

Optimization of Pc-200 Excavator Productivity in Runway Excavation Work at Sta 0+000 - 0+700 Pohuwato Airport Development Gorontalo

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ABSTRACT

The implementation of the Pohuwato Airport construction project on excavation work requires heavy equipment Excavator to excavate the Runway body which will be installed geotextile. The purpose of using this heavy equipment is to facilitate work and streamline work time. The selection of heavy equipment must be carried out carefully and precisely so that the effectiveness in its use is optimal, and costs and time can be adjusted. This research was conducted at the construction of the Pohuwato airport in Imboddu village, Randangan sub-district, Pohuwato district, Gorontalo province, in this study using several alternative experiments to find the efficient value of implementation time and operational costs. This study uses several research methods, namely the productivity test of tools and field observations. Based on the calculation of the results of productivity analysis, it is found that alternative 3 is the most efficient result with working hours of 10 hours, using 6 units of excavators capable of producing 1,296 m³ per day with a total operational cost of Rp.14,873,200 per day. per day, alternative 3 is able to complete work with a volume of 56000 m³ for 43 days or 6 weeks, faster than field conditions with 2 excavator units can be completed for 108 days at a total cost of Rp. 8,247,840, while in alternative 1 using 3 excavator units can complete for 72 days at a total cost of Rp. 10,647,840, in alternative 2 using 3 excavator units can complete for 72 days at a total cost of Rp. 10,647,840. on alternative 2 using 3 units of excavators can complete for 96 days with a total cost per day of Rp. 7,985,880.

Keywords: construction, heavy equipment, runway, productivity, operating costs

INTRODUCTION

The construction of Pohuwato Airport is a clear evidence of the Government's concern for Pohuwato Regency, which is one of the tourism destinations in Gorontalo Province. This attention is stated in Government Regulation No. 50/2011 on the National Tourism Development Master Plan 2010-2025, where Pohuwato and its surroundings are designated as a National Tourism Strategic Area that has the potential for the development of National Tourism which has an important

influence in one or more aspects, especially economic, social and cultural growth.

In the construction of this airport there is earthwork, one of which is the excavation of the Runway body to be installed with woven geotextile, which requires the help of heavy equipment Excavator. The purpose of using this excavator is to facilitate work and streamline work time. The selection of heavy equipment must be carried out carefully and precisely so that the effectiveness in its use is optimal, and costs and time can be adjusted.

Equipment is an important factor in construction, particularly in the heavy *and highways segments of the*

construction industry (Day & Benjamin, 1991). There is little doubt that increased efficiency of.

In planning the use of this heavy equipment, a search will be carried out from various alternatives to get more efficient results. Based on this background, the following problems can be formulated:

1. How to get alternative productivity of the number of tools and time of use on the Runway body excavation work?
2. How to calculate the operational cost of each alternative for Runway body excavation work?

METHOD

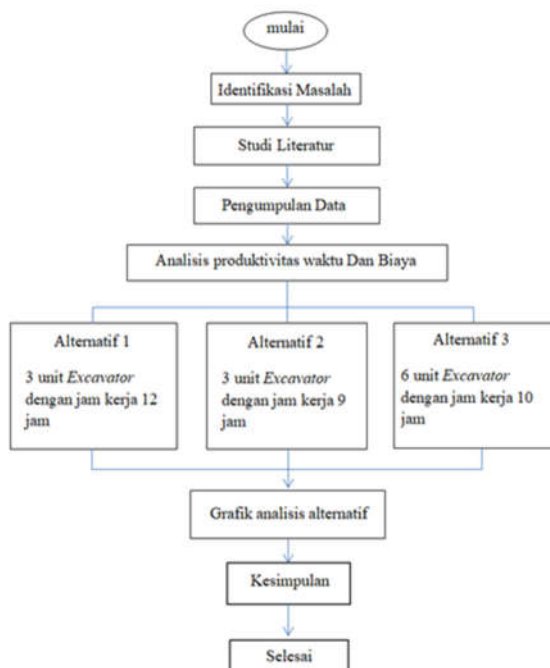


Figure 1 research flowchart

Literature study

Literature study is an activity of collecting, studying, and processing various information and data as a source of this research. The sources are documents, articles, books, and journals related to excavator productivity.

