

ANALYSIS OF HEAVY EQUIPMENT PRODUCTIVITY IN THE BINDERANG-SUNGAI IMPAT ROAD RECONSTRUCTION PROJECT

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ABSTRACT

The reconstruction of Jalan Binderang-Sungai Impat is carried out to improve the of the road. The use of heavy equipment is very important to help the work and speed up the work process. The purpose of this study is to analyze the productivity of heavy equipment and the total time in the work of the aggregate foundation layer of class A, as well as to compare the productivity of heavy equipment calculated based on theory with field data and productivity based on field implementation

In the analysis, a heavy equipment calculation method based on the Minister of PUPR Regulation No. 08 of 2023 was used to calculate theoretical productivity. In addition, observations and direct interviews were carried out in the field to obtain data on equipment working hours, types of heavy equipment, and the capacity of the tools used to calculate field productivity. For general project data, tool specifications and work volumes are obtained from the contractor or consultant.

Through the results of the analysis in this study, the theoretical productivity results of heavy equipment for wheel loaders 111.27 m³/hour, dump trucks 5,303 m³/hour, motor graders 132.69 m³/hour, vibratory rollers 78.54 m³/hour and water tank trucks 71.14 m³/hour were obtained. The total theoretical time for the work of the aggregate foundation layer of class A is 3 days, while based on the implementation in the field the time required is 10 days. Based on the theoretical analysis the number of dump truck 21 units while in the field the number of dump truck used is 17 units. For onther types of heavy equipment, the fleet size is the same with 1 units both in the theoretical analysis amd in the field reality.

Keywords: Heavy equipment, productivity, duration, number of equipment

1. INTRODUCTION

The Binderang-Sungai Impat Road Reconstruction Project is planned to be completed within 120 calendar days or about 17 weeks and the maintenance time is 180 calendar days or about 25 weeks. The overall length of the road starts from STA 0+000 to STA 2+080 and the road width is 4 meters. This road is one of the entrances and exits for local residents, during the rainy season the road will be muddy and the dry season the road becomes dusty so that it does not feel comfortable to pass through, for which road repairs are carried out.

One of the studies that examined the productivity of heavy equipment in road construction projects was conducted by Prima & Hafudiansyah (2022). In the study, it was explained that the selection of the right heavy equipment and efficient management can speed up the work process, so that the work can be completed faster than planned. The results of this study show that the heavy equipment used has good productivity, which allows the project to be completed faster than originally planned. This shows that with good management and the selection of appropriate tools, projects can be completed efficiently.

2. THEORETICAL FOUNDATIONS

Machine Productivity

Heavy equipment productivity refers to the level of efficiency and effectiveness of heavy equipment utilization in construction projects. Heavy equipment, such as motor graders and dump trucks, are designed to carry out a variety of construction tasks. According to Yanuar (2024), the use of heavy equipment in construction projects is crucial to increase productivity and reduce the duration of work implementation.

Cycle Time

Cycle time refers to the overall duration needed to complete one round of activities, starting with material retrieval until returning to the original point. Cycle time has an important role in measuring the operational efficiency and productivity of a tool. The shorter the cycle time, the more material can be transported in a given time, which in turn increases the overall output of the project (Liutari et al., 2022).

Heavy Equipment Work Efficiency

The efficiency of heavy equipment use is a crucial factor in the construction and mining industry that has a direct impact on productivity and operational costs. The utilization of heavy equipment can speed up the process and reduce the time required to complete certain tasks. Proper management of the use of heavy equipment can improve time and cost efficiency, allowing projects to be completed faster and with a lower budget (Rivana, 2024).

Work Implementation Time

The time for the implementation of work refers to the duration of the completion of a project or its stages, which is calculated from start to finish. Time efficiency in project

implementation is indispensable to ensure that the project can be completed on schedule. Some factors that affect the implementation time include weather conditions, availability of materials, labor, and methods used (Dewi et al., 2023).

3. METHOD

Research Location

This research is located on Jalan Binderang-Sungai Impat Lokpaikat District, Tapin Regency.

