



THE TARGET ACHIEVEMENT EFFORT OF MECHANICAL AVAILABILITY AND PHYSICAL AVAILABILITY OF DOOSAN 500 LCV EXCAVATOR LOADING EQUIPMENT AT PT XYZ

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ABSTRACT

Mechanical earthmoving is all work related to digging, breaking, loosening, loading, hauling, and compacting soil or rock (overburden) using mechanical devices. Based on the results of research in April 2022 it was concluded that mechanical availability and physical availability did not meet the target plan, where the mechanical availability value in April was 74% and the physical availability value in April was 79%. While the value to be achieved at PT XYZ on mechanical availability is 83% and physical availability is 90%. One of the efforts for MA and PA to achieve the target plan is to map actual conditions and then make a work plan

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1. INTRODUCTION

In mining activities, both overburden stripping and coal excavation, the presence of mechanical devices is needed to support the success of mining operations, so that in their use it is necessary to plan properly so that the capabilities of mechanical devices, both digging equipment and hauling equipment, can be used optimally. This research is more focused on tool maintenance *doosan excavator* 500 LCV, starting from checking the equipment before operation and after operation. The mechanical availability and physical availability values at PT XYZ did not reach the target plan. One of the efforts made is to provide spare parts and prepare for preventive work. *Mechanical availability* is a percentage seen from maintenance or repair while physical availability is a percentage seen from damaged roads and slippery roads, the result of mechanical availability at PT XYZ is 74% and physical availability is 75.70%. There are factors that do not reach the target plan which are influenced by breakdown hours and operating hours, especially for the Doosan 500 LCV excavator loader. Therefore, the authors want to make efforts to achieve the target of mechanical availability and physical availability of the Doosan 500 LCV excavator loading and unloading equipment because it greatly affects productivity.

In this study, the writing limits the research on the condition of an excavator on the PT XYZ plan:

1. Mechanical availability and physical availability data used in April 2022.
2. Place of research at PT XYZ in April 2022

The objectives of the research conducted at this company are:

1. Knowing the mechanical availability value of the excavator loading and unloading equipment.
2. Knowing the physical availability value of the excavator loading and unloading equipment.
3. Knowing the causes of mechanical availability and physical availability values are not achieved.
4. Know the efforts to improve the value of mechanical availability and physical availability.
5. Knowing the value of mechanical availability and physical availability after repair.

LITERATURE REVIEW

Mechanical Tool

According to Dicky (2020: 11), mechanical devices are tools used to facilitate the mining process and to increase production in large quantities. The selection of mechanical devices is carried out through two considerations, namely from a mechanical perspective and an economic one. Consideration of the mechanical aspect, namely being able to deal with minerals which naturally have relatively hard physical and mechanical properties, mechanical power (engines) in the field are designed to be able to deal with rock conditions, so that they can increase production rates at high rates compared to conventional ones, and can be used for production that is big.

Dig Load Tool

The excavation equipment is used to excavate soft excavated materials or blasting results as well as load the material into the conveyance. As the title I took focused on the Doosan 500 LCV excavator with body number 511. The excavator is a backhoe.

The digging tool has the main parts, including:

1. Top that can rotate (revolving unit)
2. The bottom for moving places (travelling unit)
3. Additional parts (attachments) that can be replaced according to the work to be done.

The heavy equipment for digging is called an excavator. This includes power shovel (front shovel), backhoe, dragline and clamshell. In some literature, backhoe, dragline, clamshell, and power shovel are sometimes referred to as separate digging tools.



Source: Author Documentation

Figure 2.1 Excavator Load Digging Tool

Transport Equipment

Equipment used to transport minerals from the site front mining work to stockpile or further processing or directly to consumers. In the field of mining, conveyance is a tool used to transport mining materials, be it material with economic value or not, from one place to another (stockpiling or processing area).

Productivity of Digging and Hauling Equipment

Productivity is the ability to produce something, so it can be said that the productivity of heavy equipment is the ability of heavy equipment to produce something per unit of time.

According to Amtiss (2021: 2), MA, PA UA and EU are the reference for calculating the main productivity of a heavy equipment.

1. Mechanical Availability

Mechanical availability is a number indicating the percentage of a tool to operate taking into account the loss of time due to mechanical causes, such as maintenance/repair.

Where :

$$MA = \frac{\text{Operating Time}}{\text{Operating Time} + \text{Break Down Time}} \times 100\% \dots \dots \dots (2.1)$$

2. Physical Availability

Physical availability a number that shows the percentage of availability of a tool to operate taking into account the time due to rain, bad roads and breaks.

