery by land ranges from 75%. Driving the economy is why the government is aggressively building a series of infrastructure on the islands of Indonesia, the government believes that good infrastructure will make the wheels of the economy run and reduce price disparities, especially in the deepest and outermost regions of Indonesia. However, there are overpasses that are built to overcome obstacles, avoid areas that always face traffic congestion problems, pass through railroad crossings to improve traffic safety and efficiency.

On the island of Java, one of the districts that continues to equalize infrastructure development is Bojonegoro Regency. Bridge construction and rehabilitation are part of the infrastructure development in Bojonegoro Regency. The construction of the Kapas - Glendeng Bridge in Kapas District is a bridge that can be used to support the smooth activities of the people of Bojonegoro Regency, especially the Kapas Village community and its surroundings so as to improve the economy, health, and human resources. Kapas - Glendeng Bridge with a composite bridge type design with a span of 24.68 meters and a height of about 7.4 meters from the river level with pillars and abutments on the south side towards Kapas District and abutments on the north side towards Tuban Regency(O'Brien, 1976).

The implementation of this bridge work uses funds from the 2023 Bojonegoro Regency APBD with a contract value of Rp. 2,828,926,009.60 which is carried out by CV Merdeka with an implementation time in the contract of 180 calendar days(Rosyid et al., 2020). The period of work implementation or the period for carrying out work is calculated based on the Work Implementation Order (SPMK) until the first handover of work. The implementing contractor is obliged to complete the work within the period of work implementation as stated in the LDP, based on the general conditions and special conditions of the contract with quality according to the technical specifications and prices stated in the contract.

In reality, in a project cannot be separated from the obstacles that hinder which result in delays in completion(Assaf et al., 1995). Delays in completing a project are a problem that often arises and can have an impact on all work in a project, especially with time delays resulting in increased costs so that it can harm many parties(Levis, 1996). The progress reported by the supervisory consultant is always in a state of minus deviation, meaning that the progress of realization in the field is still below the planning progress.(Febryanti et al., 2014) In the first week according to the time schedule contained in the S curve, the progress deviated -0.75 from the planned progress. In the second week the progress experienced a deviation of -1.59, in the third week the progress was still

experiencing delays with a deviation of -2.11. Furthermore, in the fourth week from the planned progress of 2.62, progress of 0.14 was still realized, resulting in a deviation of -2.49. In the following week, the fifth week of progress in the field also experienced delays so that progress was still at -3.03. Followed by the progress report in the sixth week, in fact in the sixth week of the second month the implementation delay also still occurred, in the sixth week the delay was -3.81 from the planned progress of 3.95. (Astina et al., 2012)The seventh week of the planned progress of 4.63 was only realized by 0.56, resulting in a delay of -4.07. Broadly speaking, the delay that occurred in the Kapas-Glendeng 8 bridge construction project in Bojonegoro Regency was due to the pile items in the procurement and delivery process experiencing delays, so that the delay also affected the delay in the implementation of other items. From the information obtained, the delay in progress that occurred in the Bridge Construction project - Kapas Glendeng 8 Bojonegoro Regency was caused by several things, ranging from delays in the start of work, weather, to delays in pile material (Soeharto, 1999).

Acceleration of project duration can be done by utilizing existing alternatives such as increasing working hours, increasing labor, using a shift work system, using more effective construction methods and using fast materials. This can indeed shorten the project implementation time (Setiono et al., n.d.), but on the other hand the cost of project implementation will increase. The project acceleration analysis must be carefully calculated so that the project duration remains as scheduled and the costs incurred do not swell. In the initial planning of a project, the factors of cost, time and quality form an interdependent relationship and have a very strong influence, therefore the acceleration of project completion must also be done with good acceleration(Yaqin et al., 2023). By utilizing optimal time, the alternative used to support the acceleration of activities is to increase working hours or provide additional working hours (overtime) / work shifts. Through the acceleration of the project, both the owner and the contractor both benefit. The owner benefits because the Kapas - Glendeng 8 Bridge construction project in Bojonegoro Regency can function faster. Likewise, the contractor can reduce indirect costs that may arise due to the duration of work that is too long, as well as a step to overcome project delays(Wirabakti et al., 2017).