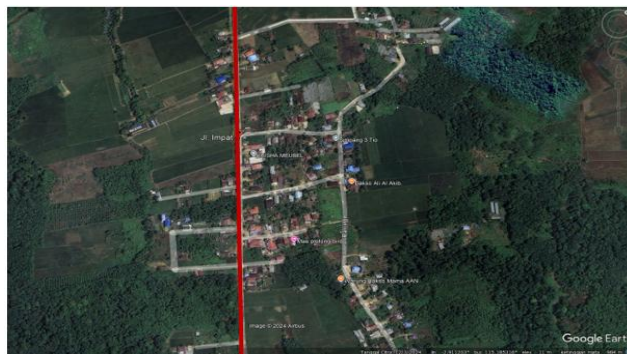


Figure 1. Research Location

Research Procedure

The first stage of this study begins with the collection of primary data which includes the type of heavy equipment, the number of tools, the working hours of heavy equipment, the cycle time of heavy equipment, and the distance between the quarry and the project location. Furthermore, productivity calculations and analysis of the cycle time of heavy equipment used in the work are carried out. After that, the duration of the work is calculated to be compared with the implementation in the field.

4. RESULTS AND DISCUSSION

In the Binderang-Sungai Impat Road Reconstruction project, the productivity of heavy equipment is calculated only for class A aggregate foundation layer work. The heavy equipment used in the work *Motor Grader, Wheel Loader, Vibratory Roller, Water Tank Truck, Dump Truck*.

Analysis of Heavy Equipment Calculation Theory and Work Duration Based on Field Data

The analysis calculation is based on the Regulation of the Minister of PUPR No. 8 of 2023, the volume of work on the distribution of aggregate materials is 1296 m³ consisting of gravel measuring 2/3, 1/2, 1 and stone ash with a predetermined JMF (Job Mix Formula).

1) Wheel Loader Heavy Equipment Productivity

To determine the productivity of a wheel loader machine depends on the volume of bucket capacity (v), bucket factor (F_b), tool efficiency factor (f_a) and cycle time (T_s). Wheel loader productivity calculations can be done using the equation contained in the Minister of PUPR Regulation Number 8 of 2023.

2) Dump Truck Heavy Equipment Productivity

To calculate the productivity of a dump truck heavy equipment depends on the capacity of the dump truck chute (v) used to carry the material, the weight of the excavated material content (B_iL) and the cycle time (T_s). The cycle time (T_s) is obtained by adding the loading time (T_1) of the dump truck using a wheel loader, the travel time of the contents (T_2) of the dump truck from the quarry, the empty travel time (T_3) of the dump truck to the quarry, the time of others (T_4) consisting of (t_1) and (t_2). Where (t_1) is the disposal time, standby until the disposal starts in units (minutes) and (t_2) is the waiting time and position taking and ready to dispose of in units (minutes). This calculation uses the formula listed in the Minister of PUPR Regulation No. 8 of 2023.

Dump Truck Heavy Equipment Productivity

3) Motor Grader Heavy Equipment Productivity

The calculation of the productivity of the motor grader heavy equipment depends on the length of the overlay (L_h), the number of passing passes (n), the effective length of the pass (m) obtained from the results of interviews in the field with the heavy equipment operator, the overlap width (b_o) which is the overlap of the material when the motor grader spreads the aggregate, the efficiency factor of the tool (F_{aMG}), the number of track lanes (N) and the cycle time (T_s) consists of spreading activities in one pass (T_1) and other activities (T_2). And for the other time (T_2) obtained based on direct observation in the field using the time study method and assisted by a stopwatch time measuring device.

This calculation uses the formula listed in the Minister of PUPR Regulation No. 8 of 2023.

4) Vibratory Roller Heavy Equipment Productivity

To calculate the productivity of the vibratory roller heavy equipment depends on the number of track lanes (N) obtained through direct observation in the field, the number of passing passes (N), the overlap sheet (bo) of the material overlap seen based on the reality in the field, the efficiency factor of the tool (Fa), the pavement elevation (t) obtained from the thickness of the material that has been compacted and the average speed (v) obtained from the results of interviews with operators. This calculation uses the formula listed in the Minister of PUPR Regulation No. 8 of 2023.