Where :

$$PA = \frac{\text{Operating Time} + \text{Standby Time}}{\text{Work Hour}} \times 100\% \dots \dots \dots (2.2)$$



3. Used Of Availability

Availability is a number that shows what percentage of time is used by a tool to operate when the tool is used.

Where :

$$UA = \frac{\text{Operating Time}}{\text{Operating Time} + \text{Standby Time}} \times 100\% \dots \dots \dots (2.3)$$

4. Effective Utilization

Effective utilization is a number that shows what percentage of the time is used to operate by a tool and all the time available.

Where :

$$EU = \frac{\text{Operating Time}}{\text{Workj Hour}} \times 100\% \dots \dots \dots (2.4)$$

MA, PA, UA and EU can be obtained through the timesheet which is usually filled in by the unit operator. Through the timesheet, must get:

- 1) Hours of Operation :
Total hours the unit worked
- 2) Standby Hours :
Total unit standby/idle hours due to external factors such as rain, bad roads and breaks
- 3) Breakdown Hours :
Total maintenance hours due to internal factors such as damage, service maintenance units.
- 4) Working hours :
Total total unit activity on that day. Working hours can be obtained by combining all the results of operating hours, standby hours and breakdown hours.

Excavator Hydraulic Components

According to Buntarto (2020: 25), the following are various types of buckets, booms, arms, and other work equipment commonly used on a hydraulic excavator:

1. Buckets

Buckets is the equipment contained in a hydraulic excavator. The main function of the bucket on a hydraulic excavator is to dig (digging) and loading (loading) soil materials, rocks, wood.

2. Ripper Buckets

Ripper buckets very suitable for working in rocky or clay areas, where ordinary buckets are not able to work optimally. Loading jobs can also use buckets like this. Trapezoidal buckets are very well used for making water channels (drainage) or irrigation canals

4. Slope Finishing Bucket

Buckets very suitable for making slopes of irrigation canals or rivers

5. Ditch cleaning bucket

It is suitable for dredging mud in ditches or rivers. This bucket has small holes that function to release water, so only hard materials are dredged.

6. Single-shank Ripper and Three-shank Rippers

Single-shank Ripper and *Three-shank Rippers* are used to uproot rocks or tree roots. Three-shank rippers are very effective for uprooting rock from slopes, digging, breaking concrete surfaces and removing tree roots

7. Clamshell Buckets

Clamshell buckets used for excavation in a vertical direction

8. Booms and Arms

Booms and arms is also part of the work equipment on a hydraulic excavator. The following are several types of booms and arms used in hydraulic excavators:

- a. Extension arm, attached to a standard arm for a longer reach.
- b. Short arm, is one of the fittings on a hydraulic excavator that is used for jobs with limited areas.
- c. Standard length arm is a standard arm used on excavators.
- d. Long arm and super long front are used to extend the range.
- e. Two piece boom is used to expand the work field, where if you use a standard arm it is less efficient.

9. Breakers

Breakers is equipment mounted on an excavator that serves to break up rock. Breaker installed on the front of the arm (replacing the Bucket)

Maintenance**Definition of Maintenance (Maintenance)**

According to Sugiarto (2017: 13), the definition of maintenance is all activities in which it is to maintain the equipment system to work properly.

The definition of maintenance is a job that is carried out sequentially to maintain or repair existing facilities so that they comply with standards (according to functional and quality standards).

Type of Treatment (Maintenance)

Several types of maintenance are available, including:

1. Maintenance when damage occurs (Breakdown Maintenance)
Breakdown maintenance is maintenance that is carried out when there is damage to the machine or work equipment so that the machine cannot operate normally or the operation stops completely with sudden conditions. This maintenance breakdown must be avoided because there will be losses due to the cessation of production machines which will not achieve quality or production output.
2. Preventive maintenance
Preventive maintenance is a type of maintenance carried out to prevent damage to the machine during operation.
3. Corrective maintenance
Corrective maintenance is maintenance that is carried out by identifying the cause of the damage and then repairing it so that the machine or production equipment can operate normally again. Corrective maintenance is usually carried out on machines or production equipment that are operating abnormally (machines are still operating but not optimal).

Purpose of Treatment (Maintenance)

Treatment goals can be defined as follows:

1. To prevent asset loss.
2. To guarantee the optimum availability of equipment installed for production and get the maximum possible return on investment.
3. To ensure the operational readiness of all equipment needed in an emergency at any time.
4. To ensure the safety of people who use these facilities.