Data Collection

The runway excavation work on this airport construction project has the following supporting data:

1. Layout of Runway body excavation work
2. Curva Target of Runway body excavation work
3. Type of equipment used (excavator pc-200)
4. Unit price of Pohuwato district



Figure 2 2 excavator pc-200

Cost and time analysis

After obtaining supporting data, the next step is to process the data. At the processing stage, the data obtained is calculated, and the results of the data processing can be reused for other data analysis, based on the formulation of the problem. By comparing several alternatives to get the most efficient alternative use with the planned target. Data management is calculated using productivity test calculations and manual calculations, the following is the data to be processed:

a. Calculating the productivity of the Excavator machine, the following data will be used:

- Excavation length : 700,00 m
- Excavation width : 50,00 m
- Existing top elevation : 5,60
- Top elevation of excavation : 4,00
- Excavation thickness : 1,60
- Excavation volume : 56.000 m³
- Implementation time : 12 weeks
- Excavator bucket capacity : 0.9 m³
- Working hours : 12 hours

b. Calculating the total operational cost of heavy equipment Excavator. Here is the data that will be used to calculate the total operational cost:

- Types and specifications of excavator pc-200
- Working hours
- Operator wages
- Fuel per hour

RESULTS

Excavator productivity calculation

a. Original Conditions at the Project Site (Existing)

From the data collection obtained, an alternative analysis can be carried out based on the results of the calculation of the production of each heavy equipment, as well as an analysis of the calculation of heavy equipment rental costs. In the original conditions at the site (existing) heavy equipment is used as many as 2 units of Komatsu PC 200 excavators. The following is a calculation of the productivity of the original conditions at the Project Site (existing):

- Tool Type : komatsu pc-200
- target implementation : 12 weeks
- Soil Type : Ordinary soil
- Working hours : 12 hours
- Bucket Capacity : 0,9 m³
- Load : 24 buckets/hour
- Bucket capacity / hour : $0.9 \times 24 = 21.6 \text{ m}^3/\text{hour}$

To calculate the productivity of the excavator we need the bucket capacity per hour multiplied by the working hours, namely:

$$21.6 \times 12 = 259.2 \text{ m}^3 / \text{day}$$

Furthermore, to know the volume of soil excavation work is needed to find the calculation of time in the use of excavators, the amount of volume and time required in the use of heavy equipment as follows:

Volume of excavation work

- Excavation length = 700.00 m
- Runway body width = 50.00 m
- Top elevation of existing = 5.60
- Top elevation of excavation = 4.00
- Excavation thickness = 1.60 m

$$\text{Volume} = \text{excavation length} \times \text{width} \times \text{excavation thickness} = 700 \times 50 \times 1.60 = 56.000 \text{ m}^3$$

- Excavator usage time calculation

$$\begin{aligned} \text{Production per unit} &= 259.2 \text{ m}^3 / \text{day} \\ \text{Number of excavators} &= 2 \text{ units} \\ &= 259.2 \times 2 \text{ units} \\ \text{Production of 2 units} &= 518.4 \text{ m}^3/\text{day} \\ \text{Excavation volume} &= 56,000 \text{ m}^3 \\ &= (56.000) / 518,4 = 108 \\ &= 108 \text{ days} \\ &= 15 \text{ weeks} \end{aligned}$$

Alternative calculation

a. Alternative 1

In alternative 1, 3 units of Excavator pc-200 are used with working hours of 12 hours with an excavation volume capacity of 56,000 m³.

Excavator Data

$$\begin{aligned} \text{Tool Type} &= \text{komatsu pc-200} \\ \text{Working hours} &= 12 \text{ hours} \\ \text{Bucket Capacity} &= 0.9 \text{ m}^3 \\ \text{Load} &= 24 \text{ buckets/hour} \\ \text{buckets/hour} &= 0.9 \times 24 \\ &= 21.6 \text{ m}^3/\text{hour} \\ &= 21.6 \text{ m}^3 \times 12 \text{ hours} \end{aligned}$$

$$259.2 \text{ m}^3 \text{ per day (production/unit)}$$

$$\begin{aligned} \text{Number of tools (alternative 1)} &= 3 \text{ units} \\ &= 259.2 \times 3 \text{ units} \\ \text{Production of 3 units} &= 777.6 \text{ m}^3/\text{day} \\ \text{Excavation volume} &= 56,000 \text{ m}^3 \\ &= (56.000) / 777,6 = 72 \\ &= 72 \text{ days} \\ &= 10 \text{ weeks} \end{aligned}$$

b. Analysis of alternative 2

In alternative 2, 3 pc-200 units are used with working hours of 9 hours with an excavation volume of 56,000 m³.