From the progress report data above, in anticipation of the delay, it is necessary to accelerate the time and cost with several control tools so that it can be prevented by optimizing acceleration in its implementation while still considering the cost factor and maintaining quality or quality standards(Budianto & Husin, 2021). Some methods that can be used to accelerate the scheduling of a project include the crashing method, the TCTO (Time Cost Trade off) method(Irawan & Juara, 2022), the fast track method (Azmy & Herzanita, 2023)and the least cost analysis method(Sutciana, 2020). In this research, the author uses one method, namely the crashing method with the alternative of adding working hours (overtime)(Zuhriyah & Oetomo, 2022). The application of other alternatives such as increasing the number of workers cannot be applied to the project because of the difficulty of finding additional labor due to other activities that cannot be abandoned, one of which is taking care of agriculture.

The crashing method is also one of the programs which is commonly used to shorten the duration of a project's activities, where activities that can be crashed are activities that are on the critical path(Prawirawati et al., 2022). (Wardana & Putra, 2023)The application of the crashing method on the project is to determine the optimum duration obtained with the alternative of adding working hours (overtime) to anticipate delays that

occur, in this study it will be applied to the Kapas Bridge construction project - Glendeng 8 Bojonegoro Regency(Alifen, 1999).

The crashing method begins with collecting project data, from the data that has been collected, then preparing the schedule with the CPM method and looking for critical activities and calculating the duration of the project(Baker, 2004). After the critical activities and project duration have been calculated, then proceed to analyze the time and cost using the crashing method(Muhyi, 2018). (Prabowo et al., 2023)From the results of calculations using the crashing method, conclusions can be drawn to determine the optimal time and cost to complete the Kapas-Glendeng 8 bridge construction project in Bojonegoro Regency.

Seeing from the background above, we need to analyze the acceleration of time and cost on the bridge construction project(Izzah, 2017), with this research it is hoped that it can be used as an alternative solution for handling work due to delays in progress in the field by knowing the critical path and actions that must be taken to optimize efforts to complete work in the field(Widjajanto, n.d.).

2. RESEARCH METHODS

The data collected is secondary data, then continued the data processing process using the Microsoft Project application program to determine the critical path(Wowor et al., 2013). From the critical path, the time acceleration analysis is carried out using the crashing method with the alternative of adding working hours to successfully obtain conclusions according to the research objectives(Wijanarko & Oetomo, 2019). Literature study was conducted before or in the early stages of the research for several main purposes. Literature study is conducted by reviewing related research journals, both the methods and data used, the object to be studied, the results of research on the work project under study, and research steps.

Data collection is carried out by collecting data related to this research, the data obtained is secondary project data, namely the Draft Budget Cost (RAB), Time Schedule, and project work plan schedule or S Curve. The subject of this research is the addition of working hours. In this case, the object of research will be focused on the cost and time of work resulting from the acceleration analyzed as the dependent variable. The location where this research was conducted was the Kapas - Glendeng 8 Bojonegoro bridge construction project located in Kalirejo Village, Kapas District, Bojonegoro Regency, East Java.

Instruments or tools used in conducting cost and time analysis research on the Kapas Glendeng 8 Bridge Construction Project Work(KARISMA, 2023). Data collection procedures in the research of Cost and Time Analysis of the Kapas Glendeng 8 Bridge Construction Project of Bojonegoro Regency using the crashing method in the form of secondary data. Secondary data is data obtained from relevant agencies in the form of cost budget plans (RAB), S curves, work progress reports & time schedules or all data containing time variables and cost variables for data processing.

Analyze the results in this study by conducting a cost and time calculation of project work using the crashing method(Paramitha & Dibiantara, 2023). In this crashing analysis with the change in project completion time, the costs will also change. If the implementation time is accelerated, the direct cost of the project will increase and the indirect cost of the project will decrease There are several ways that can be used to

accelerate the completion of project time. One of these ways is by increasing the number of working hours (overtime work).