General Terms in Nursing

The term maintenance in fact refers to the maintenance function as a whole, namely:

a. Maintenance (maintenance) is a combination of actions taken to maintain an item or to repair it to an acceptable condition. If the condition of the machine is maintained, the heavy equipment will work more optimally. Then it can also provide very high production results according to what is set by the company. Some of the benefits of carrying out maintenance, including the tool can work effectively with efficiency, does not cause sudden damage, the readiness of the tool to operate is high, operating costs are quite low, the age of the tool is optimum, the safety of the tool is guaranteed.

Carrying out maintenance on the loading and unloading equipment can minimize tool damage. If equipment damage can be minimized, operational costs will become more efficient so that it will provide benefits for the company. By carrying out good preventive maintenance, we will get 3 benefits:

- a. Reduce damage
- b. Operational costs become more efficient, and
- c. The safety of our heavy equipment is well guaranteed.

Some of the treatments that will be carried out are:

1. Refrigeration Check

Check whether the cooling water level is between the full and low marks on the radiator reserve tank. This cooling water check is related to the cooling function which will affect the performance of the cooling system, the function of this cooling system is to absorb and dissipate heat from the engine and release it into the outside air with the intermediary of water or air.



Source: Author Documentation

Figure 2.2Radiator Tank



2. Battery Check

This battery check serves to keep the battery ready and in good condition so that the supply of electric voltage to the electrical wiring will be properly supplied.



Source: Author Documentation

Figure 2.3Excavator Battery

3. Check the air cleaner or air filter

The air cleaner functions as an air purifier, so that small dust, sand and dirt can be separated first before entering the combustion chamber. Dirt, dust and sand in the atmosphere are hard substances that will cause damage to the cylinders and pistons in the engine where the hard dust is sucked in together with the air. Diesel engines require a large supply of air for the combustion process in the combustion chamber. If air enters the combustion chamber directly, it can cause damage to the combustion components.

4. Check the oil level

This check is to find out the amount of engine oil, whether it is still good or not. This oil change is in accordance with the instructions in the manual book for each type of heavy equipment. The amount of oil must also be checked by looking at the limit mark on the oil dipstick, add oil if needed through the oil table filler line.

5. Inspection of seat belts and mounting clamps.

Check the hook, catcher and hook foot for damage, if damage is found, repair it immediately. This seat belt is very important for the operator because if the tool experiences a shock it can cause the operator to be knocked over if the condition of the seat belt is not in good condition.

2.7. Treatment Planning

Broadly speaking, the notion of maintenance management is maintenance organization to provide performance regarding industrial facilities. Ideas that arise regarding the main points of view in planning a treatment program are indicated by three questions as follows:

1. So that heavy equipment is always in prime condition, has good mechanical efficiency.
2. So that the cost of repairing heavy equipment becomes economical.
3. So that the heavy equipment is always ready for use at any time.

A sound and logical rationale is the best requirement in organizing care. This organizer includes the application of management methods and requires systematic attention.

1. Maintain 10 hours of operation (daily)
2. This maintenance is basic maintenance which is routinely carried out within 10 hours after the tool is operated.
3. Maintain every 50 hours of operation (weekly)
4. In accordance with maintenance objectives, 50 working hours maintenance aims to obtain a longer life or mass usage of heavy equipment units.
5. Maintain every 250 operating hours (monthly)

Basically, the purpose of each maintenance for each working hour/operation is the same, which is the difference in the type of maintenance work for each operating hour.

4. Maintain every 500 hours of operation

In this monthly maintenance, a very thorough check is carried out on the parts that are not carried out in daily or weekly maintenance.

5. Maintain every 1000 hours of operation

Is a multiple of 2 times the 500 hour treatment. Spare parts and items replaced equal 500 hours of maintenance.

6. Maintain every 2000 operating hours

In this annual maintenance, overhaul and very thorough checks are carried out on parts that are not carried out in daily, weekly or monthly maintenance. This maintenance is also carried out by replacing components that should have been replaced.

RESEARCH METHODOLOGY

Types of Research

The type of research that will be carried out by researchers is the type of research that belongs to the type of observation with quantitative data.

Time and Place of Research

The time for the research was carried out from April 1 to June 1 2022 at PT XYZ, Kec. Rawas Ilir, Kab. Musi Rawas, South Sumatra with the person in charge of research the Head of Mining Engineering (KTT).

Research Methods

The research method used in this study are:

1. Literature study

Literature study is carried out by collecting library materials related to the research objectives that have been planned which can support this writing which can be obtained from reading books, as well as materials from the internet that have to do with the research problem to be discussed.