Excavator Data

$$\begin{aligned} \text{Tool Type} &= \text{komatsu pc-200} \\ \text{Working hours} &= 9 \text{ hours} \\ \text{Bucket Capacity} &= 0.9 \text{ m}^3 \\ \text{Load} &= 24 \text{ buckets/hour} \\ \text{buckets/hour} &= 0.9 \times 24 = 21.6 \text{ m}^3/\text{hour} \end{aligned}$$

= $21.6 \text{ m}^3 \times 9 \text{ hours} = 194.4 \text{ m}^3 \text{ per day}$
(production/unit)

Number of tools (alternative 2) = 3 units
 $= 194.4 \times 3 \text{ units}$
 Production of 3 units = $583.2 \text{ m}^3/\text{day}$
 Excavation volume = $56,000 \text{ m}^3$
 $= (56.000)/583,2 = 96$
 $= 96 \text{ days}$
 $= 13 \text{ weeks}$

c. Analisis alternative 3

In alternative 3, 6 units of equipment are used with working hours of 10 hours with an excavation volume capacity of $56,000 \text{ m}^3$.

Excavator Data

Tool Type = komatsu pc-200
 Working hours = 10 hours
 Bucket Capacity = 0.9 m^3
 Load = 24 buckets/hour
 buckets/hour = 0.9×24
 $= 21.6 \text{ m}^3/\text{hour}$
 $= 21.6 \text{ m}^3 \times 10 \text{ hours}$

$216 \text{ m}^3 \text{ per day}$ (production/unit)

Number of tools (alternative 3) = 6 units
 $= 194.4 \times 6 \text{ units}$

Production of 6 units = $1,296 \text{ m}^3/\text{day}$
 Excavation volume = $56,000 \text{ m}^3$
 $= (56.000)/1.296 = 43$
 $= 43 \text{ days}$
 $= 6 \text{ weeks}$

Results of productivity analysis

based on the results of the calculation of productivity analysis is distinguished by the number of units and working hours, can be distinguished through the table.

Table 1 calculation result

No.	Analisa	Volume	Unit	waktu Kerja	Produksi (m ³ /hari)	Waktu penyelesaian
1.	Alternatif 1	56000 m^3	3	12	$777,6 \text{ m}^3$	72 hari
2.	Alternatif 2	56000 m^3	3	9	$583,2 \text{ m}^3$	96 hari
3.	Alternatif 3	56000 m^3	6	10	1.296 m^3	43 hari

Based on the calculation, it can be seen the results of the calculation of heavy equipment productivity on the runway excavation project at the Pohuwato airport construction, Gorontalo. With a work volume of 56000 m^3 , alternative data 3 is a more efficient and faster productivity with 6 units of equipment and working hours of 10 hours with a daily production of $1,296 \text{ m}^3$ and can complete within a period of 43 days or 6 weeks. Thus it can be seen that the productivity of alternative 3 is more efficient in time than the existing conditions, this is influenced by the number of units used.

Operating Cost Calculation

a. Costs in existing conditions

Tool rental cost/hour = IDR 195,000/hour
 Number of tools = 2 units
 Working hour = 12 hours
 Volume = 56000 m^3
 Completion time = 108 days

- Total cost of tool rental rental price x working hours x number of tools

$= 195,000 \times 12 \times 2$
 $= \text{Rp } 4,680,000/\text{day}$
 $= 4,680,000 \times 108 \text{ days}$
 $= \text{Rp.}505,440,000 / 15 \text{ weeks}$

- Operational Cost

Operator wages = Rp.200,000/hour
 Operator wages / 2 units = Rp.400,000 / hour
 Fuel cost = Rp.92,320/hour
 Rental cost/hour + operator cost/hour + fuel cost/hour
 $195.000 + 400.000 + 92.320$
 $= \text{Rp. } 687,320/\text{hour}$

Total cost/day = $\text{Rp.}687,320 \times 12 \text{ hours}$
 $= \text{Rp.}8,247,840/\text{day}$

b. Cost of alternative 1

Tool Type : komatsu pc-200
 Rental tool cost/hour : Rp 195,000/hour
 Number of tools : 3 excavator units
 Working hours : 12 hours
 Volume of work : 56000 m^3
 Completion time : 72 days