3. RESULTS AND DISCUSSION

After acceleration using an increase in working hours, direct costs will increase while indirect costs will decrease. In this study, the amount of overhead and profit is taken 15% of the RAB. Based on Perpres 70/2012, the profit of service providers is 0-15%. In Perpres 54/2010 as amended by Perpres 70/2012, Paragraph on Price Adjustment Article 92 paragraph 3 that in adjusting the price to determine the Fixed Coefficient consisting of profit and overhead if the offer does not include the amount of the profit and overhead components, the Fixed Coefficient is 15%. This means that the calculation of profit in the provider's bid price is left to the provider. Unless the provider does not include it, only a conclusion of 15% is taken. The difference in cost between the normal situation and after acceleration is as follows:

Project RAB value	= Rp. 2.548.581.990,63
Overhead dan Profit	= Total Biaya Proyek x 15% = Rp. 2.548.581.990,63 x 15% = Rp. 382.287.298,59
Profit 10%	= Project RAB Value x 10% = Rp. 2.548.581.990,63 x 10% = Rp. 254.858.199,06
Overhead 5%	= Project RAB Value x 5% = Rp. 2.548.581.990,63 x 5% = Rp. 127.429.099,53

3.1. Normal Condition Project Cost

The amount of direct and indirect costs in the Kapas - Glendeng bridge construction project in Bojonegoro Regency is as follows:

a. Direct Cost	= Project Cost – Overhead dan Profit = Rp.2.548.581.990,63 - Rp.382.287.298,59 = Rp. 2.166.294.692,04
b. Material cost	= 82% x Direct Cost = 82% x Rp. 2.166.294.692,04 = Rp. 1.776.361.647,47
c. Wage Cost	= 18% x Direct Cost = 18% x Rp. 2.166.294.692,04 = Rp. 389.933.044,57
d. Wage Cost Per Day	= Wage Cost / project duration = Rp. 389.933.044,57 / 180

= Rp. 2.166.294,69

e. Direct Costs = Material cost + wage cost
= Rp. 1.776.361.647,47 + Rp. 389.933.044,57
= Rp. 2.166.294.692,04

f. Indirect Costs = Total project cost - Direct Cost
= Rp. 2.548.581.990,63 - 2.166.294.692,04
= Rp. 382.287.298,60

g. Overhead cost per day = Overhead / project duration
= Rp. 127.429.099,53/ 180
= Rp. 707.939,44

Project cost under normal conditions = Direct Costs + Indirect Costs
Direct costs include:

Material Cost = Rp. 1.776.361.647,47
Wage Cost = Rp. 389.933.044,57

Indirect Costs:
Overhead 5% = Rp. 127.429.099,53
Profit 10% = Rp. 254.858.199,06 +
Total project cost under normal conditions = Rp. 2.548.581.990,63

3.2. Project Costs Under Accelerated Conditions

The amount of project costs under accelerated conditions on the Kapas - Glendeng bridge construction project in Bojonegoro Regency is as follows:

Project duration after acceleration = 180 - 6 = 174 days

Direct costs with the medote of adding overtime working hours
= Direct cost normal + cost slope
= Rp. 2.166.294.692,04 + Rp. 10.855.202,32
= Rp. 2.177.149.894,36

Indirect costs include:
Overhead (174 x Rp. 707.939,44) = Rp. 123.181.462,56
Profit = Rp. 254.858.199,06 +
Total indirect costs = Rp. 378.039.661,62

Total project cost after crashing = Direct cost + Indirect cost
= Rp. 2.176.822.351,21 + Rp. 378.039.661,62
= Rp. 2.554.862.012,83

The following below is a recapitulation table of duration and cost comparisons between normal projects (normal cost and normal duration) and the duration and cost of projects that have been accelerated (normal cost and normal duration):

Table 1. Recapitulation Of Time And Cost Comparison (Pratiwi et al., 2022)

Waktu Proyek	*Direct cost*	*Indirect cost*	Total Biaya
Waktu Normal	2.166.294.692,04	382.287.298,60	2.548.581.990,64
Waktu Lembur	2.177.149.894,36	378.039.661,62	2.555.189.555,98
Selisih	10.855.202,32	4.247.636,98	6.607.565,34

Source: Research data analysis, 2023

3.3. Discussion

From the results of the calculation analysis, the Kapas Bridge Construction project - Glendeng 8 Bojonegoro Regency is planned to be completed within 180 calendar days starting on June 25, 2023 will be completed on December 22, 2023 with a work Budget Plan of Rp. 2,548,581,990.63 Accelerating the project duration by adding a four-hour overtime working hour method to the late work will increase the direct cost of the project and will reduce the indirect cost of the project(Priyo & Aulia, 2015). In this study, the amount of overhead and profit is taken as 15% of the Cost Budget Plan, then the overhead cost per day will be obtained(El Unas et al., 2014).