5) Water Tank Truck Heavy Equipment Productivity

The calculation of the productivity of the water tank truck depends on the capacity of the water pump (Pa) obtained from interviews with the heavy equipment operator, water requirements (WC) and equipment efficiency factors (Fa). This calculation uses the formula listed in the Minister of PUPR Regulation No. 8 of 2023.

From the results of the analysis, the productivity of each heavy equipment was obtained in units per hour. Because the working time in the field is 8 hours/day with 1 hour of rest, the effective working hours are 7 hours/day. To calculate the productivity of each machine in one day, it can be calculated by the hourly productivity value of each tool multiplied by 7 hours/day. Water Tank Truck Heavy Equipment Productivity.

Table 2. Heavy Equipment Productivity Based on Computational Analysis

No	Nama Alat	Produktivitas per jam (m ³ /jam)	Produktivitas per hari (m ³ /hari)
1	<i>Wheel Loader</i>	111,27	778,89
2	<i>Dump Truck</i>	5,303	37,12
3	<i>Motor Grader</i>	132,69	928,83
4	<i>Vibratory Roller</i>	78,54	549,78
5	<i>Water Tank Truck</i>	71,14	497,98

Calculation of the Total Time for the Implementation of Class A Aggregate Foundation Layer Work

Productivity capacity (Q) is determined based on the productivity of the tool that has the smallest capacity in class A aggregate foundation layer work. To calculate the total time of execution of the work volume (V) divided by the Productivity per day (Q).

Comparison of Analysis Results and Reality in the Field

Table 3. Comparison of the number of heavy equipment

No.	Heavy Equipment	Jumlah Tools (Unit)	
		Theoretical Analysis	Field Analysis
1	<i>Wheel Loader</i>	1	1
2	<i>Dump Truck</i>	21	17
3	<i>Motor Grader</i>	1	1
4	<i>Vibratory Roller</i>	1	1
5	<i>Water Tank Truck</i>	1	1

From the results of the analysis, it can be seen that the most visible difference is the dump truck in the theoretical analysis, the number of dump trucks is 21 units, while based on the facts in the field as many as 17 units and for other heavy equipment, the number is the same between the theoretical analysis and the analysis of the facts in the field.

Table 4. Comparison of Dura Jobs

No.	Heavy Equipment	Job Duration (Days)	
		Theoretical Analysis	Field Analysis
1	<i>Wheel Loader</i>	3	10
2	<i>Dump Truck</i>		
3	<i>Motor Grader</i>		
4	<i>Vibratory Roller</i>		
5	<i>Water Tank Truck</i>		

In Table 4. It can be seen that the duration for the material overlay work if calculated using theoretical analysis can be completed in 3 working days, but in accordance with the analysis and reality in the field, the class A aggregate foundation layer work is completed within 10 days. From the calculation of productivity using heavy equipment data in the

field, it turns out that the duration of time is less than the actual time that occurs in the field. There are obstacles during the work of the class A aggregate foundation layer, resulting in a considerable difference in the time duration between the duration of the work at the project site and the time duration of the calculation analysis results. The obstacle during the work of the class A aggregate foundation layer is the weather, especially rain, which is a natural factor that becomes an obstacle to the work. If it rains, it will cause the work area in the field to become wet, so the work process is forced to be stopped. Humid field conditions also increase the risk of land subsidence due to too much rainwater.

5. CONCLUSION

Based on the results of the research on the Binderang – Sungai Imapat Road Reconstruction Project, the following results were obtained:

1. Based on the results of heavy equipment productivity calculations carried out through theoretical analysis using field data, productivity values are obtained. Wheel loader is 111.27 m³/hour, dump truck is 5,303 m³/hour, motor grader is 132.69 m³/hour, vibratory roller is 78.54 m³/hour, water tank truck is 71.14 m³/hour.
2. Based on the results of the calculation of the productivity of the tool, it is obtained that the total time for the work of the class A foundation layer is 3 days while based on the reality in the field is 10 days.
3. Based on the results of the analysis, it can be seen that the difference for the number of tools based on theoretical analysis and field analysis is the most visible difference in the number of dump trucks. where in the theoretical analysis the number of dump trucks is 21 units, while based on the facts in the field 17 units and for other heavy equipment the number is the same between the theoretical analysis and the reality in the field.

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