- Total cost of tool rental rental price x working hours x number of tools

: 195,000 x 12 x 3
 : IDR 7,020,000/day
 : 7,020,000 x 72 days
 : Rp. 505,440,000 / 72 days

- Operation Cost

Operator wages : IDR 200,000/hour
 Operator wages /3 units : Rp.600,000/hour
 Fuel cost : Rp.92,320/hour
 Rental cost/hour + operator cost/hour + fuel cost/hour
 195.000 + 600.000 + 92.320
 : Rp. 887,320/hour
 Total cost/day : IDR 887,320 x 12 hours
 : IDR 10,647,840/day

c. Cost of alternative 2

Tool Type : komatsu pc-200
 Rental tool cost/hour : Rp 195,000/hour
 Number of tools : 3 excavator units
 Working hours : 9 hours
 Volume of work : 56000 m³
 Completion time : 96 days

- Total cost of tool rental rental price x working hours x number of tools

: 195,000 x 9 x 3
 : IDR 5,265,000/day
 : 5,265,000 x 96 days
 : Rp. 505,440,000 / 96 days

- Operation Cost

Operator wages : Rp.200,000/hour
 Operator wages /3 units : Rp.600,000/hour
 Fuel cost : Rp.92,320/hour
 Rental cost / hour + operator cost / hour + fuel cost / hour
 195.000 + 600.000 + 92.320 =
 Rp. 887,320/hour
 Total cost/day : Rp. 887,320 x 9 hours
 : IDR 7,985,880/day

d. Cost of alternative 3

Tool Type: komatsu pc-200

Rental tool cost/hour : Rp 195,000/hour
 Number of tools : 6 excavator units
 Working hours : 10 hours
 Volume of work : 56000 m³
 Completion time : 43 days

- Total cost of tool rental rental price x working hours x number of tools

: 195,000 x 10 x 6
 : IDR 11,700,000/day
 : 11,700,000 x 43 days
 : Rp. 503,100,000 / 43 days

- Operation Cost

Operator wages : Rp.200,000/hour
 Operator wages /6 units : IDR 1,200,000/hour
 Fuel cost : Rp.92,320/hour
 Rental cost/hour + operator cost/hour + fuel cost/hour
 (195.000 + 1.200.000 + 92.320) =
 Rp.1,487,320/hour
 Total cost/day : Rp. 887,320 x 9 hours
 : IDR 14,873,200/day

Operating Cost Analysis Results

In field conditions, the implementation working hours are 12 hours and the completion time is 108 days with a total cost per day of Rp. 8,247,840, while in alternative 1 with a working time of 12 hours is able to complete for 72 days with a total cost per day of Rp. 10,647,840, while in alternative 2 working for 9 hours with a completion time of 96 days with a total cost per day of Rp. 7,985,880, while in alternative 3 with 10 working hours can complete for 43 days with a total cost per day of Rp. 14,873,200.

Table 2 cost calculation result

Uraian	Kondisi existing	Alternatif 1	Alternatif 2	Alternatif 3
	Biaya (Rp)	Biaya (Rp)	Biaya (Rp)	Biaya (Rp)
Biaya/jam	687,320	887,320	887,320	1,487,320
Biaya total/hari	8.247.840	10,647,840	7,985,880	14,873,200

CONCLUSION

a. The productivity calculation found that alternative 3 is the most efficient result by

using 6 Excavator units with working hours of 10 hours with a daily production value of 1,296 m³, from alternative 3 is able to complete work with a volume of 56000 m³ for 43 days or 6 weeks.

- b. The calculation of operational costs obtained in field conditions with 2 excavator units can be completed for 108 days at a total cost per day of Rp. 8,247,840, while in alternative 1 with 3 excavator units can complete for 72 days at a total cost per day of Rp. 10,647,840, while in alternative 2 using 3 excavator units can complete for 96 days at a total cost per day of Rp. 7,985,880, while in alternative 3 with 6 excavator units can complete for 43 days at a total cost per day of Rp. 14,873,200.

ADVICE

- a. Further analysis needs to be done by adding a more varied combination of heavy equipment used with different brands, types and bucket capacities.
- b. It is hoped that further research can reproduce alternatives with different production capacities of heavy equipment, so as to produce efficient work time and costs.

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