2. Field observation

Field observations are carried out by directly observing the mechanism of measurement activities in the field, in the area PT XYZ with the problems to be discussed, namely the maintenance of the Doosan 500 LCV excavator.

3. Data collection

In this study there are two types of data, namely:

a. Primary data

Primary data is data obtained directly in the field including:

1. The process of maintaining the tool before operating the excavator tool
2. Comparison of the maintenance of the tool before and after being treated.

b. Secondary data

Secondary data is data that has been obtained from archives, parties, and companies related to this, such as data:

- 1) Rainfall data
- 2) MA, PA, and UA data
- 3) Excavator tool specification data
- 4) Data Analysis and Data Processing

Data analysis data that has been obtained during research in the field is in the form of real bucket capacity data of digging equipment. Then it can be known the work constraints that cause reduced effective working hours which often results in a decrease in the target data that has been obtained then classified based on the type of data then carried out analysis and calculations with a predetermined formula:

A. Mechanical Availability

$$MA = \text{working hours} / (\text{working hours} + \text{repair hours}) \times 100\%$$

B. Physical Availability

$$PA = W / (W + S) \times 100\%$$

C. Availability

$$UA = (W + S) / (W + S + R) \times 100\%$$

D. Effective Utilization

$$EU = W / (W + S + R) \times 100\%$$

Research Flow Chart

The research method used in this research as shown in Figure 3.1 is:

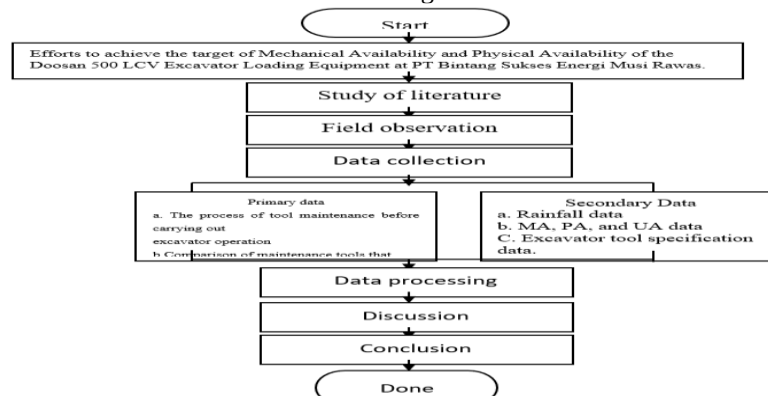


Figure 3.1 Research Flow Chart



RESULTS AND DISCUSSION

4.1 Mechanical Availability Value

In April, the mechanical availability value at PT XYZ on the Doosan 500 LCV excavator did not meet the target set by the plan. The following is a description of the April mechanical availability value:

MA in April:

$$MA = x 100\% \frac{\text{Operation Time}}{\text{Operation Time} + \text{Break Down Time}}$$

$$MA = x 100\% \frac{430,4 \text{ hours}}{430,4 \text{ hours} + 151,3 \text{ hours}}$$

$$MA = x 100\% \frac{430,4 \text{ hours}}{581,7 \text{ hours}}$$

$$MA = 74\%$$

Mechanical availability in April 2022 is 74%. April's mechanical availability results did not meet the target.

4.2. Physical Availability Value

In April, the physical availability value at PT XYZ did not meet the target set by the plan. The following describes the physical availability value:

April PA Data:

$$PA = X 100\% \frac{\text{Operation Time} + \text{Standby Time}}{\text{Work Hours}}$$

$$PA = X 100\% \frac{430,4 \text{ hours} + 138,3 \text{ hours}}{720 \text{ hours}}$$

$$PA = X 100\% \frac{568,7 \text{ hours}}{720 \text{ hours}}$$

$$PA = 79\%$$

Physical availability in April also did not meet the target plan, the value obtained was 79%.

4.3. Cause The Mechanical Availability and Physical Availability values are not Achieved.

At PT XYZ in April 2022 the mechanical availability value of the Doosan 500 LCV excavator did not meet the target. Mechanical availability is a number indicating the percentage of a tool to operate taking into account lost time due to mechanical causes, such as maintenance/repair. Therefore, the value of mechanical availability is not achieved due to high unscheduled breakdown hours, delays in the availability of spare parts, slow repair processes and inadequate preventive preparations.