From the cost analysis, the accelerated time required to complete the project is 174 calendar days or 0.97% faster than the normal duration of 180 calendar days. But the direct cost has increased from the original cost of Rp. 2,166,294,692.04 to Rp. 2,177,149,894.36 or an increase of about 1.005% from direct costs at normal working time, by accelerating the duration, indirect costs will decrease from Rp. 382,287,298.60 to Rp. 378,039,661.62 or a decrease of 0.99% from indirect costs on normal work.(Salindeho et al., 2022) The results of this analysis show that the addition of four hours of overtime work caused the total project cost to increase from Rp. 2,548,581,990.64 to 2,555,189,555.98.

Based on the discussion above, several results were obtained. First, there are advantages and disadvantages in using the system of adding four hours of overtime. The advantages are:

1. Accelerate project duration.
2. Reduced project duration effectively.
3. Avoid over time.

While the disadvantages are:

1. For the company, there will be additional wage expenditures.
2. Wages for four-hour overtime workers who are outside normal working hours can be higher.
3. It is possible that the performance of workers outside normal working hours is not as optimal as workers in normal working hours.
4. Increased risk of work accidents.

To carry out overtime system work / additional working hours must pay attention to possible conditions, such as:

1. Availability Of Labor

In general, the labor required for overtime system work must be available and cannot be lacking. This condition clearly affects the system because if there is no labor, it is certainly impossible to carry out overtime system work(Rahmat & Soekiman, 2018). And if the planned number is insufficient, the work certainly cannot run smoothly and according to the target.

2. Project site conditions

The location of the building has an important impact on the timing of project implementation, because the location of the project has an impact on the availability of resources such as materials, tools and time.

3. Material readiness

Material is the building material. Therefore, optimal management is required(Fahmi, 2014). Material management(Pangestu, 2000) is an activity that includes the functions of planning needs, determining budgets, selecting sources, transporting, storing, and monitoring goods optimally because materials are very important needs in the success of a construction project(Dimyati, 2014). By controlling construction materials in accordance with the necessary needs we will be able to provide benefits in many ways, including increasing labor productivity, preventing material loss, labor efficiency, and preventing negative cash flow. The shifting system is highly dependent on material readiness. In order for the work to be carried out smoothly without experiencing obstacles in terms of material procurement, material procurement must be carried out in an effective and efficient manner. Effective procurement relates to accuracy in quality, quantity, time, price, material source, and delivery location(Sugiyono, 2014).

4. Possible work sequences

This sequence of work is related to scheduling. In scheduling, each activity must estimate the duration considered based on the type of work, volume of work, number of resources, work environment, and worker productivity. In performing the shift system, the flow prioritizes critical or near-critical activities with maximum resources (capable of being crashed) and the lowest total float. If the availability of resources is limited and their availability is not sufficient, the project duration will be slower than planned. So that the crash that is carried out will not have an impact

4. CONCLUSION

1. The work items that are on the critical trajectory in the Kapas-Glendeng 8 Bridge construction project in Bojonegoro Regency are the work item for fixing the stepping plate with BJTP 280 plain iron, the work item for directional stakes and the work item for decorative painting on concrete structural elements, 100 µm thick.
2. The impact caused by changes in time on this cost is the increase in the amount of direct costs which originally amounted to Rp. 2,166,294,692.04 in 180 calendar days of work to Rp. 2,177,149,894.36 in 174 days with a difference of Rp. 10,855,202.32 or an increase of about 1.005%. Meanwhile, because the duration of the project after crashing is shortened, it causes a decrease in indirect costs (Indirect cost) which was originally Rp. 382,287,298.60 to Rp. 378,039,661.62 with a

difference of Rp. 4,247,636.98 or a decrease of 0.99%. The increase in direct costs and the reduction in indirect costs caused the total cost of the project to also change from Rp. 2,548,581,990.64 to Rp. 2,555,189,555.98 with a difference of Rp. 6,607,565.34. In this study, the authors found that the total cost of crashing turned out to be more expensive, which increased by 1.005% compared to the total cost when normal.

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