While physical availability is a number that shows the percentage of availability of a tool to operate taking into account the time due to rain, bad roads and breaks. The physical availability target was not achieved due to the first is waiting time for refueling or queuing, the second is when the road is damaged due to rain or is slippery so that it interferes with the operation of the equipment and the last is the queue for transporting overburden.

4.4. Efforts to Achieve Mechanical Availability and Physical Availability

In a cause that occurs in mechanical availability and physical availability data at PT XYZ there are efforts made so that the target plant is achieved. Constraints that occur in the value of mechanical availability because *unscheduled breakdowns*. Efforts made namely so that unscheduled breakdowns do not occur, it is necessary to report quickly to the plan for any damage so that repairs can be carried out without having to wait for reports a week or once a month, then provide spare parts so that when the breakdown is scheduled, the spare parts used are immediately installed and do not extend the breakdown time. Another reason that happened was due to the slow repair process, the slow repair process was due to the unavailability of spare parts, thus prolonging the breakdown time and finding an unscheduled breakdown when the service was carried out, so the importance of the availability of spare parts is more so that there is no delay in the repair process. And the last, prepare preventive maintenance is not good.

The obstacle that occurs in physical availability is when refueling the excavator loading and unloading equipment takes time so the excavator waits, the effort being made is to provide more fuel tanks so that the excavator does not wait while refueling and disrupt operating time. Second, the road was damaged by rain or slippery roads. The effort being made is to repair the road by means of a motor grader, leveling the road quickly so that there are no disturbances when the excavator is operating. And finally, the cause of not achieving physical availability is the process of queuing for overburden transport,



Figure 4.1 Doosan 500 LCV Excavator Repair Process

4.5. Post Repair Mechanical Availability and Physical Availability Values

In a case where mechanical availability and physical availability do not meet the company's targets, efforts are made so that the mechanical availability and physical availability values reach the predetermined targets. The mechanical availability value in April was 74% while the target set by the Plan was 83%. The reason is the first *breakdown unscheduled*, late availability of spare parts, slow repairing process, and lack of manpower. Efforts are being made to prevent unscheduled breakdowns, it is necessary to quickly report to the plan any damage so that repairs can be carried out without having to wait for a report a week or once a month. This effort has a great influence on the mechanical availability value because the smaller the breakdown hours, the greater the mechanical availability value. After that, the next effort is to provide spare parts so that when the breakdown is scheduled, the spare parts used are immediately installed and do not extend the breakdown time and the repair process is slow due to the unavailability of spare parts, thus extending the breakdown time and finding an unscheduled breakdown when the service is carried out. so that the availability of spare parts is more important so that there is no delay in the repair process. This effort aims to shorten the time and value of mechanical availability can reach the target. And finally, the last effort is to make preventive work preparation better or maximal

From the several efforts made, all of them had a big impact on the mechanical availability value of reaching the target plan, which should have been a breakdown hour of 151.3 hours, after efforts to repair the breakdown clock could be 65.5 hours, the mechanical availability result could reach 86%.

Physical availability also did not meet the target plan. The value obtained in April was 79% while the specified target plan was 90%. The reason is because when refueling is waiting or queuing the efforts made provide more fuel tanks as needed so that when refueling the excavator fuel there is no need to wait anymore, and the second effort is to carry out the road repair process quickly so that it disrupts the operation of the equipment.

These efforts are very influential in increasing the value of physical availability to achieve the target plan. Because all planned efforts are carried out automatically, the physical availability value can reach the target of 90%.

5. CONCLUSION

Based on the discussion that the author has conveyed in the previous chapters, in this chapter the authors draw conclusions and provide suggestions that might be useful, so that they can be used as input for the company.

1. The mechanical availability value of the Doosan 500 LCV excavator at PT XYZ in April was 74%.
2. The physical availability value of the Doosan 500 LCV excavator at PT XYZ in April was 79%.
3. The mechanical availability and physical availability data for April 2022 did not meet the target plan, due to high unscheduled breakdown hours, delays in spare parts, slow repair processes, poor preventive maintenance, when refueling and when roads are damaged.
4. Efforts to improve the value of mechanical availability and physical availability meet the target *unscheduled breakdowns* it is necessary to report to the plan quickly any damage so that repairs can be carried out without having to wait for a report once a week or once a month. Provide spare parts so that when the breakdown is scheduled, the spare parts that are used are immediately installed and do not extend the breakdown time and speed up the repair process due to the unavailability of spare parts so that it extends the breakdown time and finally provides fuel tanks as needed so that when refueling the excavator equipment does not wait any longer.
2. 5. Mechanical availability results can reach 86% and physical availability can reach 90%



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